United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Arizona Strip District Office
345 East Riverside Drive
St. George, UT 84790-6714

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In reply refer to:
2300 (AZ9100)
AZA-035138

February 2011

Dear Reader:

Attached for your review and comment is the Northern Arizona Proposed Withdrawal Draft Environmental Impact Statement (DEIS) for the Bureau of Land Management (BLM) Arizona Strip District Office. The BLM prepared this document in collaboration with 15 federal, state, local, and tribal cooperators in an effort to provide an objective analysis of the Proposed Action and Alternatives based on the best available science. This DEIS has been prepared on behalf of the Secretary of Interior to inform his decision whether or not to withdraw lands in the vicinity of the Grand Canyon from the Mining Law of 1872. This DEIS was developed in accordance with the National Environmental Policy Act of 1969 (NEPA), the Federal Land Policy and Management Act of 1976, implementing regulations, the BLM's NEPA Handbook (H-1790-1), and other applicable laws and policy.

This DEIS has been prepared in response to the Secretary of the Interior's proposed 20-year withdrawal of approximately 1 million acres of federal mineral estate in northern Arizona from the location of new mining claims under the General Mining Law of 1872 [30 United States Code 22–54]. The planning area consists of approximately 1,010,776 acres of federal mineral estate, which includes about 626,354 acres of public lands managed by the Arizona Strip Field Office, 360,349 acres of National Forest System lands managed by the Kaibab National Forest, 4,284 acres administered by the Arizona State Land Department, and 19,789 acres of private land. As of July 2009, these lands were segregated for up to 2 years from location and entry of new mining claims while the proposed withdrawal is being evaluated. Supporting information for this EIS is available on the project web site at: http://www.blm.gov/az/st/en/prog/mining/timeout.html.

The BLM encourages the public to provide information and comments pertaining to the analysis presented in the DEIS. We are particularly interested in feedback concerning the adequacy and accuracy of the proposed alternatives, the analysis of their respective management actions, and any new resource information that would help the BLM as it analyzes and evaluates the proposed withdrawal. In developing the final EIS, which is the next phase of the NEPA process, the Secretary may identify a preferred alternative that is a combination or minor variation of the management actions analyzed in the alternatives in the DEIS for the purposes of creating a strategy that best meets the needs of the resources and values in this area under the BLM multiple-use, sustained-yield mandate (the Forest Service is governed by identical principles under the National Forest Management Act of 1976). As a member of the public, your timely comments on the Northern Arizona Proposed Withdrawal DEIS will help formulate the Final EIS. Comments will be accepted for forty-five (45) calendar days following the U.S. Environmental Protection Agency's publication of its Notice of Availability in the *Federal Register*. The BLM can best use your comments and resource information submissions if received within the review period.

Comments may be submitted electronically to: azasminerals@blm.gov. Comments may also be submitted by mail to: Northern Arizona Proposed Withdrawal Project, ATTN: Scott Florence, District Manager, Bureau of Land Management Arizona Strip District Office, 345 East Riverside Drive, St. George, UT

84790-6714. To facilitate analysis of comments and information submitted, we strongly encourage you to submit comments in an electronic format.

Your review and comments on the content of this document are critical to the success of this NEPA process. If you wish to submit comments on the DEIS, we request that you make your comments as specific as possible. Comments will be more helpful if they include suggested changes, additional sources, or alternate methodologies, and if they reference a section or page number.

In order to be considered and to merit a written response, comments must be in writing (paper or electronic format), substantive, and timely. Substantive comments do one or more of the following:

- question, with reasonable basis, the accuracy of information in the DEIS.
- question, with reasonable basis, the adequacy of, methodology for, or assumptions used for the environmental analysis.
- present valid new information relevant to the analysis.
- present reasonable alternatives other than those analyzed in the DEIS.
- cause changes or revisions in one or more of the alternatives.

Comments that are not substantive generally contain only opinion or preferences, but will be considered and included as part of the decision-making process. They will not, however, receive a formal response from the BLM. Comments that are not considered substantive include the following:

- comments in favor of or against the Proposed Action or alternatives that do not include reasoning that meets the criteria listed above.
- comments that only agree or disagree with BLM policy or resource decisions and that do not include justification or supporting data that meet the criteria listed above.
- comments that do not pertain to the project area or the project.
- comments that take the form of vague, open-ended questions.

Before including your address, phone number, e-mail address, or other personal identifying information in your comment, please be advised that your entire comment, including your personal identifying information, may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Public meetings to provide an overview of the document, respond to questions, and take public comments will be announced by local media, website, and/or public mailings at least 15 days in advance. Public meetings are currently scheduled to be held the week of November 29–December 3, 2010, in Phoenix, Flagstaff, and Fredonia, Arizona, and Salt Lake City, Utah.

Copies of the DEIS have been sent to affected federal, state, and local government agencies and American Indian tribes, many of whom have been involved either as cooperating or consulting agencies. Copies of the DEIS are available for public inspection at the BLM Arizona Strip District Office at the above address, as well as at the following BLM and Forest Service offices:

BLM Arizona State Office, One N. Central Ave., Suite 800, Phoenix, AZ 85004

BLM Phoenix District Office, 21605 N. 7th Ave, Phoenix, AZ 85027

BLM Utah State Office, 440 W. 200 S. Suite 500, Salt Lake City, UT 84145

USFS Tonto National Forest, 2324 E. McDowell Rd., Phoenix, AZ 85006

USFS Kaibab National Forest, 800 S. 6th St.,Williams, AZ 86046
USFS Kaibab National Forest, 430 S. Main St., Fredonia, AZ 86022
USFS Coconino National Forest, 1824 S. Thompson St., Flagstaff, AZ 86001

In addition, the DEIS can be viewed at libraries in the following locations:

Wiliams Public Library, 113 1st St., Williams, AZ 86046
Fredonia Public Library, 118 N Main St, Fredonia, AZ 86022

You may also access the document on the Internet at:

http://www.blm.gov/az/st/en/prog/mining/timeout.html

Thank you for your continued interest in the Northern Arizona Proposed Withdrawal. We appreciate the information and suggestions you contribute to the EIS process. For additional information or clarification regarding this document or the EIS process, please contact: Chris Horyza, Project Manager, telephone 602-417-9446; Bureau of Land Management, Arizona State Office, One North Central Avenue, Suite 800, Phoenix, AZ 85004; email chris_horyza@blm.gov.

Sincerely,

Scott R. Florence

Scott R. Florence, Arizona Strip District Manager
Bureau of Land Management

ENVIRONMENTAL IMPACT STATEMENT

Northern Arizona Proposed Withdrawal

U.S. Department of the Interior
Bureau of Land Management
Arizona Strip District Office
St. George, Utah
February 2011

Lead Agency: U.S. Department of the Interior, Bureau of Land Management

Type of Action: (X) Draft ( ) Final

Cooperating Agencies: U.S. Forest Service; Kaibab National Forest
National Park Service; Grand Canyon National Park
U.S. Fish and Wildlife Service
U.S. Geological Survey
Arizona Game and Fish Department
Arizona Geological Survey
Arizona Department of Mines and Mineral Resources
Arizona State Land Department
Hualapai Tribe
Kaibab Band of Paiute Indians
Coconino County, Arizona
Mohave County, Arizona
Kane County, Utah
San Juan County, Utah
Washington County, Utah

Responsible Official: The Honorable Ken Salazar, Secretary of the Interior

For Further Information Contact: Scott Florence
District Manager
BLM Arizona Strip District
(435) 688-3200

Abstract

This Draft Environmental Impact Statement (EIS) documents the analysis of potential environmental impacts of the Secretary of the Interior's proposed 20-year withdrawal of approximately 1,010,776 acres of federal mineral estate in northern Arizona from the location and entry of new mining claims under the General Mining Law of 1872 [30 United States Code 22–54]. This federal mineral estate includes approximately 626,354 of public lands managed by the Bureau of Land Management (BLM) Arizona Strip Field Office, 360,349 acres of National Forest System lands managed by the Kaibab National Forest, 4,284 acres administered by the Arizona State Land Department, and 19,789 acres of private land. The Notice of Intent to prepare this EIS was published in the *Federal Register* on August 26, 2009.

This Draft EIS describes the physical, biological, cultural, historic, tribal, and socioeconomic resources in and around the proposed withdrawal parcels. The Draft EIS considers the impacts of four alternatives,

including changing the configuration and acreage of the withdrawals and not implementing the withdrawal at the close of the current 2-year segregation (the “No Action” Alternative). The focus for the impact analysis was based on resource issues and concerns identified during public scoping conducted for the proposed withdrawal and by BLM and other agency land managers and resource specialists. Recent concerns related to uranium exploration and development include impacts on surface and groundwater, cultural resources, air quality, wildlife, vegetation, recreation, wilderness areas, public health and safety, visual resources, and soundscapes. Other resource area concerns identified by the interdisciplinary team include tribal resources; social resources and economics; greenhouse gas emissions, ozone, and climate change; and cumulative impacts related to current uranium mining operations and other proposed development within and in the vicinity of the Grand Canyon watershed.

EXECUTIVE SUMMARY

INTRODUCTION

On July 21, 2009, the Department of the Interior published notice of the Secretary of the Interior (Secretary) Ken Salazar's proposal to withdraw (proposed withdrawal) approximately 1 million acres of federal locatable minerals in northern Arizona from the location of new mining claims under the Mining Law of 1872 [30 United States Code (USC) 22–54] (Mining Law), subject to valid existing rights. The withdrawal was proposed in response to increased mining interest in the region's uranium deposits, as reflected in the number of new mining claim locations, and concern over potential impacts of uranium mining on the Grand Canyon watershed, adjacent to Grand Canyon National Park (the Park).

The Northern Arizona Proposed Withdrawal Environmental Impact Statement (EIS) is being prepared to provide guidance to the Secretary in deciding upon this withdrawal. This document represents many months of concerted efforts on the part of experts, specialists, and representatives of the Bureau of Land Management (BLM) Arizona State Office, Arizona Strip District Office and Arizona Strip Field Office; Kaibab National Forest; Grand Canyon National Park; and multiple other federal, tribal, state, and local agencies. Any of the action alternatives outlined in the tables that follow, as a distillation of the combined thought, effort, and research from all those involved, will enable the Secretary to decide the appropriateness of withdrawal to protect the Grand Canyon watershed from adverse effects of locatable mineral exploration and development.

Currently, approximately 1,010,776 acres of federal mineral estate are segregated from entry under the Mining Law and are divided into three parcels. The three proposed withdrawal parcels border Grand Canyon National Park. They are all rich in natural and cultural resources and are intricately connected to the watershed of the Grand Canyon. The North Parcel comprises approximately 554,124 acres, the South Parcel approximately 134,454 acres, and the East Parcel approximately 322,198. Approximately 27,775 acres of non-federal surface are located within the three segregated parcels. Both the current segregation and the proposed withdrawal from location and entry under the Mining Law apply only to public domain federal mineral estate, including federal mineral estate underlying non-federal surface lands. Neither the current segregation order nor the proposed withdrawal apply to non-federal mineral estate or to leasable or salable minerals (e.g., oil and gas leasing, sand and gravel permits), which are not subject to appropriation under the Mining Law. The proposed withdrawal is subject to valid existing rights that are determined to exist on those mining claims located prior to July 21, 2009, the date the lands were segregated from location and entry under the Mining Law by the publication of the notice of proposed withdrawal in the *Federal Register*.

PURPOSE AND NEED

The purpose of preparing the Northern Arizona Proposed Withdrawal EIS is to provide guidance to the Secretary in deciding upon this withdrawal. The Proposed Action analyzed in this document is the withdrawal of minerals in approximately 1,010,776 acres near Grand Canyon National Park from location and entry under the Mining Law for 20 years. The underlying purpose of the Proposed Action is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the segregated area.

The need for the preparation of the EIS has been established by three factors: the Secretary's proposed withdrawal, the lasting impacts of some of the historic hardrock mining activities in the Grand Canyon watershed, and the concern that these historical impacts and the recent increase in the number and extent of mining claims in the area could have adverse effects on resources within the human environment.

PUBLIC ISSUES AND MANAGEMENT CONCERNS IDENTIFIED DURING SCOPING

The most important step in the process of developing this EIS has been the identification of relevant issues and concerns. An issue is defined as an opportunity, conflict, or problem regarding the use or management of federally managed lands. The formal public scoping process began on August 26, 2009, with the *Federal Register* publication of a Notice of Intent to prepare an EIS for a proposed withdrawal. By the end of the formal scoping period, the BLM had received a total of 83,525 comment submittals. All comments received for this scoping effort were assigned, based on content, to one of nine preliminary concerns categories. Individual comments were then assigned to one of 25 resource categories on the basis of the overall theme of the comment. Comments were received concerning the proposed withdrawal as well as concerning exploration and development activity.

Air Quality

Concerns for air quality in the area of the Grand Canyon include potential impacts from uranium mining, including fugitive dust from vehicular travel associated with mines, and emissions from exploration and development activity, including greenhouse gas emissions.

Alternatives

The range of alternatives developed for the EIS should reflect the expressed interest in limited withdrawal options that would protect sensitive resources, but also keep exploration and development activity open yet restricted to areas relatively close to the communities that support mine development.

Cultural and American Indian Resources

The project area is very rich in cultural and American Indian resources, including Traditional Cultural Properties, sacred and traditional sites, and historic and archaeological resources. Protection of these resources was considered in the development of alternatives for the EIS.

Aquatic Wildlife

Concerns for aquatic wildlife include potential impacts of mineral exploration and development on fish habitat surrounding the Park as well as potential impacts on water quality of surface waters in the region and the implications for aquatic species within those waters.

Cumulative Impacts

The potential for cumulative impacts in the project area extends from legacy exploration and development activity into future mine development and may include both beneficial and adverse impacts on resources such as water, sensitive species, soils, air quality, vegetation, wildlife, human health, and cultural resources.

Economic Conditions and Values

The economic condition of the project area is a considerable issue and concern. The EIS should consider general economic trends in the area, including employment, revenue generated by tourism and mineral exploration and development activity, and development in and around federal lands and how these trends may be impacted by any alternative selected.

Environmental Justice

Environmental justice, identified as disproportionate impacts to low-income and minority populations, is an issue within the project area, especially with regard to the American Indian tribes and others living in the area.

Health and Safety

Human health and safety issues have the potential to affect local residents, visiting and recreating public, and employees involved with uranium exploration and mining. Concerns for health and safety include exposure to radiation, miner safety, hazardous/toxic wastes, and potential contamination of area resources.

Lands

The proposed withdrawal area includes 986,703 acres of federal locatable minerals underlying public (BLM) land and National Forest System lands and 24,073 acres of federal locatable minerals underlying non-federal surface. Federal lands in the immediate vicinity of the proposed withdrawal include Grand Canyon National Park as well as two national monuments, a national recreation area, and four American Indian reservations. Issues regarding lands include multiple use and resource protection concerns for federal lands proposed for withdrawal as well as potential impacts on surrounding lands, both federal and non-federal.

Laws and Policies

Mining operations must comply with a variety of environmental and mining laws, including the 1872 Mining Law and BLM and Forest Service management plans. Compliance with federal law (including the National Environmental Policy Act [NEPA]), regulations, and policies and consideration of state and local statutes should be paramount in the development of the EIS.

Minerals

Issues regarding minerals, including the number of claims, quality of the mineral deposits, locatable mineral exploration and development activities, valid existing rights, and revenues associated with minerals, should be considered in the EIS.

Miscellaneous

Miscellaneous concerns that arose during scoping included requests for public involvement and full disclosure of the controversy surrounding the proposed withdrawal, as well as requests for an announcement of either support for or opposition to the proposed withdrawal and to uranium mining itself.

Natural Environment

Concern for the natural environment and the local and regional ecosystems in and near the proposed withdrawal area is a driving concern behind the proposed withdrawal.

Natural Resources

The proposed withdrawal area is rich in natural resources, including mineral and biological resources. Biological resources include timber, non-timber vegetation, and grazing range. Protection and development of these resources needs to be considered in the development of alternatives for the EIS.

Noise

Noise issues, such as the preservation of natural quiet soundscapes, include concerns about auditory intrusions into Grand Canyon National Park from machinery and equipment associated with uranium exploration and development.

Persons and Groups Affected

Groups affected by the proposed withdrawal include the BLM, U.S. Forest Service (Forest Service), National Park Service (NPS), and U.S. Environmental Protection Agency (EPA); state, local, and tribal governments; business and industrial organizations; and environmental groups such as the Center for Biological Diversity. Persons affected include local citizens, including tribal members, the touring and recreating public users, and citizens both national and international.

Recreation

Recreation concerns regarding the proposed withdrawal include access and value issues for both dispersed and developed recreation, personal recreation experiences, and illegal access by motorized recreation.

Social Conditions and Values

Issues related to social conditions include quality of life and well-being of local residents, the visiting public, and mine workers. Social values considered in the development of the EIS should include impacts on American Indian communities and lifeways, the preservation of natural and cultural resources for future generations, and impacts on the national heritage of the area.

Species of Concern

Issues associated with species of concern include the potential for exploration and mining to impact habitat for species of concern as well as individuals within populations. Specific species include California condors, black-footed ferrets, and Gunnison's prairie dogs.

Soils and Geology

Issues related to soils and geology also include concerns for paleontological resources. Other concerns considered in the EIS are the potential for the loss of topsoil and soil contamination from mineral exploration and development activities.

Transportation

Issues related to transportation include access road construction, vehicular traffic supporting mineral exploration and development, and conflicts between industrial and recreational vehicle activity.

Vegetation

Issues related to vegetation include concerns about the potential increase in noxious and invasive weeds, the loss of vegetation as wildlife habitat, and the general loss of vegetation through mineral exploration and development activity.

Visual Resources

The proposed withdrawal area is rich in scenic resources, including the vistas of the Grand Canyon. Issues related to visual resources include impacts on the scenic quality from mineral exploration and development activity, as well as concerns for visibility within the area.

Water Resources

Water resources addressed in scoping include ground and surface waters of the Grand Canyon watershed. Issues related to water resources include concerns about water quality and quantity, including contamination and/or depletion from uranium exploration and development activity, and potential impacts on riparian resources.

Wildlife

Issues related to wildlife include potential impacts on all wildlife species from exploration and development activities, as well as concerns about wildlife tolerance of contaminants that could result from the activities. Specific concerns were raised regarding impacts on game species, including mule deer, pronghorn, and turkeys, and impacts on game birds and migratory birds.

ALTERNATIVES

Alternatives are the heart of the EIS, as they present other possible courses of action that could achieve the underlying purpose of and need for action to which the agency is responding. In this case, the underlying purpose of and need for action is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of locatable mineral exploration and development that could occur in the area. Alternatives must meet the purpose and need; be reasonable; provide a mix of resource protection, use, and development; be responsive to the issues; and meet the established planning criteria. Each action alternative is a withdrawal that provides a framework for multiple use management within the management area. Under all alternatives, federal land will be managed in accordance with all applicable laws, regulations, and agency policy and guidance.

Comparison of Key Alternative Components

Proposed Withdrawal Parcel	Alternative A No Action Area Open under the Mining Law	Alternative B Proposed Action 20 Years ~1 Million Acres Withdrawn		Alternative C Partial Withdrawal 20 Years ~700,000 Acres Withdrawn		Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn	
North	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	523,922	BLM	334,724	BLM	101,797
		FS*	7,919	FS	7,919	FS	7,919
		State	4,204	State	4,204	State	801
		Private	18,079	Private	9,249	Private	681
East	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	102,432	BLM	65,125	BLM	31,444
		FS	31,273	FS	24,359	FS	24,359
		State	0	State	0	State	0
		Private	749	Private	749	Private	429
South	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	0	BLM	0	BLM	0
		FS	321,157	FS	205,616	FS	132,764
		State	80	State	80	State	80
		Private	961	Private	961	Private	407
Total Acres of Federal Locatable Mineral Estate to Be Withdrawn:	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	626,354	BLM	399,849	BLM	133,241
		FS	360,349	FS	237,894	FS	165,042
		State	4,284	State	4,284	State	881
		Private	19,789	Private	10,959	Private	1,517
		Total:	**1,010,776**	**Total:**	**652,986**	**Total:**	**300,681**

* FS = Forest Service.

Alternative A, the No Action Alternative: the proposed withdrawal would not be implemented and the proposed withdrawal area would remain open to location and entry under the Mining Law. New mining claims could be located, and exploration and mine development proposals would continue to be processed by the BLM or the Forest Service. This alternative serves as the baseline for measuring the impacts of the other action alternatives and reflects the current management situation for all federal land currently under segregation.

Alternative B, the Proposed Action: the proposed withdrawal would be implemented and the entire 1,010,776 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. 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.

Alternative C, Partial Withdrawal: 652,986 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw a large proportion of those areas, identified by analysis, having concentrations of cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development. Alternative C would leave the remaining portion of the proposed withdrawal area with isolated or lower concentrations of these resources open to operation of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

Alternative D, Partial Withdrawal: 300,681 acres of federal locatable mineral estate within the three parcels would be withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. This alternative would withdraw areas, identified by analysis, where there is a relatively high concentration of cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development (see also 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 relatively low concentrations of these resources open to operation of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

PUBLIC INVOLVEMENT

The BLM decision-making process is conducted in accordance with the requirements of the National Environmental Policy Act of 1969, Council on Environmental Quality regulations, and Department of the Interior and BLM policies and procedures implementing NEPA. NEPA and the associated regulatory and policy framework requires that all federal agencies involve interested groups of the public in their decision-making, consider reasonable alternatives to proposed actions, and prepare environmental documents that disclose the potential impacts of proposed actions and alternatives. Public involvement, consultation, and coordination have been at the heart of the planning process leading to this EIS. This was accomplished through public meetings, alternative means of comment submittal, news releases, a planning web site, and *Federal Register* notices.

The scoping process used for this EIS was initiated by publication of a Notice of Intent in the *Federal Register* on August 26, 2009. The formal period for submitting scoping comments was from August 26, 2009, through October 30, 2009, although scoping does not end until the EIS is completed.

The BLM hosted two public meetings, one in Fredonia, Arizona, and one in Flagstaff, Arizona, in September and October 2009, respectively. Pursuant to NEPA requirements, the scoping meetings were advertised in a variety of formats, beginning at least 2 weeks prior to their scheduled dates. In each format, the advertisements provided logistics and explained the purpose of the public meetings, gave the schedule for the public comment, outlined additional ways to comment, and provided methods for obtaining additional information.

The meetings were conducted in an open house format designed to allow attendees to view informational displays, ask specialists about the Proposed Action and the EIS process, and submit written or verbal comments on-site. Meeting attendees were invited to sign in upon entering and were provided with handouts and informed of the meeting format and how to comment at the meeting. Comments from the public were collected during the scoping meetings and throughout the scoping period through a variety of methods, including postal mail, fax, and electronic mail.

AFFECTED ENVIRONMENT

Air Quality and Climate

The proposed withdrawal parcels are designated Class II areas for criteria pollutants. One federally designated Class I area, the Grand Canyon National Park, borders the proposed withdrawal parcels (see Figure 3.2-1 in Section 3.2). There are several other Class I and II areas in close proximity to the proposed withdrawal parcels. The proposed withdrawal parcels are classified as being in attainment for all criteria pollutants.

The air quality resource condition indicators likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the quantity of hazardous air pollutants emitted to the atmosphere; comparison of the maximum criteria pollutant concentrations with the National Ambient Air Quality Standards; comparison of the maximum criteria pollutant concentrations with the Prevention of Significant Deterioration air quality increments; greenhouse gas emissions; and air quality related values relative to visibility.

Cultural Resources

Cultural resources are physical phenomena associated with past or present cultures and include archaeological sites and historic buildings and structures, as well as places of traditional religious and cultural importance. Cultural resources refer to both humanmade and natural physical features associated with human activity and, in most cases, are finite, unique, fragile, and nonrenewable. The proposed withdrawal parcels contain unique and distinctive resources that represent several themes important to history and prehistory. A Class I inventory of all known cultural resources within the three parcels was conducted to determine the nature of site type and distribution. Within the three parcels, 461 sites have been evaluated and recommended eligible for the National Register of Historic Places (NRHP); 12 sites have already been listed. To date, 201 sites have been determined ineligible for the NRHP; 1,981 sites have not yet been evaluated with respect to NRHP eligibility status.

Resource conditions indicators for cultural resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the number of known historic properties (historic and prehistoric) to be affected, the number of acres to be disturbed by mineral exploration and development, the changes in settings or visual qualities that contribute to the integrity of cultural resource sites (evaluated qualitatively), and the degree to which reclamation practices can be used to restore the settings of sites.

American Indian Resources

American Indian resources refer to places regarded as important to American Indian cultures and traditions. These places may be individual landforms or large landscapes; they may be associated with sacred beings or ancestors, places where people came and still come to hunt game or gather plant resources, or archaeological sites. Known American Indian resources within the proposed withdrawal area include cultural landscapes; rivers, creeks, and springs; known activity areas; and trails and subsistence areas. Data on important places within the withdrawal parcels are presently available for the following American Indian groups: Southern Paiute (Las Vegas Paiute Tribe, Kaibab Band of Paiute Indians, Moapa Band of Paiute Indians, Pahrump Paiute Indian Tribe, Paiute Tribe of Utah, which includes the Shivwits Band of Paiute, and San Juan Southern Paiute Tribe), Havasupai Indian Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe, and Pueblo of Zuni.

Resource condition indicators for cultural landscapes and places are not easily definable or quantifiable. Some possible indicators include the proximity of traditional use areas to anticipated mineral exploration and development activity, the likelihood of concurrent or overlapping timing of traditional activity with mineral exploration and development activity, the manner and degree of auditory or visual disruptions in the traditional use area, and the number or acres of key springs, plants, or traditional use items lost or damaged as a result of exploration and development activity.

Economic Conditions

Economic conditions include population and demographics; employment, unemployment, and personal income; industry and economy; taxes and revenues; and mineral and recreation economics. Mineral exploration and development activities; construction, operation, and maintenance of proposed uranium mine facilities; and/or the proposed withdrawal of mineral estates and the associated reduction in mineral exploration and development activity all have the potential to impact economic conditions resources within the study area.

Resource condition indicators for economic conditions likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the value of energy produced from study area and the equivalent amount of other energy-producing commodity represented by uranium production; visitor use days and value per visitor use days to tourist destinations, primarily Grand Canyon National Park but also National Forest System and BLM lands; number of persons in the region directly and indirectly employed by the uranium mining industry; local and state revenue from property and income taxes directly tied to uranium mining activity; and number of haul trips anticipated on major public use roads over the next 20 years; the required maintenance level on public roads systems used for mineral operations; and the net change in funding available for road maintenance.

Fish and Wildlife

The greater Colorado Plateau ecoregion supports a wide variety of terrestrial and aquatic wildlife species. With the exception of Kanab Creek on the Kaibab Plateau, perennial aquatic systems and associated riparian habitats are extremely rare within the proposed withdrawal area; therefore, fish and riparian-dependent wildlife species are naturally limited. Aquatic and riparian habitats are relatively abundant, however, immediately adjacent to the proposed withdrawal parcels along the Colorado River, seeps and springs, and associated drainages in Grand Canyon National Park.

Within the proposed withdrawal area, there are 14 associated bird species, 18 small-mammal species, including 13 bat species, nine fish species, five large-mammal species, eight reptile or amphibian species, and six invertebrate species. These include general wildlife species as well as species of special concern.

Resource condition indicators for fish and wildlife likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and chemistry at aquatic sites); and the influence of these habitat changes on the reproductive success, population size, health, and diversity of organisms.

Geology and Mineral Resources

The proposed withdrawal area lies within the Colorado Plateau physiographic province. The primary economic mineral resource within the proposed withdrawal area consists of locatable mineral deposits, including both stratabound deposits and breccia pipe deposits. Stratabound deposits were studied and considered small and unattractive for commercial development. All other locatable deposits are associated entirely with breccia pipes. The uranium deposits within the northern Arizona breccia pipes are of higher grade than approximately 85% of the world's known uranium deposits. The lands within the proposed withdrawal area are considered to have a high potential for uranium with a high level of certainty.

Resource condition indicators likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the 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 percent of known domestic resources, current domestic demand, and current domestic production; depletion of uranium resources within withdrawal area; amount of uranium mined as percent of global demand and production; and cumulative amount of high potential uranium resources lands withdrawn from exploration and development.

Recreation

Recreation activities occurring throughout the proposed withdrawal area involve a broad spectrum of pursuits, ranging from dispersed and casual recreation to organized, BLM-permitted and Forest Service–permitted group uses. The Arizona Strip is known for its large-scale undeveloped areas and remoteness. Typical recreation in the region includes off-highway vehicle driving, scenic driving, hunting, hiking, wildlife viewing, horseback riding, camping, backpacking, mountain biking, geocaching, picnicking, night-sky viewing, and photography. The area's proximity to the globally recognized Grand Canyon enables large numbers of U.S. residents and foreign visitors to access the public lands conveniently.

Resource condition indicators for recreation resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include visitor use by activity and desired recreation experiences, acres within the BLM Recreation Opportunity Spectrum designation, and the miles, acres, or number of recreation sites that are currently designated in the proposed withdrawal area.

Social Conditions

The six-county socioeconomics study area for this EIS covers more than 46,000 square miles in northern Arizona and southern Utah. Other than a handful of towns and cities in each county, the study area is relatively remote and sparsely populated. Population centers in Coconino and Mohave counties are generally located south of the proposed withdrawal area. With the exception of tribal communities located along travel routes, communities in the area tend to be located far from major transportation corridors and industrial centers, and in general the small towns and communities within the counties have maintained their rural character. American Indians who live within the study area reside predominantly in Coconino County and form part of the Navajo Nation, Hopi Tribe, Hualapai Tribe, Havasupai Indian Reservation, and Kaibab Band of Paiutes. Some of the Navajo Nation chapters in the area include Cameron, Bodaway, Tuba City, and LeChee. Hopi chapters in Coconino County include Moenkopi and West Dinnebito.

Mineral exploration activities; construction, operation, and maintenance of proposed uranium mine facilities; and/or the proposed withdrawal of mineral estates and the associated reduction in mineral exploration and development activity have the potential to affect social condition resources. Resource condition indicators for social conditions likely to be affected as a result of exploration and development activities in the proposed withdrawal parcels include demographics, stakeholder values, public health and safety, and environmental justice.

Soils

Soil types within the three proposed withdrawal parcels vary widely, reflecting differences in the environmental and geomorphic conditions under which soils were formed and differences in parent materials. The dominant soil orders that occur in the proposed withdrawal parcels are Alfisols, Aridisols, Entisols, and Mollisols. Resource condition indicators for soil resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include soil physical properties, soil erosion, and soil chemical quality.

Soundscapes

All three of the proposed withdrawal parcels border Grand Canyon National Park. The area is naturally quiet and generally not subject to modern sources of unnatural sound intrusion or noise. The Grand Canyon National Park Enlargement Act of 1975 established that natural quiet should be protected as a resource and value to the Park. Natural quiet, defined as the level of all natural sounds in an area, excluding all mechanical, electrical, and other human-caused sounds, is the baseline sound level used for this analysis.

Special Status Species

Special status species within the proposed withdrawal area include 1) species listed or being considered for listing by the U.S. Fish and Wildlife Service; 2) BLM Sensitive species; 3) Forest Service Sensitive species; 4) NPS species of concern; and 5) Arizona Game and Fish Department species of greatest conservation need. There are 10 federally listed plant species, one mammal species, seven bird species, five amphibian or reptile species, and five fish species. In addition to these, the BLM lists 14 plant species, eight mammal species, three amphibian or reptile species, four fish species, one bird species, and three invertebrate species as Sensitive. The Forest Service Sensitive species list adds three plant species, seven mammal species, two bird species, and one reptile species to the tally. The Arizona Game and Fish Department list one additional fish species and 10 bird species as being species of greatest conservation need.

In addition to the resource condition indicators for fish and wildlife, resource condition indicators for special status species include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and chemistry at aquatic sites), which affect overall species health and abundance, as well as potential impacts to (modification or destruction of) designated critical habitat.

Vegetation Resources

More than 300 plant species are endemic to the Colorado Plateau and the Colorado Plateau provides habitat for numerous vertebrates, many of which are identified as “species of greatest conservation need” by the Southwest Regional Gap Analysis Project. In addition, several plant species are listed as federally protected species. Vegetation communities in the proposed withdrawal parcels include riparian, Great Basin Grassland, Great Basin Desertscrub, Great Basin Conifer Woodland, and Petran Montane Conifer Forest.

Resource condition indicators for vegetation resources likely to be affected as a result of the exploration and development activities in the proposed withdrawal parcels include the amount of disturbance resulting in loss of vegetation, change in productivity, loss of diversity; degree of infestation of invasive species, degree and amount of fragmentation, degree and amount of contamination, and loss of water resources for vegetation.

Visual Resources

Visual resources are the visible physical features on a landscape and may include land, water, vegetation, animals, structures, and other features. The combination of these physical features creates scenery and provides an overall landscape character. The proposed withdrawal area is internationally recognized for its diverse landscapes and scenic qualities and offers many developed and dispersed backcountry recreation opportunities for sightseeing, wildlife viewing, and on-road touring.

Resource conditions indicators for visual resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include consistency with and conformity to designated BLM Visual Resource Management class objectives; consistency with and conformity to Forest Service scenic quality management or integrity objectives; consistency with and conformity to Park visual objectives from key viewpoints within the Park; and qualitative analysis of the potential changes to the darkness of the night sky in the proposed withdrawal parcels and Grand Canyon National Park.

Water Resources

The study area for the water resources analysis includes local surface water drainage areas and groundwater basins that could potentially be impacted by reasonably foreseeable activities in the three proposed withdrawal parcels. Except for the main stem of the Colorado River, virtually all of the perennial surface water base flow in the study area, including the base flow for the Little Colorado River, is supported solely by flow from springs and seeps. Groundwater moves from areas of recharge to areas of discharge. In the study area, groundwater recharge occurs from infiltration of precipitation and ephemeral stream flow.

Resource condition indicators for water resources likely to be affected as a result of mineral exploration and development activities in the proposed withdrawal parcels include the quantity and quality of water discharge at springs that issue from perched groundwater zones that may be affected by operations at nearby mine sites, quantity and quality of water discharge at springs that issue from the regional R-aquifer system that may be depleted by operations at mine sites, and the quantity and chemical quality of receiving surface waters.

Wilderness

Designated wilderness areas are, by designation, withdrawn from mineral entry. There is one wilderness area adjacent to the North Parcel: Kanab Creek. There are two wilderness areas adjacent to the east parcel: Paria Canyon–Vermilion Cliffs and Saddle Mountain. There are no wilderness areas adjacent to the South Parcel. These wilderness areas currently provide a standard of solitude and naturalness that ranges from good to outstanding. They contain little to no evidence of surface disturbance, other than former vehicle ways and scattered prospects. The basic resource condition indicators used to characterize wilderness are those indicators that reflect the wilderness characteristics that supported the designation. Resource condition indicators for wilderness likely to be affected as a result of the exploration and development activities in the proposed withdrawal parcels include changes in or to the wilderness characteristics of naturalness, opportunities for solitude, and opportunities for primitive and unconfined recreation.

ENVIRONMENTAL CONSEQUENCES

Impacts on Air Quality

Under all alternatives, pollutants would be emitted into the atmosphere during the mine operation activities. The amount of pollutants emitted would depend on the level of mineral exploration and development activity under each alternative. Modeling results demonstrate that plume impacts from a typical mining operation are below absolute contrast value but exceed the contrast limit (i.e., ΔE). Current governing laws and regulations would require any future exploration and development activities to demonstrate that the proposed activity would not impact Class I areas such as Grand Canyon National Park, and a Level 2 analysis would be required to determine potential impacts on the Park.

Impacts on Cultural Resources

Under all alternatives, there would be no direct impacts to the disturbance of historic and prehistoric sites, assuming that direct impacts on sites by individual projects are mitigated through established regulations and policies. Under current regulations and policies, any proposed project would require an individual assessment of the impacts to cultural resources and mitigation of impacts if necessary. The primary mitigation measure for both the BLM and Forest Service would be avoidance. If direct impact mitigation is not possible, *Alternative A* would have a major direct impact on all parcels; *Alternative B* would have a major direct impact on the North Parcel, no direct impact on the East Parcel, and a minor direct impact on the South Parcel; *Alternative C* would have a major direct impact on the North and East parcels and a minor direct impact on the South Parcel; and *Alternative D* would have a major direct impact on all parcels. All alternatives would have minor short-term indirect impacts to historic and prehistoric sites as a result of visual and auditory impacts to the sites.

Impacts on American Indian Resources

There are no tribal trust resources or assets within the proposed withdrawal area; however, all alternatives could result in long-term indirect impacts of unknown magnitude on Havasupai Springs, which is located outside the proposed withdrawal area. The types of known resources for traditional cultural practices and uses in the proposed withdrawal area include landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, and camps. *Alternative A* would have a major long-term direct impact on resources on all three parcels including disturbance to a Traditional Cultural Place, minor short-term visual and auditory (indirect) impacts, and major long-term visual impacts from power lines. *Alternative B* would have major long-term direct impacts to resources on the North Parcel, no direct impacts on resources in the East Parcel, minor long-term direct impacts on the South Parcel, minor long-term visual and auditory (indirect) impacts on the North and South parcels, and major long-term visual impacts from power lines on the North and South parcels. *Alternative C* would have major long-term direct impacts on resources on the North and East parcels in areas excluded from withdrawal, minor long-term direct impacts on the South Parcel, minor long-term visual and auditory (indirect) impacts on all three parcels, and major long-term visual impacts from power lines on the North and South parcels. Since the majority of resources would be outside the withdrawal boundaries, *Alternative D* would have major long-term direct impacts to resources on all three parcels, including disturbance to a Traditional Cultural Place, minor short-term visual and auditory (indirect) impacts on all three parcels, and major long-term visual impacts from power lines on all three parcels.

Impacts on Economic Conditions

Overall regional tourist activity and associated employment within the proposed withdrawal area would not be affected under all alternatives. Mining companies would be responsible for maintenance of unpaved public roads used to haul ore under all alternatives, resulting in no impact to road condition and maintenance. *Alternative A* would result in beneficial moderate to major long-term impacts to economic activity from mineral development because of the potential economic value of uranium mined of $2.9 billion and direct industry employment total of $613.7 million. *Alternative B* would result in beneficial minor long-term impacts to economic activity from mineral development because of the potential economic value of uranium mined of $364.9 million and direct industry employment total of $225 million. *Alternative C* would result in beneficial moderate long-term impacts to economic activity from mineral development because of the potential economic value of uranium mined of $1.28 billion and direct industry employment total of $368.27 million. *Alternative D* would result in beneficial moderate to major long-term impacts to economic activity from mineral development because of the potential economic value of uranium mined of $2.34 billion and direct industry employment total of $531.9 million.

Impacts on Fish and Wildlife

Impacts on wildlife habitat and habitat fragmentation are expected to occur under each alternative. The magnitude of these impacts will vary, depending on the location of mines and overall water quality and quantity impacts to area seeps, springs, and other water bodies. *Alternative A* would have a minor to major long-term impact on aquatic and terrestrial habitats and a minor long-term impact on unfragmented habitat. *Alternatives B* and *C* would have minor long-term impacts on aquatic and terrestrial habitats and minor long-term impacts to unfragmented habitat as a result of the decrease in acres disturbed, compared with *Alternative A. Alternative D* would have a moderate impact to aquatic and terrestrial habitats and a moderate long-term impact to unfragmented habitat as a result of the decrease in acres disturbed, compared with *Alternative A.* The increase in the levels of uranium and its decay constituents in water and soil is anticipated to be minor and long term under all alternatives. While these increased levels may impact individuals, impacts are not anticipated to alter overall fish and wildlife populations. Impacts to sensitive aquatic habitats, such as Kanab Creek, are anticipated to be reduced under *Alternatives B, C,* and *D* because a greater area is being withdrawn from new mines.

Impacts on Geology and Mineral Resources

Alternative A would have no impact on the underground geological conditions, availability of mineral resources, or depletion of uranium resources within the proposed withdrawal area. *Alternative B* would reduce the number of ore deposits mined but would not change the potential for subsidence or alteration of geology or topography in the proposed withdrawal area. *Alternatives C* and *D* would also reduce the number of ore deposits mined but would not reduce the number as much as *Alternative A. Alternatives B, C,* and *D* would also cause a moderate to major long-term impact to the availability of mineral resources and depletion of uranium resources within the proposed withdrawal area.

Impacts on Recreation

The increase in miles of new mining-related roads for all alternatives would benefit driving for pleasure but would adversely impact users seeking primitive recreation opportunities in adjacent areas, although there are no primitive settings within the proposed withdrawal area. *Alternative A* would increase the road density more than the other alternatives and would increase visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would be moderately impacted by exploration and development activity. The haul traffic on State Route 64 would be moderate and would have a long-term impact on visitors driving to Grand Canyon Village. *Alternative B* would have minor increases to the existing road density and visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would experience minor impacts from exploration and development activity. Impacts to visitor use on State Route 64 would be minor and long term. *Alternative C* would have the smallest increase in road density and the least impact on visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would be moderately impacted by exploration and development activity. Impacts on visitor use on State Route 64 would be moderate and long term. *Alternative D* would increase the road density more than any other action alternative and would have a moderate impact to visitor use of the remote and undeveloped areas; users accessing adjacent primitive areas would be moderately impacted by exploration and development activity. Impacts to visitor use on State Route 64 would be moderate and long term.

Impacts on Social Conditions

There are no impacts on demographics under *Alternatives B, C,* and *D*; however, *Alternative A* could result in minor long-term impacts as a result of the population increase from exploration and development activity. In terms of stakeholder values, impacts on different groups (i.e., those who support mineral exploration and development activity or those who support withdrawal) depend on the groups' perspective and the level of exploration and development activity under each alternative; generally, impacts range from minor to moderate and would be long term. Similarly, impacts on health and human safety range from no measurable impacts to minor or moderate long-term impacts, depending on the level of exploration and development activity; the more exploration and development activity under a given alternative, the higher the risk for health or human safety impacts. Nine communities and four tribes meet EPA criteria for an environmental justice population; however, there are no disproportionate health or environmental impacts as a result of any of the alternatives. This would result in a minor long-term impact on environmental justice populations.

Impacts on Soils

The magnitude, extent, and duration of impacts to soil resources depend on the amount of disturbed area exposed to water and wind, soil types affected, topography at sites of disturbance, duration of individual exploration or development operations, and success of reclamation efforts at each area of operation. Disturbance of soils could result in reduced productivity and increased erosion, which would generally be minor and limited to the vicinity of sites of disturbance. Duration of such impacts would be expected to be long term for soil productivity and short term for increased erosion. Impacts from distribution of mine-related constituents in soil would generally be limited to the vicinity of mine sites but would be long term. *Alternative A* potential impacts range from minor to moderate in all three parcels because some mines might be located in areas with sensitive soils or where increased erosion and contaminant distribution might extend beyond the vicinity of sites of activity. *Alternative B* potential impacts are minor to moderate in the North Parcel because substantial new exploration and development activity is foreseen throughout the parcel, regardless of the proposed withdrawal; impacts are none in the East Parcel because no mining-related exploration or development is foreseen; and impacts are minor in the South Parcel, where all sensitive areas would be withdrawn. *Alternative C* potential impacts are minor to moderate in the North Parcel and minor in the East and South parcels because nearly all sensitive areas would be withdrawn. *Alternative D* potential impacts are minor to moderate in the North Parcel and minor to moderate in the East and South parcels because a few sensitive areas are not withdrawn.

Impacts on Soundscapes

Mineral 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 for all alternatives. Impacts on soundscapes within the proposed withdrawal area range from minor to moderate long-term impacts, depending on the location and level of mining-related exploration and development.

Impacts on Special Status Species

Impacts on special status species are expected to occur under each alternative. The magnitude of these impacts will vary, depending on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. *Alternative A* would have a minor to major long-term impact on aquatic and terrestrial habitats. *Alternatives B* and *C* would have minor long-term impacts on aquatic and terrestrial habitats as a result of the respective decrease in acres disturbed, compared with *Alternative A. Alternative D* would have a moderate impact on aquatic and terrestrial habitats as a result of the decrease in acres disturbed, compared with *Alternative A.* The increase in the levels of uranium and its decay constituents in water and soil is anticipated to be minor and long term under all alternatives. While these increase levels may impact individuals, impacts are not anticipated to alter special status species populations. Impacts on sensitive aquatic habitats, such as Kanab Creek, are anticipated to be reduced under *Alternatives B, C,* and *D* because more area is being withdrawn from new mines.

Impacts on Vegetation Resources

Impacts on vegetation are expected to occur under each alternative. The magnitude of these impacts will vary, depending on the location of the mine and associated roadway and transmission line facilities. Depending on the location of the mine facilities, impacts could range from minor to moderate and have the potential to be measurable but not apparent. The acres disturbed under *Alternative B* would be an approximate decrease of 88%, compared with *Alternative A*; acres disturbed under *Alternative C* would be a 61% decrease, compared with *Alternative A*; and acres disturbed under *Alternative D* would be a 30% decrease, compared with *Alternative A.* All alternatives would have a minor long-term impact on the productivity of aquatic and terrestrial habitats.

Impacts on Visual Resources

The degrees of contrast and impact vary and are specific to each viewpoint, ranging from temporary to major and short to long-term under all alternatives. *Alternative A* does not withdraw any sensitive visual designations (Class I, Class II, Preservation, High), resulting in a moderate long-term impact on the conformance with BLM and Forest Service visual management objectives and a minor to moderate long-term impact on the conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative A* would have a minor to moderate short-term impact on changes in night sky within the proposed withdrawal area. *Alternative B* would withdraw all of the sensitive visual designations, resulting in no impact on the conformance with BLM and Forest Service visual management objectives and on the conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative B* would have no impact to minor short-term impact on changes in night sky within the proposed withdrawal area. *Alternative C* would withdraw approximately 88% of the sensitive visual designations, resulting in a minor long-term impact on the conformance with BLM and Forest Service visual management objectives and on the conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative C* would have a minor short-term impact on changes in night sky within the proposed withdrawal area. *Alternative D* would withdraw approximately

53% of the sensitive visual designations, resulting in a minor long-term impact on the conformance with BLM Visual Resource Management class objectives and a minor to moderate long-term impact on the conformance with Grand Canyon National Park visual objectives from key observation points. *Alternative D* would have would have a minor to moderate short-term impact on changes in night sky within the proposed withdrawal area.

Impacts on Water Resources

The degree of impact on water resources varies, depending on the number and location of mines, and is specific to each water resource condition and local groundwater and surface water sub-basin. Under all alternatives, impacts range from none to major and impact duration ranges from short to long term. Duration of impacts is generally long term for groundwater and ranges from short to long term for surface water across all alternatives. *Alternative A* has the greatest overall impact and *Alternative B* has the least overall impact, including no impact in the East Parcel. For all alternatives, the impact on perched aquifer groundwater is none or negligible, except where it ranges up to moderate or major in the North Parcel. The impact on deep aquifer springs is none or negligible across all alternatives, except where it ranges up to moderate for water quality in the North Parcel (*all alternatives*) and East Parcel (*Alternatives A, C,* and *D*), and locations where it ranges up to major for the South Rim springs near the South Parcel (Alternative A). Under all alternatives, the impact on deep wells at Tusayan, Arizona, is negligible for water quantity and none to major for water quality. The impact on surface water under *Alternative A* ranges from negligible to moderate, except where it ranges up to major for quantity and quality in the South Parcel. The impact on surface water under *Alternatives B* and *C* is none or negligible, except where it ranges up to moderate in the North Parcel. The impact on surface water under *Alternative D* is none or negligible, except where it ranges up to moderate in the North and South parcels. The impact on the Colorado River across all alternatives is none or negligible and of short-term to long-term duration. The impact on the Virgin River across all alternatives is none or negligible and of long-term duration.

Impacts on Wilderness

Under all alternatives, there would be no direct impacts on designated and proposed wilderness characteristics. Potential indirect impacts to designated and proposed wilderness range from minor to moderate and from short-term to long-term depending on the 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.

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ACRONYMS AND ABBREVIATIONS

BLM

Arizona Strip FEIS	*Arizona Strip Final Environmental Impact Statement* (BLM 2007)
Arizona Strip ROD/RMP	*Arizona Strip Field Office Record of Decision and Approved Resource Management Plan* (BLM 2008b)

Forest Service

Kaibab EA	*Environmental Assessment for Amendment of the Kaibab National Forest Management Plan—Recreation and Scenery Management* (Forest Service 2004)
Kaibab LRMP/ROD	*Kaibab National Forest Land and Resource Management Plan, as Amended, and Record of Decision* (Forest Service 1988)

Other Abbreviations

°F	degrees Fahrenheit
%	percent
#	number of
ΔB_{ext}	light extinction
ΔE	delta E
4WD	4-wheel-drive
^{235}U	uranium 235
^{238}U	uranium 238
AAC	Arizona Administrative Code
ACEC	Area of Critical Environmental Concern
ADEQ	Arizona Department of Environmental Quality
ADMMR	Arizona Department of Mines and Mineral Resources
ADOC	Arizona Department of Commerce
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
AIRFA	American Indian Religious Freedom Act
AMA	active management area
amsl	above mean sea level
AQMP	air quality management plan
AQRV	Air Quality Related Value
APP	Aquifer Protection Program
ARS	Arizona Revised Statutes
ASLD	Arizona State Land Department
ATV	all-terrain vehicle
avg	average
AZGS	Arizona Geological Survey
BADCT	best available demonstrated control technology
BEA	Bureau of Economic Analysis
BEIR	Biological Effects of Ionizing Radiation
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
bls	below land surface
BMP	best management practice

BSFC	brake specific fuel consumption
C	Candidate
Ca	calcium
CA	Conservation Agreement
CAA	Clean Air Act
CAFÉ	Corporate Average Fuel Economy
CARB	California Air Resources Board
CDP	Census designated place
Census Bureau	U.S. Census Bureau
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH	critical habitat
CH_4	methane
Cl	chloride
CO	carbon monoxide
CO_2	carbon dioxide
CWA	Clean Water Act
CWMA	Cooperative Weed Management Area
dB	decibel
dBA	decibel “A-weighted” sound level
DEM	digital elevation model
Denison	Denison Mines (USA) Corporation
E	Endangered
EA	environmental assessment
EF	emission factor
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FLPMA	Federal Land Policy and Management Act
Forest Service	U.S. Forest Service
FY	fiscal year
GA	geographic area
GHG	greenhouse gas
GIS	geographic information system
GMU	game management unit
gpd/foot	gallons per day per foot width of aquifer
gpm	gallons per minute
GTES	General Terrestrial Ecosystem Survey
GWP	global warming potential
GWSI	ADWR Groundwater Site Inventory
HAP	hazardous air pollutant
Harshbarger	Harshbarger and Associates
HC	hydrocarbon

HCO_3	bicarbonate
hp	horsepower
HR	House of Representatives
hr	hour
I-	Interstate
IMPROVE	Interagency Monitoring of Protected Visual Environments
I/O	input/output
L	liter(s)
L_{dn}	day-night average noise level
L_{eq}	equivalent noise level
L_{max}	maximum sound pressure level
L_n	percentile noise level
m	meter(s)
Max	Maximum
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
$\mu g/m^3$	microgram(s) per cubic meter
µg/L	microgram(s) per liter
µg/min	micrograms per minute
µR/h	microrad(s) per hour
Mg	Magnesium
mGy/h	milligray per hour
mg/L	milligram(s) per liter
mg/m^3	milligram(s) per cubic meter
mgal	million gallons
Min	minimum
Mining Law	General Mining Law of 1872
MIS	Management Indicator Species
Montgomery	Errol L. Montgomery and Associates, Inc.
µPa	micropascals
mpg	mile(s) per gallon
mph	mile(s) per hour
mrem	millirem(s)
mrem/yr	millirems per year
MSHA	Mine Safety and Health Administration
Mt.	Mount
MW	molecular weight
Na	sodium
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
N/D	not determined
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act of 1976
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NO	nitrogen monoxide

NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NP	no projection available at this geographic level
NPS	National Park Service
NR	not reported
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSA	noise-sensitive area
NSR	New Source Review
NURE	National Uranium Resource Evaluation
NVUM	National Visitor Use Monitoring
O_3	ozone
OHV	off-highway vehicle
OSHA	Occupational Safety and Health Administration
PAC	Protected Activity Center
Park	Grand Canyon National Park
Pb	lead
pCi/g	pico-Curie per gram
PCPI	per capita personal income
PEL	permissible exposure level
PILT	payment in lieu of taxes
PL	Public Law
$PM_{2.5}$	fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers
PM_{10}	particulate matter with a nominal aerodynamic diameter of less than 10 micrometers
ppb	part(s) per billion
ppm	part(s) per million
PSD	prevention of significant deterioration
PSL	potential soil loss
RDP	radon decay product
Reclamation	U.S. Bureau of Reclamation
rem	roentgen equivalent man
Resource Advisory Council	Bureau of Land Management Arizona Resource Advisory Council
RFD	reasonably foreseeable development
RM	river mile
RMIS	Recreation Management Information System
RMP	resource management plan
RN	roaded natural
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum
S	Sensitive
SC	Species of Concern
SCAQMD	South Coast Air Quality Management District
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Office
SIL	significant impact level

SIO	Scenic Integrity Objective
SIP	State Implementation Plan
SMS	Scenery Management System
SO_2	sulfur dioxide
SO_4	sulfate
SPM	semi-primitive motorized
SPNM	semi-primitive non-motorized
SR	State Route
SRL	Soil Remediation Level
SSURGO	Soil Survey Geographic
STATSGO	State Soil Geographic
SWCA	SWCA Environmental Consultants
SWDI	Shannon-Weaver Diversity Index
T	Threatened
TCP	Traditional Cultural Property
TDS	total dissolved solids
tpd	ton(s) per day
TES	Terrestrial Ecosystem Survey
tpy	ton(s) per year
TSL	tolerance soil loss
TSP	total suspended particulate
U_3O_8	uranium
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality
U.S.	U.S. Route
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VANE	VANE Minerals, Inc.
VOCs	volatile organic compounds
VQO	Visual Quality Objective
VRM	visual resource management
w/	with
w/o	without
WEG	Wind Erodibility Group
WEI	Wind Erodibility Index
WTP	willingness to pay
yr	year

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Chapter 1

INTRODUCTION: PURPOSE OF AND NEED FOR ACTION

1.1 INTRODUCTION

On July 21, 2009, the Department of the Interior published notice of the Secretary of the Interior (Secretary) Ken Salazar's proposal to withdraw (proposed withdrawal) approximately 1 million acres of federal locatable minerals in northern Arizona from the location of new mining claims under the Mining Law of 1872 [30 United States Code (USC) 22–54] (Mining Law), subject to valid existing rights. The withdrawal was proposed in response to increased mining interest in the region's uranium deposits, as reflected in the number of new mining claim locations, and concern over potential impacts of uranium mining to the Grand Canyon watershed, adjacent to Grand Canyon National Park (the Park).

Under Section 204 of the Federal Land Policy and Management Act (FLPMA), publication of the *Federal Register* notice of the proposed withdrawal (Appendix A) had the effect of segregating the lands involved for up to 2 years from the location and entry of new mining claims while the Bureau of Land Management (BLM) evaluates the withdrawal application. The 2-year time frame, which began on July 21, 2009, is being used to complete various studies and analyses of resources in the segregated area, including environmental review of the proposed withdrawal under the National Environmental Policy Act of 1969, as amended [42 USC 4321–4347] (NEPA). These studies and reviews will provide the basis for a final decision by the Secretary of the Interior regarding whether or not to proceed with the proposed withdrawal or to select an alternative action.

The proposed withdrawal, serialized as BLM casefile AZA-35138, constitutes a major federal action subject to the requirements of NEPA. BLM is the lead agency processing the proposed withdrawal application and preparing the associated NEPA analysis, in this case an environmental impact statement (EIS). The EIS addresses the potential direct, indirect, and cumulative effects on the human environment of the proposed withdrawal and alternatives to the proposed withdrawal. The EIS also discloses any unavoidable adverse impacts, impacts to the long-term productivity of affected resources, and any irreversible or irretrievable commitments of resources that result from the proposed withdrawal or the alternatives to the proposed withdrawal, including the No Action Alternative.

The Proposed Action would withdraw an estimated 1,010,776 acres of federal locatable minerals underlying lands in the vicinity of Grand Canyon National Park and that border the Park in some locations. The land proposed for withdrawal is contained within three parcels: the North Parcel, with approximately 554,124 acres; the East Parcel, with approximately 134,454 acres; and the South Parcel, with approximately 322,198 acres (Figure 1.1-1). The North and East parcels are both north of the Park, while the South Parcel is south of the Park. The proposed withdrawal has no effect on mine development of any non-federal lands within the exterior boundaries shown in Figure 1.1-1; however, they are included in the event that they are subsequently acquired by the federal government.

Approximately 986,703 acres within the boundaries of the proposed withdrawal are managed by the BLM or the U.S. Forest Service (Forest Service). The remaining 24,073 acres are split estate lands where the surface is non-federal but the locatable minerals are owned by the federal government. Both the 2-year temporary segregation and the proposed 20-year withdrawal would apply to all minerals locatable under the Mining Law, regardless of surface ownership. Neither the current segregation nor the proposed withdrawal apply to non-federal mineral estate or to leasable or salable minerals (e.g., oil and gas leasing, sand and gravel permits), which are not subject to appropriation under the Mining Law.

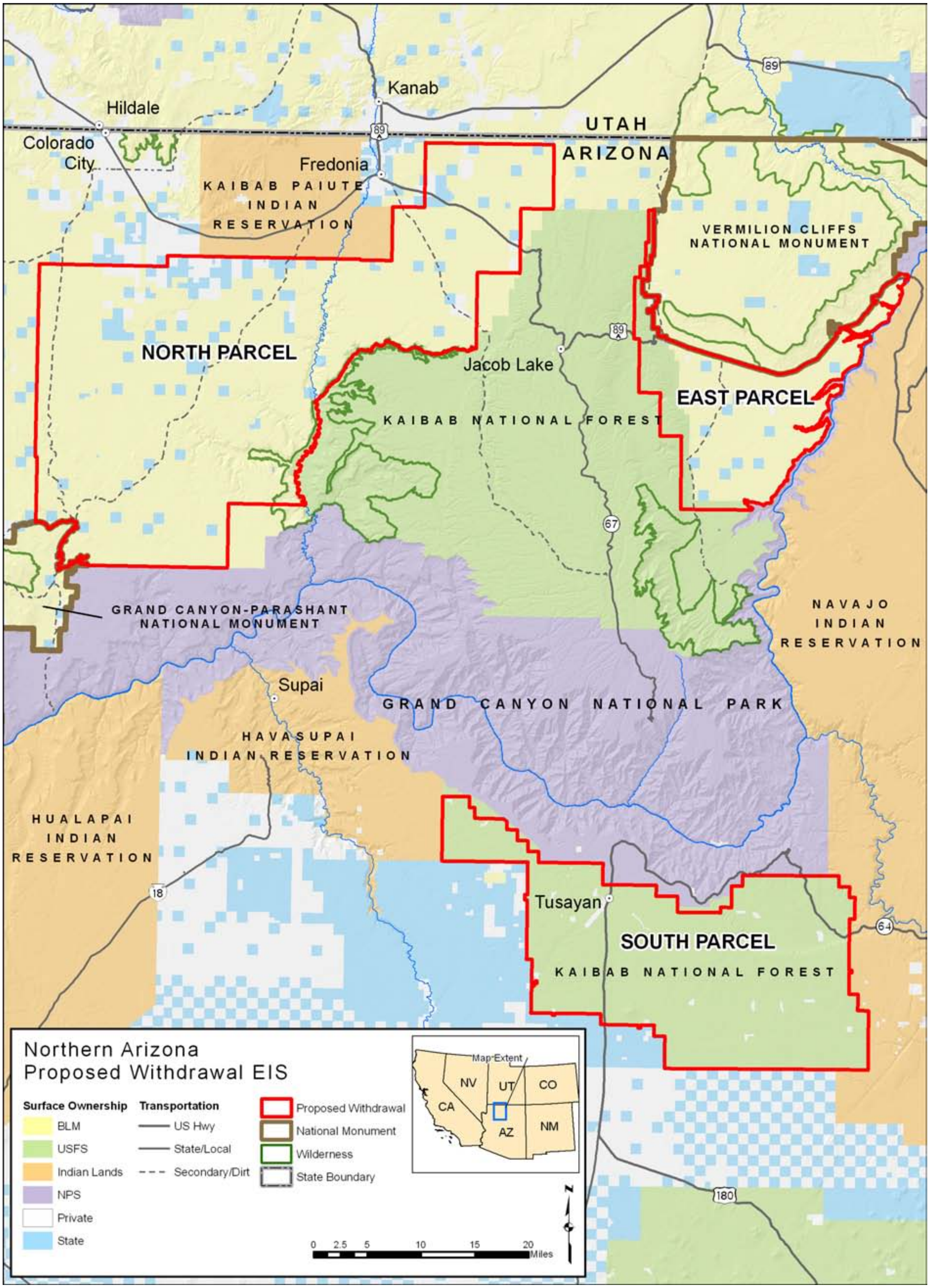

Figure 1.1-1. Proposed withdrawal area.

Acreage of federal locatable minerals proposed for withdrawal is shown, by parcel, in Table 1.1-1. The table also identifies those acres of federal locatable minerals located beneath non-federal surface that are either state owned or private.

Table 1.1-1. Acreage, by Parcel, of Federal Locatable Minerals Proposed for Withdrawal

	North Parcel	East Parcel	South Parcel
Federal locatable minerals underlying federal surface	531,841	133,705	321,157
Federal locatable minerals underlying non-federal surface	22,283	749	1,041
Total	**554,124**	**134,454**	**322,198**

The proposed withdrawal is subject to valid existing rights that are determined to exist on those mining claims located prior to July 21, 2009, the date the lands were segregated from location and entry under the Mining Law by the publication of the notice of proposed withdrawal in the *Federal Register*. The general principles and requirements for locating and developing mining claims, as well as procedures for determining valid existing rights, are described in Appendix B.

1.2 BACKGROUND

In 2007, the demand for uranium pushed the commodity price to over $130/lb before returning to the low $40/lb range in 2009. This price spike prompted new interest in the breccia pipe uranium deposits located on federal lands to the north and south of Grand Canyon National Park, causing thousands of new mining claims to be located in the area. Along with the increase in new mining claim locations came greater public concern that uranium mining could adversely affect natural, cultural, and social resources in the Grand Canyon watershed, which includes resources in Grand Canyon National Park.

In response to the concern over potential environmental effects, a number of events occurred in 2008 and 2009 to bring attention to these lands and the potential for long term or permanent impacts to the Grand Canyon watershed. Among those events was legislation introduced by Representative Grijalva (D-AZ) in March 2008 to permanently withdraw essentially these same lands from location and entry under the Mining Law, as well as from mineral leasing and from mineral material sales and disposal. The area proposed for legislative withdrawal is located in northern Arizona and includes federal lands north of Grand Canyon National Park administered by the BLM Arizona Strip Field Office and lands south of the Park in the Tusayan Ranger District administered by the Forest Service. The most recent bill [House of Representatives (HR) 644] for a legislative withdrawal was introduced on January 22, 2009.

On July 21, 2009, the Department of the Interior published notice of the Secretary of the Interior’s proposed 20-year withdrawal under the authority of the FLPMA. Consistent with Section 204(b) of FLPMA and BLM’s regulations at 43 CFR 2091.5-1(a), publication of the notice of the proposed withdrawal segregated the lands within the boundaries specified in the notice from location of new mining claims under the Mining Law for 2 years. The Secretary’s proposed withdrawal was published on July 21, 2009, and initiated the 2-year segregation (or time-out) on the location of new mining claims. The Secretary’s proposed 20-year withdrawal covers essentially the same area as the proposed legislative withdrawal in HR 644; however, under the Secretary’s proposal, the subject lands would only be withdrawn from location under the Mining Law and would remain available for mineral leasing and mineral materials sales.

The 2-year segregation does not prohibit continuation of already approved mineral exploration and development activity, nor does it prohibit the approval of new mining on existing mining claims, provided that those claims were valid as of July 21, 2009, and have remained valid. As of June 2010, there were approximately 5,300 mining claims located within the three segregation parcels.

During the segregation period, the Secretary directed that additional studies be conducted, including preparation of this EIS, in order to provide the factual information needed to make a decision on a withdrawal of the area. At the conclusion of the 2-year segregation period, the Secretary will determine whether it is necessary to withdraw some, all, or none of the segregation area for up to 20 years to protect natural, cultural, and social resources in the Grand Canyon watershed from the potential adverse effects of mineral exploration and development.

1.3 PURPOSE OF AND NEED FOR ACTION

1.3.1 Purpose of Action

The Proposed Action analyzed in this document is the withdrawal of minerals in 1,010, 776 acres near Grand Canyon National Park from location and entry under the Mining Law for 20 years. The underlying purpose is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of the reasonably foreseeable locatable mineral exploration and development that could occur in the segregated area. Consistent with Section 204(b) of FLPMA, the Department of the Interior published a notice in the *Federal Register* describing the proposed withdrawal application and segregating the lands proposed for withdrawal from location of new mining claims under the Mining Law for 2 years (*Federal Register* 74:35887) (July 21, 2009). The decision to be made by the Secretary is whether or not to withdraw, for up to 20 years, some or all of the area from location and entry under the Mining Law.

1.3.2 Need for Action

There is a history of hardrock mining activities in the Grand Canyon watershed dating back to the 1860s. In some cases, these mining activities have left lasting impacts within the watershed, primarily associated with older copper and uranium mines (see also U.S. Geological Survey [USGS] 2010a). These historical impacts and the recent increase in the number and extent of mining claims located in the area have raised concerns that future hardrock mining activities in the Grand Canyon watershed, particularly for uranium, could result in adverse effects on resources, which include the following:

- Surface water and groundwater, including seeps, springs, wells, and runoff, that may ultimately flow into the Colorado River, which is used for agricultural, municipal, commercial, domestic, and recreational purposes by people throughout the southwestern United States;
- Cultural resources, including prehistoric and historic sites, places of traditional religious and cultural importance (including Traditional Cultural Properties [TCPs]), and other places of significance to American Indians;
- Air quality and visibility in Grand Canyon National Park, a Class I airshed;
- Federally listed or proposed endangered, threatened, and candidate species; agency-listed sensitive species, conservation agreement species, and species of concern; and designated critical habitat;

- Vegetation, wildlife, and aquatic species and their habitat that are unique to the Grand Canyon watershed;
- Recreational values and opportunities for visitors to the region and for the estimated 4.4 million people who visit Grand Canyon National Park each year;
- Designated and proposed wilderness areas, areas allocated for maintenance of wilderness characteristics, and the relevant and important resources for which Areas of Critical Environmental Concern (ACECs) were designated;
- Visual resources, including night skies, scenic overlooks, and other designated scenic areas;
- Natural soundscapes, designated quiet zones, and quality-of-life values for both area residents and visitors, including intangible issues such as peace, solitude, heritage, and sense of place.

1.4 ROLES, RESPONSIBILITIES, AND AUTHORITIES

This section describes the roles and responsibilities of the lead and cooperating agencies with respect to processing the proposed withdrawal and preparing this EIS. It also describes the relevant and applicable federal, state, and local laws and regulations and how they pertain to the scope of the analysis or may apply to the decisions to be made.

1.4.1 Bureau of Land Management

The BLM is the agency responsible for processing the proposed withdrawal and is the lead agency for preparing the EIS. Approximately 626,354 acres of surface managed by the BLM Arizona Strip Field Office in Saint George, Utah, are included in the proposed withdrawal, including the majority of the North and East parcels (see Figure 1.1-1). The public lands within these parcels are managed under the *Arizona Strip Field Office Record of Decision and Approved Resource Management Plan* (Arizona Strip Field Office ROD/RMP) (BLM 2008b). Locatable mineral exploration and development are managed under the current regulations at 43 Code of Federal Regulations (CFR) 3715 and 3809. In accordance with FLPMA, the Arizona Strip Field Office RMP allows for sustainable multiple uses of public lands. If a withdrawal alternative is implemented, the RMP will be updated if necessary.

The BLM follows the procedures in Section 204 of FLPMA and the regulations at 43 CFR 2300 to process withdrawals of federal lands from operation of the public land laws, including the Mining Law. Although BLM is responsible for processing the withdrawal application, the Secretary of the Interior is the decision-maker for withdrawals up to 20 years under FLPMA Section 204. Following the analysis and public commenting process conducted through the EIS process, the Secretary will issue a Record of Decision (ROD) detailing the decisions concerning the withdrawal, including the rationale for these decisions.

The BLM manages locatable mineral activity (including uranium exploration and development) in accordance with provisions of Section 302(b) of FLPMA that require the Secretary to prevent unnecessary or undue degradation of the lands from activities authorized by the Mining Law. The BLM promulgated regulations at 43 CFR 3715 and 3809 that set forth the review procedures, performance standards, and other requirements that mining claimants and operators must follow when conducting operations on public lands under the Mining Law, in order to prevent unnecessary or undue degradation.

Section 309 of FLPMA provided for the establishment of advisory councils that represent the various major interests and concerns of citizens relating to land use planning and the management of public lands within the area for which the advisory council was established. Following issuance of the temporary segregation, the BLM Arizona Resource Advisory Council (Resource Advisory Council) convened to identify key issues; outline resource data study needs; and engage the public, tribes, environmental groups, industry, state and local government, and other stakeholders. The Resource Advisory Council provided specific recommendations to BLM on issues and alternatives for the EIS process.

1.4.2 Cooperating Agencies

The Council on Environmental Quality (CEQ) regulations [40 CFR 1508.5] define a cooperating agency as any federal agency (other than the lead agency) and any state or local agency or Indian tribe with jurisdictional authority or special expertise with respect to any environmental impact involved in a proposal. Because of the size of the proposed withdrawal area and the resources potentially affected by the proposed withdrawal or alternatives, 15 agencies (federal, state, tribal, and county) with jurisdictional authority and/or applicable special expertise cooperated in the development of this EIS.

The cooperating agencies assisted with EIS preparation in a number of ways, including conducting or providing studies and inventories, reviewing baseline condition reports, identifying issues, assisting with the formulation of alternatives, and reviewing Preliminary Draft EIS text and other EIS materials. Not all of the cooperating agencies participated in all aspects of the EIS preparation. As lead agency, BLM is responsible for the content of the EIS.

Federal Cooperating Agencies

U.S. FOREST SERVICE

Approximately 321,157 acres of the Kaibab National Forest in the Tusayan Ranger District and 31,273 acres of the North Kaibab Ranger District are included in the proposed withdrawal area (see Figure 1.1-1). The *Kaibab National Forest Land Management Plan, as Amended, and Record of Decision* (Kaibab LMP/ROD) (Forest Service 1988) is the presiding Kaibab National Forest management document. The Forest Service and the BLM worked closely to develop alternatives. While BLM is the lead agency for this project, the Kaibab National Forest, as a cooperating agency with jurisdictional authority, contributes vital expertise and guidance regarding the proposed withdrawal area.

The Forest Service manages locatable mineral activity (including uranium exploration and development) in accordance with provisions of the Organic Act of 1897 [16 USC 478, 551]. The Forest Service promulgated regulations at 36 CFR 228A that describe the review and approval requirements, performance standards, and other requirements that mining claimants and operators must follow when conducting operations on National Forest System lands under the Mining Law.

NATIONAL PARK SERVICE

Grand Canyon National Park has jurisdictional authority over 1.2 million acres of the Grand Canyon watershed. The proposed withdrawal area is located immediately adjacent to parts of Grand Canyon National Park both north and south of the Park boundary (see Figure 1.1-1). Although Grand Canyon National Park has no jurisdictional authority over the lands proposed for withdrawal, the National Park Service (NPS) has an affirmative responsibility under the NPS Organic Act of 1916 to ensure that activities outside Park boundaries do not adversely affect Park resources and values. Thus, NPS is a cooperating agency by virtue of its special expertise in the resources of the Grand Canyon.

The Park is already withdrawn from location and entry under the Mining Law, subject to valid existing rights; however, locatable mineral activities on adjacent (non-withdrawn) lands may have the potential to affect Park resources, such as seeps and springs, air quality, wildlife, vegetation, aquatic species, natural viewsheds, dark skies, soundscapes, important cultural resources, and recreation opportunities and settings.

The National Park Service Organic Act [16 USC 1–4] requires the NPS to conserve Park resources and the values and purposes for which the Park was established, as well as "to provide for the enjoyment" of those resources and values "in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." To fulfill these mandates, conscientious care is necessary to preserve and protect natural and cultural resources, including the primeval character of the Park backcountry, while still providing opportunities for public enjoyment of these NPS lands.

U.S. FISH AND WILDLIFE SERVICE

The U.S. Fish and Wildlife Service (USFWS) is the federal agency with jurisdictional authority concerning listed threatened and endangered, proposed, and candidate species, conservation agreement species, and critical habitat under the Endangered Species Act of 1973, as amended (ESA); bald and golden eagles under the Bald and Golden Eagle Protection Act of 1940, as amended; and migratory birds under the Migratory Bird Treaty Act of 1918 (MBTA). One of USFWS's responsibilities is to address trust species for tribes. During the EIS process, the role of USFWS is to provide input and recommendations regarding the special status species and critical habitat that could be impacted by the proposed withdrawal. In addition, as required under Section 7 of the ESA, federal agencies must consult with USFWS regarding a project's potential impacts to threatened and endangered species and critical habitat.

U.S. GEOLOGICAL SURVEY

USGS has no jurisdictional authority concerning the potential environmental impacts of the proposed withdrawal. However, USGS has special expertise in mining-related environmental conditions, mineral resource availability, geology, hydrology, and biology, and this expertise was drawn on to more fully inform this EIS process by providing baseline technical studies and engaging in consultation with the other agencies on scientific matters. To provide important foundational information for the EIS, USGS prepared Scientific Investigations Report 2010-5025, *Hydrological, Geological, and Biological Site Characterization of Breccia Pipe Uranium Deposits in Northern Arizona* (USGS 2010b).

State of Arizona Cooperating Agencies

ARIZONA GAME AND FISH DEPARTMENT

In Arizona, the Arizona Game and Fish Department (AGFD) has jurisdictional authority over fish and wildlife conservation and management, as well as public uses and recreation relating to fish and wildlife conservation and management, including off-highway vehicle (OHV) use. AGFD is tasked with conserving, enhancing, and restoring Arizona's diverse wildlife resources and habitats and therefore has special expertise with respect to Arizona's wildlife. Because the proposed withdrawal has the potential to impact fish and wildlife within Arizona, AGFD is a cooperating agency for the EIS.

ARIZONA GEOLOGICAL SURVEY

The Arizona Geological Survey's (AZGS's) charter is to serve as a primary source of geological information in Arizona to enhance public understanding of the state's geological character and mineral resources (AZGS 2010). AZGS provides technical advice and assistance in geology to other state and local governmental agencies engaged in projects in which the geological setting, character, or mineral resources of the state are involved (AZGS 2010). In addition, AZGS informs, advises, and assists the public and other agencies in matters concerning geological processes, materials, and landscapes and in the development and use of the mineral resources of Arizona. Because of its special expertise in geology, geological hazards and limitations, and mineral resources within the state, AZGS is a cooperating agency in the EIS process.

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

The primary objective of the Arizona Department of Mines and Mineral Resources (ADMMR) is to promote the development of the mineral resources of Arizona through technical and educational processes. ADMMR also provides mining, metallurgical, and other technical information and assistance to those interested in developing the mineral resources of Arizona (ADMMR 2006). ADMMR provides services such as maintaining a site-specific database of unpublished reports and maps; maintaining an information bank and reference library of mineral and mining information; and producing mineral reports, annual directories, technical reports, mineral industry surveys, and information circulars. ADMMR provides special expertise with respect to the development of mineral resources in Arizona and is therefore a cooperating agency in the EIS process.

ARIZONA STATE LAND DEPARTMENT

The Natural Resources Division of the Arizona State Land Department (ASLD) administers all natural resource-related leases and Conservation Districts, along with any natural resource issues affecting State Trust land. Approximately 57,726 acres of State Trust land are located within the proposed withdrawal area, mostly in the North and East parcels. While the state-owned minerals are not subject to the temporary segregation or proposed withdrawal, the withdrawal of federal minerals has the potential to influence mineral development on adjacent state lands. In addition, 4,284 acres of the federal minerals proposed for withdrawal underlie state-owned surface. Therefore, because of their special expertise regarding the resources within these lands and the state’s interest in maximizing revenue from its trust lands, ASLD has been designated a cooperating agency.

Tribal Governments as Cooperating Agencies

In August 2009, the BLM and Forest Service initiated consultation via letter with the following American Indian governments regarding the proposed withdrawal: Chemehuevi Tribe, Colorado River Indian Tribes, Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Las Vegas Paiute Tribe, Moapa Band of Paiute Indians, Pahrump Band of Paiutes, Paiute Indian Tribe of Utah, Pueblo of Zuni, San Juan Southern Paiute Tribe, Navajo Nation, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe. Additional information on the consultation process is presented in Chapter 5, Consultation and Coordination.

During the consultation process, the Hualapai Tribe and Kaibab Band of Paiute Indians requested to be involved in the EIS process as cooperating agencies. The interests of these cooperators with respect to the EIS process are described below.

HUALAPAI TRIBE

The Hualapai Reservation is located west of the South Parcel. The Hualapai Tribe considers the Grand Canyon region to be of great cultural, historical, and religious significance. Lands held sacred or culturally significant to American Indian tribes are not only located within the present Hualapai Reservation boundaries, the Hualapai hold a substantial portion of the project area to be culturally significant.

KAIBAB BAND OF PAIUTE INDIANS

The Kaibab Band of Paiute Indians Reservation is located adjacent to the North Parcel proposed for withdrawal (see Figure 1.1-1), and aboriginal lands are included in all three parcels. Haul truck traffic from current uranium ore production in the North Parcel passes through the reservation and is of concern to the residents. Like the Hualapai Tribe, the Kaibab Band of Paiute Indians considers the Grand Canyon region to be of great cultural, historical, and religious significance.

County Governments as Cooperating Agencies

Coconino and Mohave counties in Arizona and Kane, San Juan, and Washington counties in Utah are cooperating agencies in the EIS process. A substantial portion of the economies of these rural counties is based on both mining and recreation in the Grand Canyon region (Arizona Department of Commerce [ADOC] 2009a). The proposed withdrawal and alternatives have the potential to impact socioeconomic conditions in these counties, and the BLM invited them to participate in the EIS process as cooperating agencies.

COCONINO COUNTY, ARIZONA

The majority of the proposed withdrawal area (all of the South Parcel, all of the East Parcel, and a portion of the North Parcel) is located in Coconino County. ADOC official population estimates for Coconino County are 136,735 for July 1, 2009 (ADOC 2009b). Coconino County's commercial economy is largely tourism based accounting for a large percentage of the county's jobs and tax income.

Coconino County Board of Supervisors passed a resolution opposing uranium mining in proximity of the Grand Canyon National Park and its watersheds (Resolution No. 2008-09). The resolution requested a moratorium on the mineral leasing of State Trust lands and a permanent congressional withdrawal of the Tusayan Ranger District and House Rock Valley (the South and East parcels).

MOHAVE COUNTY, ARIZONA

The North Parcel is partially in Mohave County. The official ADOC population estimates for Mohave County are 206,763 for July 1, 2009 (ADOC 2009c). Leading industries in the county are retail trade, tourism, construction, and health care and social services.

Mohave County passed Resolution 2009-040 on February 5, 2009. The resolution urges Congress to preserve access to the uranium reserves of northern Arizona in order to meet America's demand for clean non-carbon emitting energy and energy independence (Mohave County 2009).

KANE COUNTY, UTAH

Because of its proximity to the proposed withdrawal area and its historic dependence on the Arizona Strip as a significant source of income and employment for its residents, Kane County is participating as a cooperating agency in the EIS process. Kane County had an estimated population of 6,577 in 2008 (U.S. Census Bureau [Census Bureau] 2008a). Like Coconino County, Kane County's economy is primarily tourism based. Lake Powell, Zion National Park, and other recreation sites attract tens of thousands of visitors each year. As a result, the leisure/hospitality services sector is the leading employment sector. The mining industry is also a significant employer in Kane County. Mining wages and salaries per job have consistently been the largest in the study area and have experienced steady growth from 1980 through 2000. However, it should be noted that the number of mining jobs in Kane County has been low since at least 1980 (BLM 2008c).

Kane County passed Resolution 2008-10 on May 12, 2008. The resolution says the county supports multiple uses on public lands in general and lists uranium mining as one of the uses that should continue (Kane County 2008).

SAN JUAN COUNTY, UTAH

San Juan County had an estimated population of 15,055 in 2008 (Census Bureau 2008a). One of the major employment sectors driving San Juan County's economy is mining. Denison Mines (USA) Corporation (Denison) and the recently closed Lisbon Valley Copper Mine are located in the county and have both historically, as well as recently, provided employment for county residents. The White Mesa Uranium Mill, located 6 miles south of Blanding, is used for processing uranium ore mined in the proposed withdrawal area. The proposed withdrawal or alternatives could change the amount of ore transported to the mill. Because of its economic connection with mining in the proposed withdrawal area, San Juan County is participating as a cooperating agency in the EIS process.

WASHINGTON COUNTY, UTAH

Washington County had an estimated population of 137,589 in 2008 (Census Bureau 2008a). The Arizona Strip (where the North and East parcels are located) has historically been recognized as a primary source of income and employment for many of southern Utah's residents. For this reason, Washington County is a cooperating agency in the EIS process. Over the past decade, Washington County has experienced major population growth. From 1990 to 2008, the total population increased by 183.3% and is expected to continue growing. Manufacturing, wholesale and retail trade, construction, and tourism- and recreation-related services are the leading industries. Nearby Grand Canyon National Park, Zion National Park, Dixie National Forest, and Snow Canyon State Park are important recreational attractions.

1.4.3 Authorities

A number of legal authorities apply to the processing of the proposed withdrawal application and preparation of the associated EIS. These include laws, policies, and orders that established the basic tenets of the Mining Law, set the requirements for consultation between federal agencies and tribal governments, formulated the policies on the use of federal lands, promulgated the regulations for mining on federal lands, and set overall management objectives in agency legislation. These are briefly discussed below.

Federal Laws, Statutes, and Regulations

LAWS AND STATUTES

General Mining Law of 1872

The Mining Law [30 USC 22–54] authorizes citizens to enter federal lands open to location and stake or "locate" mining claims upon discovery of a valuable mineral deposit and compliance with all other applicable statutory or regulatory requirements. A mining claim gives the claimant a possessory interest against the government and rival claimants. Mineral exploration and development conducted under the Mining Law must be performed in compliance with federal and state statutes and regulations. Additional information on the Mining Law and mining claim requirements is presented in Appendix B.

Mineral deposits that are subject to appropriation under the Mining Law are termed "locatable" and include most metallic mineral deposits, such as uranium, and certain nonmetallic and industrial minerals, such as specialty building stone. Locatable minerals do not include minerals such as coal or oil and gas, which are classified as “leasable.” Deposits of sand and gravel are termed “salable” and may be available for purchase from the land managing agency.

The authorization to locate mining claims under the Mining Law may be terminated if the lands are withdrawn from location and entry under the Mining Law. Congress can withdraw lands from operation of the Mining Law and has done so in the past (e.g., for national parks, wilderness areas, military reservations, etc.). The Secretary of the Interior can also withdraw lands from operation of the Mining Law, but as FLPMA explicitly states, the Secretary may “make, modify, extend, or revoke withdrawals but only in accordance with the provisions and limitations” of Section 204.

The Forest Service Organic Administration Act of 1897

Under the Forest Service Organic Administration Act of 1897, the Secretary of Agriculture permits access to National Forests for all lawful purposes, including prospecting for, locating, and developing mineral resources. The Organic Act remains in effect today and is one of several legal authorities directing and guiding Forest Service policy and operations, in conjunction with the Multiple-Use Mining Act of 1955, Multiple-Use Sustained-Yield Act of 1960, and NFMA.

National Park Service Organic Act of 1916

The NPS was established under the National Park Service Organic Act of 1916 [16 USC 1–4]. The Organic Act states, “The Service such established shall promote and regulate . . . to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations.”

Act to Establish Grand Canyon National Park, 1919

In 1919, Congress expanded and designated Grand Canyon National Monument a national park, creating Grand Canyon National Park. The Act of February 26, 1919, directed that NPS assume the responsibility for the administration, protection, and promotion of the park and authorized the NPS to grant commercial concessions “for the accommodation or entertainment of visitors” [16 USC 221 *et seq*., 40 Stat. 1175]. The Act also “reserved and withdr[ew] from settlement, occupancy, or disposal under the laws of the United States and set apart as a public park for the benefit and enjoyment of the people” land in the state of Arizona under the name of Grand Canyon National Park. The Grand Canyon National Park was withdrawn by statute from mining entry.

Surface Resources Act of 1955

The Surface Resources Act of 1955 [30 USC 611–615] did three things: 1) it expressly removed common varieties of building or construction materials from appropriation under the Mining Law; 2) it verified that unpatented mining claims could only be used for prospecting, mining, or processing operations and uses reasonably incident thereto; and 3) it subjected mining claims located after 1955 to government management and disposal of the surface resources. The Act lays the groundwork for both BLM and Forest Service surface management regulations at 43 CFR 3715 and 3809 and at 36 CFR 228A, respectively.

Multiple-Use Sustained-Yield Act of 1960

The Multiple-Use Sustained-Yield Act of 1960 provides that the purposes of the National Forest System lands include outdoor recreation, range, timber, watersheds, and fish and wildlife. While the Act supports these uses in particular, it does not directly affect the use or administration of the mineral resources on National Forest System lands.

National Historic Preservation Act of 1966

The National Historic Preservation Act of 1966 (NHPA) requires the Secretary of the Interior to maintain the National Register of Historic Places (NRHP). NHPA creates a process under which federal agencies must consider the effect of a proposed project on any property listed or eligible for listing in the NRHP before it authorizes or funds any undertaking. Section 106 of the NHPA requires federal agencies to take into account the effects of their actions on historic properties. The intent is to identify such properties, assess effects, and seek ways to avoid, minimize, or mitigate any adverse effects. The NHPA stresses the importance of active consultations with the public, Indian tribes, State Historic Preservation Offices (SHPOs), and other parties and provides the Advisory Council on Historic Preservation with the opportunity to comment on a project's potential to affect historic resources. The BLM or Forest Service review of a plan of operations for exploration or development must follow the Section 106 process in order to identify, assess, and seek ways to avoid, minimize, or mitigate any adverse effects on properties listed or eligible for listing in the NRHP.

National Environmental Policy Act of 1969

NEPA requires federal agencies to prepare an EIS prior to undertaking a major federal action that would significantly affect the quality of the human environment. NEPA also requires federal agencies to study, develop, and describe appropriate alternatives to any proposed agency action that involves unresolved conflicts concerning alternate uses of available resources. Under NEPA, agencies are required to prepare environmental documents, with input from the state and local governments, Indian tribes, the public, and other federal agencies. Because the proposed withdrawal constitutes a "major federal action," detailed analysis, agency cooperation, and public or stakeholder involvement under NEPA is required before a decision can be made.

The Department of the Interior prepares an EIS in accordance with NEPA, with the CEQ regulations implementing NEPA at 40 CFR 1500–1508, with Department of the Interior requirements in Department Manual 516, with Department of the Interior regulations implementing NEPA at 43 CFR 46, and with the BLM NEPA Handbook (H-1790-1) (BLM 2008a).

Mining and Minerals Policy Act of 1970

The current federal policy for minerals resource management reflected in the Mining and Minerals Policy Act of 1970, which is cited in the policy statements of FLPMA. In the Mining and Minerals Policy Act, Congress declared that it is the continuing policy of the federal government in the national interest to foster and encourage private enterprise in the following: 1) the development of economically sound and stable domestic mining, minerals, metal, and mineral reclamation industries; 2) the orderly and economic development of domestic mineral resources and reserves and reclamation of metals and minerals to help ensure satisfaction of industrial, security, and environmental needs; 3) mining, mineral, and metallurgical research, including the use and recycling of scrap to promote the wise and efficient use of our natural and reclaimable mineral resources; and 4) the study and development of methods for the disposal, control, and reclamation of mineral waste products and the reclamation of mined land, in order to lessen any adverse impact of mineral extraction and processing on the physical environment that may result from mining or mineral activities.

For the purpose of this Act, "minerals" includes all minerals and mineral fuels, including oil, gas, coal, oil shale, and uranium. The Act further requires the Secretary of the Interior to carry out this policy when exercising his or her authority under such programs as may be authorized by law other than under this section.

Clean Air Act (Extension) of 1970

The Clean Air Act of 1970, as amended (CAA), established National Ambient Air Quality Standards (NAAQS) to control air pollution. Impacts to air quality from industry, including mineral exploration and development, are controlled by mitigation measures developed on a case-by-case basis during project review. The CAA has been amended several times, most importantly in 1977 and 1990. Part C of the 1977 amendments stipulates requirements to prevent significant deterioration of air quality and, in particular, to preserve air quality in national parks, national wilderness areas, national monuments, and national seashores [42 USC 7470] by establishing federal Class I areas, including Grand Canyon, Zion, and Bryce Canyon national parks. Class I areas have more stringent controls on emission increases and protection of visibility, with a goal of no human-caused impairment. The 1990 amendment established a permit program to streamline compliance with air quality regulations into an enforceable permit for operators. The purpose of the operating permits program is to ensure compliance with all applicable requirements of the CAA and to enhance the U.S. Environmental Protection Agency's (EPA's) ability to enforce the Act.

Endangered Species Act of 1973

The general policy of the ESA, as set forth by Congress, is that "all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the Act." Section 7 of the ESA directs all federal agencies to use their existing authority to conserve threatened and endangered species and, in consultation with the USFWS or National Marine Fisheries Service (NMFS), to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7 applies to management of federal lands as well as other federal actions that may affect listed species, including the proposed withdrawal. A decision to implement a withdrawal is an action subject to consultation with the USFWS on the effects to threatened or endangered species and their designated critical habitat. In addition, the individual approval of a plan of operations for uranium exploration or mining is an action requiring consultation with the USFWS or NMFS.

Grand Canyon Enlargement Act of 1975

The Grand Canyon Enlargement Act, enacted in 1975, provided for the further protection of the Grand Canyon area, doubling the size of Grand Canyon National Park to approximately 1.18 million acres (1,904 square miles). In addition, the Enlargement Act modified the deadlines for wilderness suitability review set forth in the Wilderness Act, requiring the Secretary of the Interior to report to the President, within 2 years, his recommendations regarding the suitability or non-suitability of any area within Grand Canyon National Park for preservation as wilderness [Public Law (PL) 93-620, 88 Stat. 2089]. The Act consolidated several contiguous federally owned areas, some of which already were designated as units of the National Park System, into a single national park to be administered under common administrative guidelines.

Federal Land and Policy Management Act of 1976

FLPMA establishes the BLM's multiple-use mandate to serve present and future generations. Title I, Section 102(a)(8), 43 USC 1701(a)(8), of FLPMA states that it is the policy of the United States that

> public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that,

> where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use.

Section 102(a)(10–12) states, "It is the policy of the United States that . . . public lands be managed in a manner which recognizes the Nation's need for domestic sources of minerals . . . including implementation of the Mining and Minerals Policy Act of 1970 . . . as it pertains to the public lands." Section 103(c) provides for a

> combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and non-renewable resources including but not limited to recreation, range, timber, minerals, watershed, wildlife and fish and natural scenic, scientific and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output.

Section 204 of FLPMA establishes the Secretary's authority to make, modify, extend, or revoke withdrawals in accordance with the provisions and limitations of FLPMA. In concert with other applicable federal laws, statutes, and regulations, as described below, FLPMA mandates the requirements for proceeding with any proposed withdrawal. Withdrawals aggregating 5,000 acres or more are limited to 20 years' duration.

Section 302(b) of FLPMA requires the Secretary to prevent unnecessary or undue degradation of the lands, including from activities authorized by the Mining Law. The BLM promulgated regulations at 43 CFR 3809 (3809 regulations) that detail the review, plan of operations approval, performance standards, and other requirements that mining claimants and operators must follow when conducting operations on public lands under the Mining Law in order to prevent unnecessary or undue degradation.

National Forest Management Act of 1976

The National Forest Management Act (NFMA) established the Forest Service's management provisions in response to the population boom (and subsequent timber clear-cutting required for construction) that followed World War II. NFMA supplemented the 1897 National Forest Organic Act as the primary authority for Forest Service policy. This Act was also an amendment to the Forest and Rangeland Renewable Resources Planning Act of 1974. NFMA requires forest plans to be developed in accordance with NEPA's procedural requirements.

Federal Water Pollution Control Act of 1972/Clean Water Act of 1977

The Federal Water Pollution Control Act of 1948 was largely amended in 1972 and further revised in 1977. With the 1977 amendments, the Act became commonly known as the Clean Water Act (CWA). The CWA, enforced by the EPA and state authorities, provides means and guidance to eliminate or reduce direct pollutant discharges into waterways and manage polluted runoff. The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water [33 USC 1251(101)(a)]. Sections 401 and 404 of the CWA provide for permits for discharge of pollutants, or dredge or fill material, respectively, into waters of the United States and are administered by the U.S. Army Corps of Engineers (USACE).

Redwoods Act of 1978

The Redwoods Act of 1978 was an amendment to the NPS General Authorities Act of 1970. By this amendment, Congress reaffirmed the provisions of the Organic Act and made all areas of the National Park System equal in the protections afforded, no matter the individual designation. This provides equal protection to all areas of the National Park System from impairment and/or derogation of their resources: "The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established . . . directly and specifically provided by Congress."

American Indian Religious Freedom Act

The American Indian Religious Freedom Act (AIRFA) says that on and after August 11, 1978, "it shall be the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites."

National Materials and Minerals Policy, Research, and Development Act of 1980

The National Materials and Minerals Policy, Research, and Development Act of 1980 specifically emphasizes the USGS's responsibility to assess the mineral resources of the nation. It also charges the Secretary of the Interior to improve availability and analysis of mineral data in federal land use decision-making [30 USC 1604(e)(3)].

Energy Policy Act of 2005

The Energy Policy Act of 2005 encourages energy efficiency and conservation; promotes alternative and renewable energy sources; reduces dependence on foreign sources of energy; increases domestic production; modernizes the electrical grid; and encourages the expansion of nuclear energy.

REGULATIONS

Title 43 Code of Federal Regulations Part 2300

These regulations set forth procedures implementing the Secretary of the Interior's authority to process federal land withdrawal applications and, where appropriate, to make, modify, or extend federal land withdrawals. The regulations contain the content and processing requirements for a withdrawal application casefile. One of the requirements for a withdrawal casefile is an environmental analysis prepared in accordance with NEPA. If a withdrawal alternative were selected, the current EIS would constitute the required NEPA analysis.

Title 43 Code of Federal Regulations Subpart 3715

The regulations at 43 CFR 3715 apply to all activities purported to be conducted under the Mining Law on BLM-administered land. The purpose of the regulations is to manage the use and occupancy of the public lands for the development of locatable mineral deposits by limiting such use or occupancy to that which is reasonably incident to prospecting, mining, or processing operations.

The regulations address the unlawful use and occupancy of unpatented mining claims for non-mining purposes, setting forth the restrictions on use and occupancy of public lands open to the operation of the mining laws in order to limit use and occupancy to those reasonably incidental uses. The rule establishes procedures for beginning occupancy, standards for reasonably incidental use or occupancy, prohibited acts, procedures for inspection and enforcement, and procedures for managing existing uses and occupancies. It also provides for penalties and appeals procedures. The rule is used to prevent unnecessary or undue degradation of the public lands from uses and occupancies not reasonably incident to mining. The rule does not adversely affect bona fide mining operations or alter BLM's regulations in 43 CFR 3800 pertaining to them.

Title 43 Code of Federal Regulations Subpart 3809

The regulations at 43 CFR 3809 apply to exploration and development activity for locatable minerals, including uranium, on BLM-managed lands. The regulations were developed to implement Section 302(b) of FLPMA, which requires the Secretary to prevent unnecessary or undue degradation of the lands, including from activities authorized by the Mining Law. The "3809 regulations" underwent major revision in November 2000 and again in October 2001. The regulations detail the review, plan of operations approval, performance standards, reclamation requirements, financial guarantee, and enforcement provisions that mining claimants and operators must follow when conducting exploration and mining. Because the 3809 regulations have a key role in the protection of the Grand Canyon watershed from the potential adverse effects of uranium mining, they are discussed briefly in Chapter 2 and Appendix B of this EIS.

Title 36 Code of Federal Regulations Part 228 Subpart A

The regulations at 36 CFR Part 228 Subpart A (228A regulations) apply to all prospecting, exploration, and mining operations, whether within or outside the boundaries of a mining claim, authorized under the Mining Law and conducted on National Forest System lands, including the lands in the proposed withdrawal area. These regulations were originally promulgated in 1974 as 36 CFR 252 and were based on the Forest Service's authority under the Organic Administration Act of 1897. In 1981, the rules were redesignated 36 CFR 228A. In 2005, a final rule clarifying when a plan of operations is required [36 CFR 228.4A] also was adopted. However, the regulations have not been significantly revised since 1974. The regulations detail the review, approval, performance standards, reclamation requirements, financial guarantee, and enforcement provisions that mining claimants and operators must follow when conducting mining operations, including uranium mining operations. Because the 228A regulations have a key role in the protection of the Grand Canyon watershed from the potential adverse effects of uranium mining, they are discussed briefly in Chapter 2 and Appendix B of this EIS.

EXECUTIVE ORDERS

Executive Order 12898 of 1994, Environmental Justice

Executive Order (EO) 12898 says that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. To address environmental justice requires federal agencies to ensure that proposed projects under their jurisdictions do not cause a disproportionate environmental impact that would affect any group of people owing to a lack of political or economic strength on the part of that affected group. Each federal agency shall conduct the programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. The Department of the Interior, in coordination with the Working Group established by the EO, and, after consultation with tribal leaders, shall coordinate steps to be taken pursuant to this order that address federally recognized Indian tribes.

With regard to the proposed withdrawal, low-income populations and minority populations will be identified and their participation sought in the EIS process. The EIS will analyze the potential effects of the proposed withdrawal and alternatives and identify low-income populations and minority populations that may disproportionately be subject to the project benefits and risks. The requirements of EO 12898 also apply when BLM or the Forest Service reviews a site-specific plan of operations for uranium exploration or development.

Executive Order 13007 of 1996, Sacred Sites

EO 13007 limits the meaning of "sacred site" to a "specific, discrete, narrowly delineated location on Federal land" that a practitioner has identified to an agency as having "established religious significance." Where such sites have been identified, EO 13007 says that in managing federal lands, each executive branch agency with statutory or administrative responsibility for such management shall, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, do the following: 1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners; and 2) avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies shall maintain the confidentiality of sacred sites.

Table 1.4-1 lists the above laws and regulations, as well as other relevant authorities.

Table 1.4-1. Federal Laws, Statutes, Regulations, Executive Orders, and Presidential Proclamations

Federal Laws and Statutes
Act to Establish Grand Canyon National Park, 1919
American Indian Religious Freedom Act of 1978 [PL 95-341; 42 USC 1996]
Archaeological and Historic Data Preservation Act of 1974 [PL 86-253, as amended by PL 93291; 16 USC 469]
Archaeological Resources Protection Act of 1979 [PL 96-95; 16 USC 470aa–mm]
Bald and Golden Eagle Protection Act
Clean Air Act of 1990 [as amended by PL 92-574; 42 USC 4901]
Endangered Species Act of 1973 [PL 85-624; 16 USC 661, 664, 1008]
Energy Policy Act of 1992
Energy Policy Act of 2005 [PL 109-59]
Federal Land Policy and Management Act of 1976, Section 201(a) [PL 94-579; 43 USC 1701 *et seq*.]
Federal Water Pollution Control Act (CWA) of 1972 [33 USC 1251]
Forest Service Organic Administration Act of 1897 [16 USC 475]
Grand Canyon Enlargement Act of 1975
Hazardous Materials Transportation Act of 1975
Historic Sites Act of 1935 [PL 292-74; 16 USC 461–467]
Migratory Bird Treaty Act of 1918 [16 USC 703–712, as amended]
Mining Law of 1872 [30 USC 21-42]
Mining and Minerals Policy Act of 1970 [30 USC 21a]
Multiple-Use Mining Act of 1955
Multiple-Use Sustained-Yield Act of 1960 [16 USC 528-31]
National Environmental Policy Act of 1969 [PL 91-190; 42 USC 4321]
National Materials and Minerals Policy, Research and Development Act of 1980

Table 1.4-1. Federal Laws, Statutes, Regulations, Executive Orders, and Presidential Proclamations (Continued)

Federal Laws and Statutes, continued
National Historic Preservation Act of 1966 [PL 89-665; 16 USC 407(f)]
National Park Service Organic Act of 1916
Native American Graves Protection and Repatriation Act of 1990 [PL 101-601]
National Forest Management Act of 1976
National Materials and Minerals Policy, Research and Development Act of 1980
Nuclear Waste Policy Act of 1974
Redwoods Act of 1978
Safe Drinking Water Act of 1982
Surface Resources Act of 1955
Uranium Mill Tailings Radiation Control Act of 1978
Executive Orders
EO 11514, Protection and Enhancement of Environmental Quality
EO 11593, Protection and Enhancement of the Cultural Environment
EO 11988, Floodplain Management [43 CFR 6030]
EO 11990, Wetland Protection
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
EO 13007, Indian Sacred Sites
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds
EO 13175, Tribal Consultation
EO 13212, Actions to Expedite Energy-Related Projects
EO 13287, Preserve America
Federal Regulations
40 CFR 1500–1508, CEQ implementation of NEPA
43 CFR 2300, Land Withdrawals
33 CFR 320–331 and 40 CFR 230, Section 404 of the CWA and Its Implementing Regulations
43 CFR 46, Department of the Interior, Implementation of NEPA
36 CFR 220, Forest Service NEPA Procedures
36 CFR 228, Minerals
36 CFR 800, as amended, Protection of Historic Properties
43 CFR 2800, as amended, Rights-of-Way Principles and Procedures 43 CFR 3715, Use and Occupancy Under the Mining Laws
43 CFR 3809, Mining Claims under the Mining Law: Surface Management
50 CFR Parts 10, 14, 20, and 21, USFWS Implementation of MBTA
50 CFR 400, USFWS Implementation of ESA

State Laws, Regulations, and County Plans

Table 1.4-2 lists state and county laws and regulations applicable to uranium mining and the proposed withdrawal.

Table 1.4-2. Arizona State Laws and County Plans

State Regulations
Arizona Revised Statutes (ARS) 27, Minerals, Oil and Gas
ARS 17, Game and Fish
ARS 30, Power
ARS 40, Public Utilities and Carriers
ARS 45, Waters
ARS 48, Special Taxing Districts
ARS 27–151, AZGS
ARS 28, OHVs
ARS 37, Public Lands
ARS 41, State Government
ARS 49, The Environment
Arizona Administrative Code 12, Natural Resources, Chapter 5
Arizona Native Plant Law
ADMMR Special Report 12, *Laws and Regulations Governing Mineral Rights in Arizona*
ADMMR Special Report 23, *Manual for Determination of Status and Ownership, Arizona Mineral and Water Rights*
Coconino County Comprehensive Plan; adopted September 23, 2003.
Mohave County Arizona General Plan; adopted December 5, 2005.

1.5 IDENTIFICATION OF ISSUES

1.5.1 Process

Publication of the Notice of Intent (NOI) in the *Federal Register* on August 26, 2009, initiated the formal scoping process. The scoping comment period concluded on October 30, 2009. During the scoping period, BLM hosted two public meetings; the first was held on September 30 in Fredonia, Arizona, the second on October 15 in Flagstaff, Arizona. Pursuant to NEPA requirements, the scoping meetings were advertised in a variety of formats (*Federal Register*, news media, BLM website, and by mail), beginning at least 2 weeks prior to their scheduled dates. In each format, the advertisements provided logistics and explained the purpose of the public meetings, gave the schedule for the public scoping period, outlined additional ways to comment, and provided methods for obtaining additional information.

The public meetings were conducted in an open house format designed for attendees to view informational displays, ask specialists about the Proposed Action and the EIS process, and submit written or verbal comments. Meeting attendees signed in upon entering, at which time they were provided with handouts and informed of the meeting format and how to comment. The handouts and displays provided information about the following:

- NEPA process,
- proposed withdrawal background,
- proposed withdrawal schedule,
- preliminary issues to be analyzed in the EIS,
- proposed withdrawal location, and
- how to provide comments.

The public was afforded several methods for providing comments during the scoping period:

- Comments could be recorded on comment forms at the scoping meetings. Comment forms were provided to all meeting attendees and were also available throughout the meeting room, where attendees could write and submit comments during the meeting.
- Emailed comments could be sent to a dedicated email address: azasminerals@blm.gov.
- Individual letters and comment forms could be mailed via U.S. Postal Service to Bureau of Land Management, Mineral Withdrawal EIS, 345 East Riverside Drive, St. George, UT 84790.

What Is an Issue?

Issues are usually expressed in terms of actual or perceived effects, risks, or hazards that a particular land or resource use may have on other lands or resources that are used or valued for other purposes.

During the scoping process, a number of issues were identified by the public, by BLM, and by cooperating agency managers and resource specialists. The Resource Advisory Council provided recommendations on issues and alternatives to consider.

One purpose of scoping is to provide an opportunity for members of the public to learn about the proposed withdrawal and to share any concerns or comments they may have. Input from the scoping process is then used to identify issues and concerns to be considered in the EIS. In addition, the scoping process helps identify potential alternatives to the Proposed Action as well as issues that are not considered significant and that can therefore be eliminated from detailed analysis in the EIS. The list of stakeholders and other interested parties is also updated and generally expanded during the scoping process.

The BLM received a total of 83,525 individual comment submittals during the public scoping period from 90 countries. Approximately 97% of these submittals consisted of 15 different form letters; other submittals included emails, BLM-furnished comment forms, and letters and faxes. Comments obtained during the scoping period were used to define the relevant (i.e., significant) issues that would be addressed in the EIS, as well as to assist in development of the alternatives. Scoping comments were analyzed and placed in one of two categories: 1) issues identified for analysis in the EIS (see Section 1.5.2); and 2) issues eliminated from detailed analysis because they are beyond the scope of the EIS (see Section 1.5.3).

1.5.2 Issues for Analysis

Substantive issues and concerns expressed during the agency and public scoping period were grouped by topic in the following categories:

- Air quality/climate
- American Indian resources
- Cultural resources
- Wilderness
- Mineral resources
- Public health and safety
- Recreation
- Social conditions
- Economic conditions
- Soil resources
- Soundscapes
- Special status species
- Vegetation resources
- Visual resources
- Water resources
- Fish and wildlife resources

Issue statements were then developed that describe the relevant issues identified during scoping to be analyzed in the EIS. The issues are described below in Table 1.5-1 and follow the general organization of

EIS Chapters 3 and 4. Issues include those raised by agencies, the general public, interest groups and businesses, and the Resource Advisory Council. The issues represent topics for analysis, not conclusions regarding environmental effects.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis

Resource Category/ Issue	Description of Relevant Issue
Air Quality and Climate	
Release of particulates	The release of particulates (dust) from exploration drilling operations, mining, and ore hauling traffic and other vehicles on unpaved roads could have an effect on the regional air quality. This could occur in combination with pre-existing emissions from coal plants, cities, traffic, and other sources of regional air pollution to create a cumulative regional effect on air quality.
Increase in regional haze	Emissions from all exploration and development activity and equipment could contribute to the regional haze affecting air quality in the defined prevention of significant deterioration area, as well as affect overall scenic quality.
Geology and Mineral Resources	
Change in underground geological conditions	Mining of uranium deposits would alter conditions underground, which could allow uranium and other minerals to be mobilized, entering the groundwater system. It has also been suggested that mining uranium deposits could remove a potential source of long-term contamination.
Availability of mineral resources	Providing a domestic source of mineral resources is one of the legitimate uses of public lands. Restrictions or closures individually and cumulatively decrease this ability, and substantial energy potential would be unavailable if the proposed withdrawal is put into effect.
Depletion of uranium resources	Mining these uranium deposits in the near future will deplete domestic resources that may be needed later for energy production or national security purposes.
Water Resources	
Dewatering of shallow perched aquifers	Mining of some uranium deposits would penetrate near-surface aquifers and could dewater them. The resulting water loss could affect nearby springs or shallow water developments.
Surface runoff from active or reclaimed mines	Surface runoff from active or reclaimed mine sites could contain elevated uranium and other metals, which would affect downstream water quality.
Contamination of deep regional aquifers by metals leached from mined ore deposits	Mining of uranium ore deposits could change the flow of groundwater and increase the leaching of metals into the deep groundwater aquifers (e.g., Redwall Limestone). This leaching could occur both during mining and after mine closure and could affect downgradient water quality. There are scientific uncertainties associated with understanding the hydrogeology and connections between groundwater and surface water systems, as well as how potential contamination in those systems would travel. The potential to contaminate water in the Grand Canyon region, including seeps and springs, thereby impacting water quality and biotic communities at discharge points, is an issue.
Contamination or loss of the Tusayan municipal water supply	The potential for the Tusayan municipal water supply to be affected by nearby uranium exploration or development activity is an issue.
Contamination of municipal water supplies derived from the Colorado River	The potential for elevated uranium and other metals, in either surface water or groundwater, to enter the Colorado River and contaminate the major downstream municipalities' primary source of drinking water in several western states is an issue.
Soil Resources	
Disturbance of soil resources	Soil resources in the area are valuable and could be difficult to re-establish once disturbed by exploration and development.
Loss of soil productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil productivity, creating potential short-term, long-term, and cumulative environmental impacts on soils and overall watershed function.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis (Continued)

Resource Category/ Issue	Description of Relevant Issue
Vegetation Resources	
Disturbance of vegetation	Vegetation in the area are could be difficult to re-establish once disturbed by exploration and development. Riparian vegetation could be affected by changes in groundwater conditions.
Vegetation productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil cover and vegetation productivity.
Special status species (Vegetation)	The potential short-term, long-term, and cumulative environmental impacts of uranium exploration and development on threatened, endangered, proposed, candidate, and sensitive species and their critical habitat are an issue. For vegetation species, these are usually direct impacts tied to surface disturbance; for species that rely on groundwater in the area, springs and seeps are significant.
Fish and Wildlife Resources	
Wildlife habitat	Issues associated with wildlife habitat include fragmentation of habitat by construction of new roads and transportation of uranium ore, noise from exploration or development activities that disrupts wildlife, wildlife disturbed by visual instructions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species. Uranium mining could affect groundwater resources through groundwater contamination or depletion at springs, caves, seeps, and creeks; this in turn could affect species associated with these areas.
Wildlife populations	The potential loss of critical wildlife winter range and the potential for activity to occur in critical calving or fawning areas or to disrupt nesting habitat, etc., are an issue.
Wildlife mortality	The increase in vehicle traffic associated with increased uranium exploration and development or increased recreational use on new roads could cause increased vehicle/wildlife accidents and associated wildlife mortality.
Special status species (wildlife)	The potential short-term, long-term, and cumulative environmental impacts of uranium exploration and development on threatened, endangered, proposed, candidate, and sensitive species and their critical habitat are an issue. For wildlife, these issues are usually indirect impacts associated with disturbance of habitat, loss of habitat, and contamination of habitat (including aquatic habitat), such as effects on area springs and seeps, increased noise, and increased traffic.
Visual Resources	
Changes in regional visual quality	Exploration and development activity would release pollutants, which could increase regional haze (see Air Quality issue) and result in changes in visibility that could affect the scenic quality of the region.
Visual intrusion to Park visitors	Exploration and development activity may be visible to Park visitors, either from key observation points within the Park or from areas in the backcountry of the Park. This could detract from visitors' experiences.
Visual intrusion to public outside the Park	Exploration and development activity may be visible to the public, either from key observation points or from areas in the backcountry. This could detract from visitors' experiences. The potential short-term, long-term, and cumulative impacts from mineral exploration and development activities on the area's visual quality and recreation use patterns are an issue. There could be a conflict between mineral exploration and development activities and Visual Resource Management classes.
Soundscape	
Noise disruption from exploration or development activity	Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park. The areas subject to noise effects and the intensity of sound from these activities need to be evaluated.
Cultural Resources	
Disturbance of historic and prehistoric sites	Surface disturbance associated with exploration or development activity could expose and cause damage to archaeological sites. Visual and atmospheric changes could adversely affect the integrity of site settings and cultural landscapes. It may not be possible to mitigate all adverse effects through scientific data recovery.
Effect on TCPs	Surface disturbance associated with exploration or development activity could disrupt the setting or integrity of TCPs such as the Red Butte area on the Tusayan Ranger District or other TCPs located in or near the parcels.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis (Continued)

Resource Category/ Issue	Description of Relevant Issue
American Indian Resources	
Disturbance of traditional cultural practices and uses	Mineral exploration and development activity could affect the integrity of religiously and culturally significant sites and landscapes and could disrupt traditional practices and uses. Such practices include ceremonial activities, gathering of plants or other natural resources, and use of springs and trails. Tribes have expressed concerns about potential disturbance and contamination of culturally important resources.
Protection of tribal trust resources or assets	Tribal trust resources and assets are property, or property rights or interests, actually owned by a tribe. These may include property or rights located on- or off-reservation. As a trustee for the tribes, the federal government has the responsibility to preserve and protect tribal trust resources and assets from loss or degradation. One trust resource issue is the potential contamination of Havasupai Springs and the economic impact of reduced tourism for the Havasupai Tribe if the springs were to be contaminated.
Wilderness	
Wilderness Areas	Designated wilderness is already withdrawn. However, mining adjacent to Wilderness Areas could affect the wilderness characteristics of these lands, including lands managed as wilderness in Grand Canyon National Park.
Recreation	
Roads and access	Development of roads for mineral exploration and development could both facilitate access for some recreation users and provide too much public access in areas currently used for more primitive recreation. Uranium exploration and development in the area may create conflicts between tourism and mining-associated development and traffic.
Primitive recreation opportunity	Changes in amount of mineral exploration and development activity would change visual and auditory conditions, which in turn could affect primitive recreation opportunities in the area. The potential for water contamination and impacts to area seeps and springs, as well as recreation users, including river runners, backpackers, and hikers in the Park, is an issue.
Social Conditions	
Population trends	There could be changes in population levels associated with decreased mineral exploration and development activity under a withdrawal. Likewise, the continued mineral development in the absence of a withdrawal could involve local population increases, as additional workers are required. Increases in population increase the demands on local infrastructure such as schools, roads, and emergency services. Decreases in populations, while decreasing the demand for such services, can also reduce revenue available to support services.
Road condition, maintenance, and safety	The total number of ore truck trips that would be required for mineral exploration and development activity would affect the region’s resources. The use of road systems to service mine operations requires increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access. Mineral exploration and development activity could provide funding from property and use taxes for maintenance needs. Decreases in activity mean less maintenance along with less potential revenue. The increased traffic volumes, roadway use conflicts between haul trucks, local residents, and visitors to the region, and highway safety concerns are an issue.
Public health effects	The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport. There are concerns about the potential short-term, long-term, and cumulative environmental impacts of uranium exploration and development activity, including toxic waste hazards, on human health. Potential human health impacts that could accompany mining and any resulting accumulation of uranium in water, soils, and airborne particulate matter in the Grand Canyon region and in the Colorado River and its tributaries are an issue.
Environmental justice	The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. Environmental justice is the equitable distribution of project benefits and risks with respect to low-income populations and minority populations. In the case of uranium mining, it is the distribution of the project benefits, primarily economic, compared with the distribution of the project impacts such as pollution or risk of pollution, that is the issue.

Table 1.5-1. Description of Relevant Issues for Detailed Analysis (Continued)

Resource Category/ Issue	Description of Relevant Issue
Economic Conditions	
Energy resources available	The withdrawal could lead to increased reliance on energy sources other than nuclear, such as additional mining elsewhere, imports of uranium from foreign sources, or production from equivalent amounts of other sources like coal, petroleum, natural gas, wind power, or solar.
Effects on economic activity from tourism	Tourism represents a large component of the economic activity for many communities in the region and for the state. The manner and degree to which continued mining could change the nature and quality of the natural resources that attract tourism are an issue. Specifically, the potential for uranium exploration, development, and haulage to disrupt visitor experiences could impact the regional tourist economy. The regional tourism economy is connected to the Grand Canyon in terms of jobs, annual revenues, and tax revenues across different tourism sectors.
Economic activity from mineral development	Mineral resources and the benefits associated with mineral extraction would be foregone or potentially foregone should the proposed withdrawal go into effect. Mineral exploration and development activity represents a large component of the economic activity for many communities in the region. The manner and degree of the proposed withdrawal could directly affect the economic activity in the area, particularly in smaller communities.

1.5.3 Issues Eliminated from Detailed Analysis

Issues beyond the scope of the EIS include issues not directly related to decisions to be made regarding the proposed withdrawal and issues that are not relevant to the purpose of and need for action. Also, issues more properly considered at a different level of analysis or by a different entity have been eliminated from detailed analysis.

The following issues have been eliminated from detailed analysis because they are beyond the scope of the EIS:

- Revision of the Mining Law.
- The assertion that mining companies have been allowed to exploit public lands without giving the American people a fair return for their use (i.e., charging a royalty on mine production).
- Illegal activities such as poaching, vandalism, and unauthorized collection of cultural artifacts, or unauthorized OHV travel; these are law enforcement issues.
- Acid deposition or acid rain from power generation and its effects on flora or fauna.
- Analysis of specific alternative energy sources (e.g., wind or solar) to employ and where to employ them as substitutes for uranium resources made unavailable if lands in the area were to be withdrawn.
- The role of nuclear energy in the nation’s energy future.
- The amount by which the use or non-use for energy production of uranium found in the proposed withdrawal area could change global temperatures.
- The extent to which uranium energy production offsets the use of carbon-based fuels that contribute to the release of greenhouse gases (GHGs), which have been linked to global climate change.
- National defense use of uranium.
- Disposal of spent nuclear fuel.
- Alternate locations besides the White Mesa Mill in Blanding, Utah, in which mined uranium should or should not be processed, stored, or sold.

Chapter 2

PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

Chapter 2 describes in detail the proposed withdrawal (Proposed Action) and alternatives to the Proposed Action. Section 2.2 explains how the issues identified during scoping were used to develop alternatives. Section 2.3 describes the alternatives that were considered but eliminated from detailed analysis. In Section 2.4, each alternative is presented in detail in three segments: 1) an explanation of what lands would be withdrawn from location under the Mining Law, 2) the operating requirements for locatable mineral exploration and development, and 3) the level of reasonably foreseeable future locatable mineral operations that could occur under that alternative based on the reasonably foreseeable development (RFD) scenarios (see Appendix B). Section 2.5 describes past, present, and reasonably foreseeable future actions that may contribute to cumulative impacts. The identification of a preferred alternative is discussed in Section 2.6. Comparison tables are presented in Sections 2.7 and 2.8 to summarize and contrast the major provisions and impacts of each alternative.

NEPA and its implementing regulations promulgated by the CEQ require that an agency rigorously explore and objectively evaluate all reasonable alternatives. Reasonable alternatives are those that meet the purpose of and need for action and that are feasible to implement, taking into consideration regulatory, technical, economic, environmental, and other factors. In addition to reasonable alternatives, the EIS must also analyze the No Action Alternative, which provides a baseline against which to compare the potential environmental impacts for the action alternatives.

Alternatives are the heart of the EIS, as they present other possible courses of action that could achieve the underlying purpose of and need for action to which the agency is responding. In this case, as described in Chapter 1, the underlying purpose of and need for action is to protect the natural, cultural, and social resources in the Grand Canyon watershed from the possible adverse effects of locatable mineral exploration and development that could occur in the area.

In response to the above-stated purpose and need, approximately 1 million acres have been proposed for up to a 20-year withdrawal in order to prevent the location and development of new mining claims. This chapter of the EIS explores other options to the Proposed Action in the form of alternatives that could be used to address the purpose and need, as well as the No Action Alternative. How the Proposed Action and alternatives achieve the underlying purpose of and need for action is assessed by the decision-maker based in part on the environmental effects of each alternative, which are described in detail in Chapter 4 and summarized in Table 2.8-1. This comparative analysis of alternatives is done to provide the decision-maker, as well as the public, with a clear picture of the distinctions between the alternatives from the standpoint of environmental effects, which contributes to providing a clear basis for making an informed choice between alternatives.

2.2 DEVELOPMENT OF ALTERNATIVES

As detailed in Section 1.5, two public meetings were held to identify issues and assist with alternatives development. The formal public scoping process began on August 26, 2009, with the *Federal Register* publication of an NOI to prepare an EIS for a proposed withdrawal. By the end of the formal scoping period, the BLM had received a total of 83,525 comment submittals.

The alternative development process began with evaluating the public input collected during scoping and continued with extensive discussion between the BLM, as the lead agency, and the cooperating agencies, including the Forest Service, NPS, USFWS, and USGS; tribal governments; and state and local governments; recommendations were also sought from the Resource Advisory Council. The main issues identified during scoping were in the categories of Air Quality, Cultural Resources, Public Health and Safety, Recreation and Visuals, Socioeconomics, Soil and Water Resources, Special Status Species, Transportation, and Wildlife. These preliminary concerns were grouped into five categories in order to seek specific input from agency resource specialists: Biological Resources (vegetation, wildlife), Cultural Resources, Hydrologic Resources (including groundwater, surface water, and soils/erosion potential), Recreation/Visuals, and Socioeconomics. Alternatives were developed by superimposing the above categories of resource values on a single map in order to identify where such resource values were concentrated and hence outline the areas that were most sensitive to surface disturbance activities such as might occur during locatable mineral exploration and development.

In formulating alternatives to the proposed withdrawal, the BLM and cooperating agency managers and scientists—as a group and as separate resource-specific teams—initially decided on several general parameters that could be changed in order to develop a range of reasonable alternatives that would meet the purpose of and need for action, minimize impacts to resources, and address the key concerns identified in scoping. The parameters initially used were as follows:

- The proposed withdrawal area boundaries could be reduced to focus on those areas with a high concentration of sensitive resources or areas with limited data on sensitive resources.
- The proposed withdrawal area boundaries could be changed based on the uranium potential within the parcels, i.e., to include or exclude high-potential lands.
- The environmental protection requirements and other management programs in the proposed withdrawal area could be changed, possibly eliminating the need for the proposed withdrawal.
- The time frame of the proposed withdrawal could be decreased; for example, the withdrawal could be limited to 10 years instead of 20 years.

In addition, the necessity that all alternatives must be reasonable and meet the purpose of and need for action as defined in Chapter 1 (Section 1.3) was emphasized to all personnel involved in the alternative development process.

The initial suggestions for alternatives were subjected to a formal screening process to determine which were or were not viable, that is, which types of alternatives would meet the purpose of and need for action, would eliminate or minimize potential impacts, and would be distinct enough from other alternatives to provide a range of reasonable alternatives for the decision-maker. Suggestions such as phasing mining, limiting the number of mines that could operate at any given time, changing the Mining Law, and others, were screened out as parameters. The alternatives screened out and the rationale for not considering them are included in Section 2.3, Alternatives Considered but Not Analyzed in Detail.

As a result of this process, four alternatives have been developed for detailed analysis to address the significant relevant issues identified during scoping. Note that the preferred alternative to be identified in the Final EIS could be any one of the alternatives presented in the Draft EIS, or some combination or minor variation of the alternatives presented (see Section 2.6).

- **Alternative A**, the No Action Alternative: the proposed withdrawal would not be implemented and 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 B**, the Proposed Action: the proposed withdrawal would be implemented and the entire 1,010,776 acres of federal locatable mineral estate within the three parcels would be

withdrawn for 20 years from operation of the Mining Law, subject to valid existing rights. On mining claims where valid existing rights determined to exist, drilling and mining activities would continue to be processed by the BLM or the Forest Service.

- **Alternative C**, Partial Withdrawal: 652,986 acres of federal locatable mineral estate within the three parcels would be withdrawn 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 cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development (see also Figures 2.4-2 through 2.4-4 in Section 2.4.4). Alternative C would leave the remaining portion of the proposed withdrawal area with isolated or low concentrations of these resources open to operation of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.
- **Alternative D**, Partial Withdrawal: 300,681 acres of federal locatable mineral estate within the three parcels would be withdrawn 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 cultural, hydrologic, recreational, visual, and biological resources that could be adversely affected by locatable mineral exploration and development (see also 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 of the Mining Law. The mitigation of potential effects from exploration or development would continue under the applicable surface managing agency regulations.

One of the purposes of alternatives is to address relevant significant issues identified scoping. Each of the above alternatives was prepared to address certain issues raised during scoping or to meet requirements for alternatives analysis contained in regulation and policy, as explained below.

Alternative A is the No Action Alternative as required by NEPA [40 CFR 1502.14(d)]. The No Action Alternative “provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives” (CEQ 1981:Question 3). Alternative A provides the environmental baseline against which the other alternatives are compared.

Alternative A would continue to rely upon the existing requirements and programs to protect the resources in the Grand Canyon watershed without the proposed withdrawal. It addresses the comments and concerns raised during scoping that the existing regulations applicable to exploration and development may not be adequate to protect the resources in the Grand Canyon watershed and that the withdrawal would unnecessarily restrict mining and result in economic impacts to local communities that are counting on mining to support their economies. Alternative A addresses the identified concern that uranium production needs to be maintained or allowed to expand as a low-carbon energy source to meet the nation’s clean energy needs.

Alternative B, the Proposed Action, is the Secretary’s proposal to withdraw 1,010,776 acres of federal locatable mineral estate, subject to valid existing rights. As the Proposed Action, it is the major federal action requiring preparation of the EIS. This alternative addresses the issues and concerns raised during scoping over the natural resource and human health and safety impacts that could be associated with increased uranium mining in the Grand Canyon watershed and the potential impacts of mining on tourism, recreational uses, American Indian tribes, and cultural resource values.

Alternatives C and D are partial withdrawal alternatives designed as geospatial approaches to balance the socioeconomic impacts of a complete withdrawal (particularly the potential loss of economic benefits associated with uranium exploration and development in the area) and the protection of the areas that contain concentrations of biological, cultural, ethnographic, hydrologic, recreational, and visual resources. These alternatives focus the withdrawal preventing the location of new mining claims on areas with concentrations of nonmineral natural resources yet leave some high-potential uranium lands available for development.

To arrive at the partial withdrawal areas shown for Alternatives C and D, resource specialists and scientists from the federal agencies attended several alternatives discussion and development workshops. During the workshops, resource specialists considered the purpose of and need for action, to protect the natural, cultural, and social resources in the Grand Canyon watershed in order to identify the geographic areas of highest resource occurrence. The geographic areas from each group of resource specialists were then superimposed to determine the areas where such resources were concentrated in order to formulate the withdrawal boundaries of Alternatives C and D.

Representatives from the state, tribal, and county cooperating agencies were consulted during the development of the alternatives and invited to provide input. In addition, the Resource Advisory Council was asked to provide recommendations on issues and alternatives to be considered.

More detailed descriptions of Alternatives A through D are provided in Section 2.4, below. Section 2.7, Comparison of Alternatives, includes summary tables that identify key components, acreages, and reasonably foreseeable future mining-related activities by alternative for each parcel.

2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

Sometimes, alternatives are suggested or proposed that on closer examination do not adequately respond to the purpose of and need for action, are technically or economically infeasible, are not ripe for consideration because they are remote or speculative, are substantially similar in design to an existing alternative, or would have substantially similar effects as an existing alternative. In such cases, the alternatives are usually eliminated from detailed analysis. Alternatives to the proposed withdrawal that were considered and eliminated from detailed analysis are described below, along with the rationale for their elimination.

2.3.1 Change in Duration of Withdrawal

An alternative was initially considered to change the time frame of the proposed withdrawal from 20 years to 10 years, or even to 5 years. However, it was determined a shorter term withdrawal does not warrant evaluation as a separate alternative because withdrawals can be renewed by the Secretary of the Interior, provided that the underlying reason for the withdrawal is still valid. Since protection of the Grand Canyon watershed is a long-term need and mining interest is foreseeable in the long term, it is quite possible that a shorter term withdrawal would simply be renewed, resulting in no meaningful difference between a 10-year and a 20-year withdrawal. Therefore, an alternative that consisted solely of changing the duration of the proposed withdrawal was eliminated from further detailed analysis.

2.3.2 Withdraw Only Lands with Low Mineral Potential

It was suggested early in scoping that a partial withdrawal of only the lands with low mineral resource potential be considered for withdrawal. Such an alternative was suggested as a possible means to leave the high-potential lands available for mineral development, with a withdrawal to remove other lands with high nonmineral natural resource values from location and entry under the Mining Law.

This alternative was eliminated from detailed analysis for several reasons. All the lands in the proposed withdrawal area are rated as having a high potential for uranium resources, lying within what USGS terms Favorable Area A (USGS 2010b). While certain specific areas within the proposed withdrawal area have attracted greater industry interest than others (the North and South parcels in particular), all of the lands involved in the proposed withdrawal are considered to be lands with some of the highest uranium potential in the country. Another factor affecting the feasibility of this alternative is that much of the uranium exploration and development activity to date tends to coincide with many of the areas that have the highest concentration of nonmineral resource values. This is evident when comparing the active and existing mines shown on the figures in this chapter with the areas depicted as having high concentrations of nonmineral resources. This coincidence suggests that mineral potential, or mineral development interest, would not be a useful discriminating factor in designing a partial withdrawal alternative that would meet the purpose of and need for action.

2.3.3 No Withdrawal—Phased Mine Development

This alternative was considered as a way to limit the level of exploration and development activity in place of a withdrawal. Under this alternative, potential impacts to resources in the Grand Canyon watershed would be protected by limiting mineral development to certain areas at certain times, with a limited amount of mineral exploration and development activity occurring at any one time. This "phased development" alternative was eliminated from detailed analysis because it does not address the relevant aspect of the mining issue—the location of the activity—and the effects from specific individual mines on area resources. The RFD scenarios described in Appendix B do not indicate the likelihood of multiple mines' overlapping in time or location and creating such extensive cumulative impacts that phased development would be a particularly useful mitigation approach.

Alternatives that better address the issue of impacts from the development of multiple mines either prohibit mining in areas with sensitive resources under one of the withdrawal alternatives or include careful screening for cumulative impacts under the existing regulations. Therefore, the phased mine development alternative, as a separate alternative, was eliminated from further analysis.

2.3.4 Permanent Withdrawal

During scoping, it was suggested that a permanent withdrawal be implemented instead of the proposed withdrawal for 20 years. The rationale for this is that if Grand Canyon resources require protection from the potential adverse effects of mining, that protection should be for longer than 20 years.

This alternative was considered but eliminated from detailed analysis for several reasons. A permanent withdrawal would require congressional action because the Secretary does not have the ability to implement a withdrawal for more than 20 years for areas aggregating more than 5,000 acres [FLPMA Section 204(c)], In addition, Congress is already considering just such a proposal under the legislative process [HR 644], which is the appropriate venue for such an action. Furthermore, it is unclear whether there would be much difference between how a permanent withdrawal addresses the relevant significant issue of effects from uranium mining in the Grand Canyon watershed, compared with the proposed 20-year withdrawal. Withdrawals made by the Secretary under the authority of FLPMA are renewable as long as the underlying reason for the withdrawal is still valid. Hence, the environmental consequences of a permanent withdrawal and a 20-year withdrawal with respect to uranium mining could be difficult to distinguish in a separate alternative.

2.3.5 Change the Mining Law

Many comments received in response to the Notice of Proposed Withdrawal and during scoping suggested that reforming or changing the Mining Law would address potential environmental impacts to the Grand Canyon watershed. While the Mining Law is fundamentally a law for acquiring property rights, rather than an environmental law, presumably the comments were directed at eliminating the ability to establish property rights and increasing agency discretion to prevent mining. This alternative was eliminated from consideration for several reasons.

Making or amending law is an explicit function of the Congress, and proposals to change the Mining Law are currently under consideration before Congress. Even if such a change in law could be structured that responded to the purpose of and need for action with respect to mining in the Grand Canyon watershed, it is unlikely to be implemented in time to have any effect before the segregation expires and new mining claims can be located. Because an alternative to amend the Mining Law is too speculative, may not address the purpose and need, and is not within the ability of the Secretary to implement, it has been eliminated from detailed analysis.

2.3.6 New Mining Requirements

During scoping, it was suggested by members of the public and the Resource Advisory Council that instead of the withdrawal, the BLM and Forest Service should consider new locatable mineral exploration and development requirements, along with certain program initiatives, to protect the resources in the Grand Canyon watershed from the potential adverse effects of uranium exploration and development. During alternative formulation, the interagency team identified a number of potential new requirements for uranium exploration and development within the area proposed for withdrawal. Such requirements included processing and review requirements specific to notices and plans of operation, as well as regional monitoring programs, remediation efforts, targeted research initiatives, and coordinated interagency oversight, including the following:

- The BLM and Forest Service would require a plan of operations for all activity exceeding casual use in the area. Surface disturbance exceeding casual use, including exploratory drilling, could not be conducted under a notice but would require a plan of operations and be subject to NEPA analysis and the opportunity for public comment.
- The BLM and Forest Service would not approve a plan of operations in which the environmental analysis determines that substantial irreparable harm would occur to significant natural or cultural resources in the Grand Canyon watershed that could not be effectively mitigated. This requirement would be used where the plan of operations was considered unreasonable because it posed a substantial risk of causing impacts that would result in the permanent loss of significant values and irreplaceable resources that could not be mitigated using available technology.
- Before approving a plan of operations, the BLM or Forest Service would consult with the NPS on the operating and reclamation standards needed to prevent the impairment of Grand Canyon National Park System resources. Such measures would be incorporated into the BLM or Forest Service decision as conditions of approval when determined necessary to protect National Park System resources.
- The BLM and Forest Service would assess civil penalties, when necessary, in order to enforce their respective operating requirements.
- A compensatory off-site mitigation program would be established that could be used for regional mitigation at legacy uranium mine sites that require cleanup, or for responding to unanticipated

events or conditions at mine operations that are found to be adversely affecting natural, cultural, or social resources in the Grand Canyon watershed.

- A cost recovery program would be used to fund federal agency monitoring and compliance activities determined necessary to oversee individual mining operations.
- The BLM and Forest Service would undertake an initiative, in conjunction with other federal and state agencies, to establish regional programs to monitor wildlife indicator species for effects resulting from uranium mining.
- The BLM and Forest Service would undertake an initiative, in conjunction with other federal and state agencies, to establish regional programs to identify, characterize, and monitor area groundwater and spring conditions for effects associated with uranium mining.
- The BLM and Forest Service would undertake an initiative, in conjunction with other federal agencies and tribal governments, to establish regional programs to identify and monitor other natural and cultural resources for effects associated with uranium mining.
- The BLM and Forest Service would establish a standing regional interagency workgroup to advise the federal land managing agencies on monitoring, research needs, and operating and reclamation performance standards.

Most of the requirements described above would require changing the BLM and Forest Service surface management regulations at 43 CFR 3809 and 36 CFR 228A, respectively, in order to be implemented. The rulemaking process for amending regulations can take years, and the final outcome is not certain until a final rule is published. Furthermore, changing the regulatory requirements could be proposed as a subsequent action in conjunction with any of the withdrawal alternatives, including the No Action Alternative. The other program requirements or initiatives listed above could be implemented under any alternative independent of a withdrawal action or a regulation change. Because a New Mining Requirements Alternative would depend on the outcome of some future regulatory process yet to be initiated, its ability to be implemented is speculative, and a separate alternative considering such measures and their effectiveness has been eliminated from detailed analysis.

2.4 DESCRIPTION OF THE ALTERNATIVES

This section describes the elements of each alternative in sufficient detail to understand what would be involved in its implementation. The individual alternative description is divided into three components: 1) a description of the area that would be withdrawn from location and entry under the Mining Law with accompanying maps as appropriate; 2) a narrative that describes the operating requirements for locatable mineral exploration and development activities; and 3) the reasonably foreseeable future activity or actions that could occur based on the RFD scenario developed for each alternative, as detailed in Appendix B.

The first component, the description of area to be withdrawn, focuses on Alternatives B, C, and D. There is no withdrawal associated with Alternative A, since Alternative A is the No Action Alternative. The second component, the narrative describing the operating requirements for locatable mineral exploration and development activities, is essentially the same for Alternatives A through D. Requirements for mining companies to comply with environmental regulations administered by other federal and state agencies would also apply to all alternatives. Many of these compliance requirements are expressed as project design features intended to reduce or minimize environmental impacts. Some aspects of the requirements, such as the procedures for determining valid existing rights, are especially relevant to the alternatives that include a withdrawal since new activity would be limited to those claims with valid existing rights as of the date of the segregation, July 21, 2009.

The reasonably foreseeable future activity, the final component described under each alternative, focuses on key outputs from Appendix B, Locatable Mineral Resources—Reasonably Foreseeable Development Scenarios. The RFD scenarios were prepared in order to provide a broad overview of the types and amount of reasonably foreseeable future locatable mineral exploration and development. As an overview, the RFD scenarios do not replace the detailed review required at the project level, nor are they substitutes for the validity examinations required to assess valid existing rights under the Mining Law. Instead, the RFD scenarios provide a consistent set of assumptions regarding anticipated exploration or development that could occur under each alternative and serve as the basis for assessing the environmental effects in Chapter 4.

Predictions of reasonably foreseeable future locatable mineral exploration, development, and mining activities are presented for each alternative and include estimates of the following:

- Number of mines,
- Amount of exploration activity,
- Miles of new mine access roads,
- Miles of power lines,
- Number of ore haul trips,
- Acreage of surface disturbance, and
- Water use.

These numbers from the RFD scenarios should not be regarded as absolute, meaning they are only estimates of what could occur under each alternative using a consistent set of assumptions. Their main utility is for comparing the alternatives. The RFD numbers do not constitute a limit or minimum on the level of future locatable mineral operations.

The acreages of areas withdrawn, operating requirements, and RFD projections for each alternative are summarized at the end of this chapter in Tables 2.7-1 through 2.7-3, respectively.

2.4.1 Past Withdrawals

Discrete areas in the region have already been withdrawn, or made unavailable, to entry and location under the Mining Law. These previously withdrawn lands, illustrated in Figure 2.4-1 and listed in Table 2.4-1, would remain withdrawn under all of the alternatives. In addition, several tribes in the region, including the Havasupai Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe, and Kaibab Band of Paiute Indians, have declared a uranium mining moratorium for their tribal lands.

Table 2.4-1. Lands in the Vicinity of the Proposed Withdrawal Area Previously Withdrawn from Mining Activity

Withdrawn Land Designation	Surface Area (square miles)	Acres
Grand Canyon National Park	1,904	1,218,375
Grand Canyon–Parashant National Monument	1,638	1,048,316
Grand Canyon Game Preserve	997	638,080
Vermilion Cliffs National Monument	459	294,000
Total for Withdrawn Areas	**4,998**	**3,198,771**

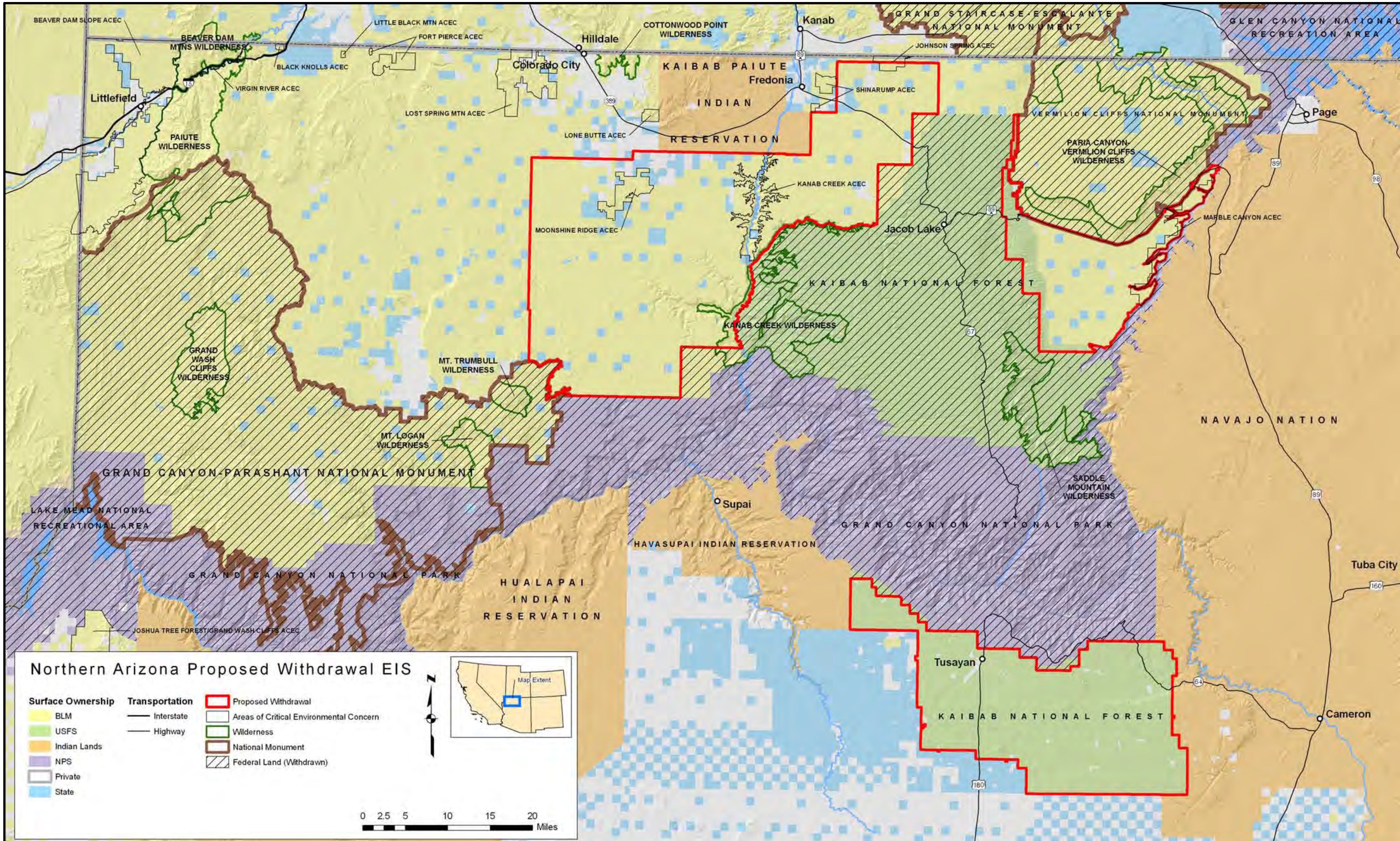

Figure 2.4-1. Previously withdrawn lands in the proposed withdrawal region.

2.4.2 Alternative A: No Action Alternative

Alternative A—Area Withdrawn

Under the No Action Alternative, the Secretary would not withdraw any of the lands identified in the Notice of Proposed Withdrawal from location and entry under the Mining Law. The proposed withdrawal area (see Figures 1.1-1 and 2.4-1) would remain open to location and entry under the Mining Law. New mining claims could be located. The BLM and Forest Service would continue to oversee locatable mineral exploration and development in accordance with their existing programs, policies, and regulations.

Alternative A—Locatable Mineral Operating Requirements

Locatable mineral exploration and development on BLM land is subject to the surface management regulations at 43 CFR 3715 and 3809. Locatable mineral operations on National Forest land are regulated under 36 CFR 228A. The following is a brief description of the each agency's existing requirements.

On BLM land, locatable mineral operations beyond "casual use" require that a detailed plan of operations be submitted to the BLM for review and approval. Casual use is generally defined as "activities ordinarily resulting in no or negligible disturbance of the public lands or resources" (43 CFR 3809.5). Exploration activities exceeding casual use can submit what is called a *notice* rather than a *plan of operations*, provided that the surface disturbance is less than 5 acres and does not occur in what are called special-category lands [43 CFR 3809.11(c)]. These special-category lands include ACECs, Wild and Scenic Rivers, National Monuments, National Conservation Areas, designated wilderness areas, OHV closed areas, and threatened and endangered species critical habitat. Areas disturbed must be reclaimed upon completion of operations. The operator is required to provide the BLM with an approved financial guarantee that is adequate to cover the estimated cost to complete the reclamation plan before beginning activities under either a notice or plan of operations. In addition, under the regulations at 3715, the BLM must make a formal decision of concurrence before a proposed occupancy of a mining claim or millsite can occur. This is usually done in conjunction with the review of a notice or approval of a plan of operations.

On National Forest System lands, for most locatable mineral operations, "a notice of intent to operate is required from any person proposing to conduct operations which might cause significant disturbance of surface resources" [36 CFR 228.4(a)]. The requirement is further defined and clarified in the regulations. If the operation is likely to cause significant disturbance of surface resources, a plan of operations must be submitted in lieu of the notice of intent. The determination of the significance of surface disturbance is made by the District Ranger, in accordance with Forest Service Manual 2810, Section 2817.11. In either case, "if the District Ranger determines that any operation is causing or will likely cause significant disturbance of surface resources, the District Ranger shall notify the operator that the operator must submit a proposed plan of operations for approval and that the operations cannot be conducted until a plan of operations is approved" [36 CFR 228.4(a)(4)].

The review and approval of a plan of operations by the BLM or Forest Service involve the following basic steps: 1) review of the proposed plan of operations to determine whether the operator has submitted complete operating, reclamation, monitoring, and interim management plans; 2) NEPA analysis, including the opportunity for public comment; 3) development of mitigating measures as conditions of approval required to meet the requirements of the regulations; 4) determination of the reclamation cost and financial guarantee amount; and 5) approval of the plan of operations and financial guarantee instrument. The approved plan of operations is subject to compliance monitoring by the BLM or Forest Service to ensure that the operator is following the approved plan.

Operations conducted under a *notice*, *notice of intent*, or an approved *plan of operations* must comply with all applicable state and federal laws and regulations related to environmental protection.

A more detailed description of the operating requirements of each agency is in Table 2.7-2 and in Appendix B.

Alternative A—Reasonably Foreseeable Future Activity

Uranium is the primary locatable mineral commodity of interest in the proposed withdrawal area. In this region uranium deposits of economic interest occur within geological structures termed breccia pipes. There are 45 confirmed breccia pipes within the proposed withdrawal area. Twenty-six of these confirmed breccia pipes are known to have some level of mineralization that may be economic to develop. Based on confirmed breccia pipe occurrence, as well as uranium resource estimates made by the USGS for the proposed withdrawal area, the RFD scenario estimates that 30 underground uranium mines could be developed within the proposed withdrawal area over the next 20 years. An approved plan of operations would be required for each new mine and would include detailed project planning and NEPA review, as described above.

In the North Parcel, the BLM believes that 18 new mines can be reasonably foreseen to come into production over the next 20 years in addition to the three that existed prior to the Proposed Withdrawal—Pinenut, Arizona 1, and Kanab North. The Arizona 1 Mine is in active production, while the Pinenut and Kanab North Mines are operating under interim management as approved in their plans of operation. The total estimated surface disturbance is estimated to be 945 acres from exploration and development in the North Parcel over 20 years. It is estimated that 208,385 ore haul trips would be associated with this level of mining activity.

Each mine would likely require a deep production well for operational water during the average 5-year life span of the mine, with most water usage occurring during the anticipated 3-year ore production phase. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 221 million gallons (mgal) of water could be required for mine operations in the North Parcel over 20 years.

A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-2. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would be present at the same time.

Table 2.4-2. Reasonably Foreseeable Future Activity, Alternative A, North Parcel

Alternative A (No Action)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	504	25 projects/year
Acres disturbed for exploration (1.1 acres/project)	554	28 acres/year
Predicted mining projects (3 existing + 18 new)	21	1 mine/year
Acres new disturbance for mining (20 acres/mine)	360	18 acres/year
Number of ore haul trips (25 tons ore/trip)	208,385	10,420 trips/year
Miles of new power lines (parallel to access roads)	16.4	0.8 mile/year
Miles of new roads for new mine access	16.4	0.8 mile/year
Total acres disturbed for exploration and development	945	47 acres/year
Water usage (10.5 mgal/mine)	221	11 mgal/year

In the East Parcel, there are no existing mines, although two new mines are possible over the next 20 years, based on the RFD scenario. The total estimated surface disturbance is 107 acres from exploration and development in the East Parcel over 20 years. It is estimated that 22,240 ore haul trips would occur from mining in the East Parcel.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 21 mgal of water would be required for mine operations in the East Parcel over 20 years.

A breakdown by the type of activity that could occur in the East Parcel is shown below in Table 2.4-3. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

Table 2.4-3. Reasonably Foreseeable Future Activity, Alternative A, East Parcel

Alternative A (No Action)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	56	3 projects/year
Acres disturbed for exploration (1.1 acres/project)	62	3 acres/year
Predicted mining projects (2 new)	2	–
Acres disturbed for new mining (20 acres/mine)	40	–
Number of ore haul trips required (25 tons ore/trip)	22,240	3,707 trips/year/mine
Miles of new power lines (parallel to access roads)	2.4	–
Miles of new roads for new mine access	2.4	–
Total acres disturbed for exploration and development	107	5 acres/year
Water usage (10.5 mgal/mine)	21	1 mgal/year

In the South Parcel, there is one existing uranium mine, the Canyon Mine, where the shaft has been partially developed, with an additional six new uranium mines likely to occur over the next 20 years, based on the RFD scenario. The total estimated surface disturbance is 312 acres in the South Parcel over 20 years from exploration and development. It is estimated that 69,540 ore haul trips could occur from mines in the South Parcel. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine, with most water being used during ore production. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 74 mgal of water could be required for mine operations in the South Parcel over 20 years.

A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-4. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3, at the end of this chapter, compares the amount of activity predicted by the RFD scenario for each alternative.

Table 2.4-4. Reasonably Foreseeable Future Activity, Alternative A, South Parcel

Alternative A (No Action)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	168	8 projects/year
Acres disturbed for exploration (1.1 acres/project)	185	9 acres/year
Predicted mining projects (1 existing + 6 new)	7	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	120	6 acres/year
Number of ore haul trips (25 tons ore/trip)	69,540	3,477 trips/year
Miles of new power lines (parallel to access roads)	3.6	–
Miles of new roads for new mine access	3.6	–
Total acres disturbed for exploration and development	312	16 acres/year
Water usage (10.5 mgal/mine)	74	4 mgal/year

2.4.3 Alternative B: Proposed Action (20-Year Withdrawal)

Alternative B—Area Withdrawn

Alternative B is the proposed withdrawal from location and entry under the Mining Law of the federal locatable mineral estate underlying approximately 626,354 acres of BLM land, 360,349 acres of National Forest land, 4,284 acres of state lands, and 19,789 acres of private lands in the North, East, and South parcels, subject to valid existing rights. These lands are identified by legal description in the July 21, 2009, *Federal Register* Notice of Proposed Withdrawal and Opportunity for Public Meeting (see Appendix A) and shown in Figures 1.1-1 and 2.4-1. The private and state lands within the parcel boundaries with non-federal mineral estate would not be subject to the proposed withdrawal. However, if these lands were ever acquired by the federal government through means such as sale or exchange, they would be subject to the withdrawal and closed to locatable mineral exploration and development.

The proposed withdrawal would prohibit the location of new mining claims. Exploration or development operations on BLM and National Forest System lands on existing mining claims under notices or plans of operation submitted after the effective date of the withdrawal would not be able to proceed unless the subject mining claim were determined to be valid under the Mining Law as of the date of the segregation, July 21, 2009.

Alternative B—Locatable Mineral Operating Requirements

Locatable mineral operations would continue to be managed under the operating requirements described above for Alternative A. Locatable mineral operations on BLM land are subject to the surface management regulations at 43 CFR 3809. Locatable mineral operations on National Forest System land are regulated under 36 CFR 228A. A key difference under Alternative B is that the BLM and Forest Service would only process new notices and plans of operation on mining claims located prior to July 21, 2009, and where it was determined that the mining claim was valid before the withdrawal and remains valid.

On BLM land, existing mining claims in the withdrawn area would be subject to provisions of 43 CFR 3809.100(a), which states, "After the date on which the lands are withdrawn from appropriation under the mining laws, BLM will not approve a plan of operations or allow notice-level operations to proceed until BLM has prepared a mineral examination report to determine whether the mining claim was valid before the withdrawal, and whether it remains valid." During the preparation of a mineral examination, activities would be limited to sampling and testing in order to verify the presence of a discovery or to perform required annual assessment work. The time frame listed in the regulations for responding to a notice or plan of operations would be suspended pending the results of the mineral examination.

If the mineral examination determines that the mining claims involved in the notice or plan of operations are valid, i.e., held by a discovery of a valuable mineral deposit under the Mining Law, then the notice or plan of operations would continue to be processed in accordance with the regulations at 43 CFR 3809. If the mineral examination determined that the mining claims were not valid, then the BLM would not approve the plan of operations or allow notice-level activities to proceed and would institute contest proceedings against the subject mining claims.

On National Forest System lands, the Forest Service would follow essentially the same procedure as explained above for BLM lands. Although there are no specific regulations, the Forest Service would not accept a notice of intent nor approve a plan of operations unless and until the subject mining claims were examined and determined to be valid under the Mining Law as of July 21, 2009, and remain valid.

Alternative B—Reasonably Foreseeable Future Activity

Reasonably foreseeable locatable mineral exploration and development operations under Alternative B are expected to be considerably more limited than under Alternative A because the area would be closed to new mining claim location. The only activity, in addition to the current approved operations, would be on existing mining claims determined valid as of July 21, 2009. Based on the number of confirmed breccia pipes within the proposed withdrawal area, it is estimated that in addition to the four existing uranium mines, seven more uranium mines could be developed.

In the North Parcel, there are three mines under plans of operation approved before the Notice of Proposed Withdrawal segregated the area—Arizona 1, Kanab North, and Pinenut—and seven mineralized breccia pipes with estimated uranium resources that are currently held under mining claims and would be likely to be developed into production. Ten mines could therefore operate during the 20-year time frame.

The total estimated surface disturbance from these mines, 10 additional drilling projects (incidental to existing claims), 6.4 miles of new power lines, and 6.4 miles of new roads is 163 acres in the North Parcel over 20 years. It is estimated that 86,065 ore haul trips could occur as a result of mining in the North Parcel.

It is estimated that a total of 105 mgal of water could be required over 20 years to support mine operations. A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-5. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

In the East Parcel, there are no existing mines, and there is only one breccia pipe confirmed through drilling. No mineral exploration or development is anticipated in this parcel under Alternative B, as it is unlikely any of the approximately two dozen mining claims had identified a valuable mineral deposit prior to July 21, 2009.

In the South Parcel, there is one partially developed mine, the Canyon Mine, but there are no other breccia pipes with estimated uranium resources. Therefore, it is likely that only the Canyon Mine would operate over the next 20 years. Total estimated surface disturbance from this mine is the 20 acres of existing disturbance and 1 acre related to drilling. It is estimated that 2,820 ore haul trips from mining in the South Parcel could occur based on the resources assumed to be present at the Canyon Mine. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Table 2.4-5. Reasonably Foreseeable Future Activity, Alternative B, North Parcel

Alternative B (Proposed Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	10	<1 project/year
Acres disturbed for exploration (1.1 acres/project)	11	<1 acres/year
Predicted mining projects (3 existing + 7 new)	10	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	140	7 acres/year
Number of ore haul trips (25 tons ore/trip)	86,065	4,303 trips/year
Miles of new power lines (parallel to access roads)	6.4	0.3 mile/year
Miles of new roads for new mine access	6.4	0.3 mile/year
Total acres disturbed for exploration and development	163	8 acres/year
Water usage (10.5 mgal/mine)	105	5 mgal/year

It is estimated that a total of 11 mgal of water could be required to support the Canyon Mine operations. A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-6. Because of the low level of activity, essentially one mine, it is likely that the drilling or mine disturbance would occur within a 4- to 5-year time frame, rather than being spread out evenly over 20 years.

Table 2.4-6. Reasonably Foreseeable Future Activity, Alternative B, South Parcel

Alternative B (Proposed Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	1	–
Acres disturbed for exploration (1.1 acres/project)	1	–
Predicted mining projects (1 existing)	1	–
Acres new disturbance for mining (20 acres/mine)	0	–
Number of ore haul trips (25 tons ore/trip)	2,820	564 trips/year/mine
Miles of new power lines (parallel to access roads)	0	0 new
Miles of new roads for new mine access	0	0 new
Total acres disturbed for exploration and development	1	–
Water usage (10.5 mgal/mine)	11	~2 mgal/year/mine

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3 at the end of this chapter compares the amount of activity predicted by the RFD scenario for each alternative.

2.4.4 Alternative C: Partial Withdrawal

Alternative C—Area Withdrawn

Alternative C is the withdrawal from location and entry under the Mining Law of the federal locatable mineral estate underlying approximately 399,849 acres of BLM land, 237,894 acres of National Forest System land, 4,284 acres of state lands, and 10,959 acres of private lands in the North, East, and South parcels subject to valid existing rights. This is only a portion of the area proposed to be withdrawn under Alternative A, the Proposed Action. The private and state lands within the Alternative C withdrawal area with non-federal mineral estate would not be subject to the withdrawal. However, if these lands were ever acquired by the federal government through means such as sale or exchange, they would be subject to the withdrawal and closed to locatable mineral exploration and development.

The location of new mining claims would be prohibited within the Alternative C withdrawal area. Exploration or development operations on BLM and National Forest System land on existing mining claims under notices or plans of operation submitted after the effective date of the withdrawal would not be able to proceed unless the involved mining claim were determined to be valid under the Mining Law as of the date of the segregation, July 21, 2009.

This alternative would withdraw those contiguous areas with a high concentration of natural resources. The remaining areas would stay open to locatable mineral exploration and development. Under Alternative C, the withdrawal of 652,986 acres amounts to approximately 65% of the total area being proposed for withdrawal under Alternative B (64% of the North Parcel, 67% of the East Parcel, and 64% of the South Parcel).

In the North Parcel, the 356,096 acres that would be withdrawn under this alternative include all or part of three ACECs—Johnson Spring, Kanab Creek, and Moonshine Ridge—as well as other lands known to contain cultural, biological, recreational, visual, and hydrologic resources. The Alternative C withdrawal boundaries and the identified areas of resource occurrence within the North Parcel are shown in Figure 2.4-2.

In the East Parcel, the 90,233 acres that would be withdrawn under this alternative includes the contiguous area with a high concentration of cultural, biological, recreational, visual, and hydrologic resources. This includes the lands along the southern boundary of Vermilion Cliffs National Monument and land adjacent to Marble Canyon. The Alternative C withdrawal boundaries and the identified areas of resource occurrence within the East Parcel are shown in Figure 2.4-3.

In the South Parcel, the 206,657 acres that would be withdrawn under this alternative form a contiguous area with a high concentration of cultural, biological, recreational, visual, and hydrologic resources. The proposed withdrawal includes Red Butte, regarded by American Indian tribes as a sacred site, and the Coconino Rim area, which is also important to area tribes. The Alternative C withdrawal area includes the Grand Canyon Railroad route and the area east and west of State Route (SR) 64, the entrance corridor to Grand Canyon National Park. The Alternative C withdrawal boundaries and areas of resource occurrence within the South Parcel are shown in Figure 2.4-4.

Alternative C—Locatable Mineral Operating Requirements

Locatable mineral operations would continue to be managed under the operating requirements described above for Alternative A. A key difference under Alternative C is that within the Alternative C withdrawal area, the BLM and Forest Service would only process new notices and plans of operation on mining claims located prior to July 21, 2009, and where it was determined that the mining claim was valid before the withdrawal and remains valid.

On BLM land, existing mining claims in the withdrawn area would be subject to provisions of 43 CFR 3809.100(a), which states, “After the date on which the lands are withdrawn from appropriation under the mining laws, BLM will not approve a plan of operations or allow notice-level operations to proceed until BLM has prepared a mineral examination report to determine whether the mining claim was valid before the withdrawal, and whether it remains valid.” During the preparation of a mineral examination, activities would be limited to sampling and testing in order to verify the presence of a discovery or to perform required annual assessment work. The time frames in the regulations for responding to a notice or plan of operations would be suspended pending the results of the mineral examination.

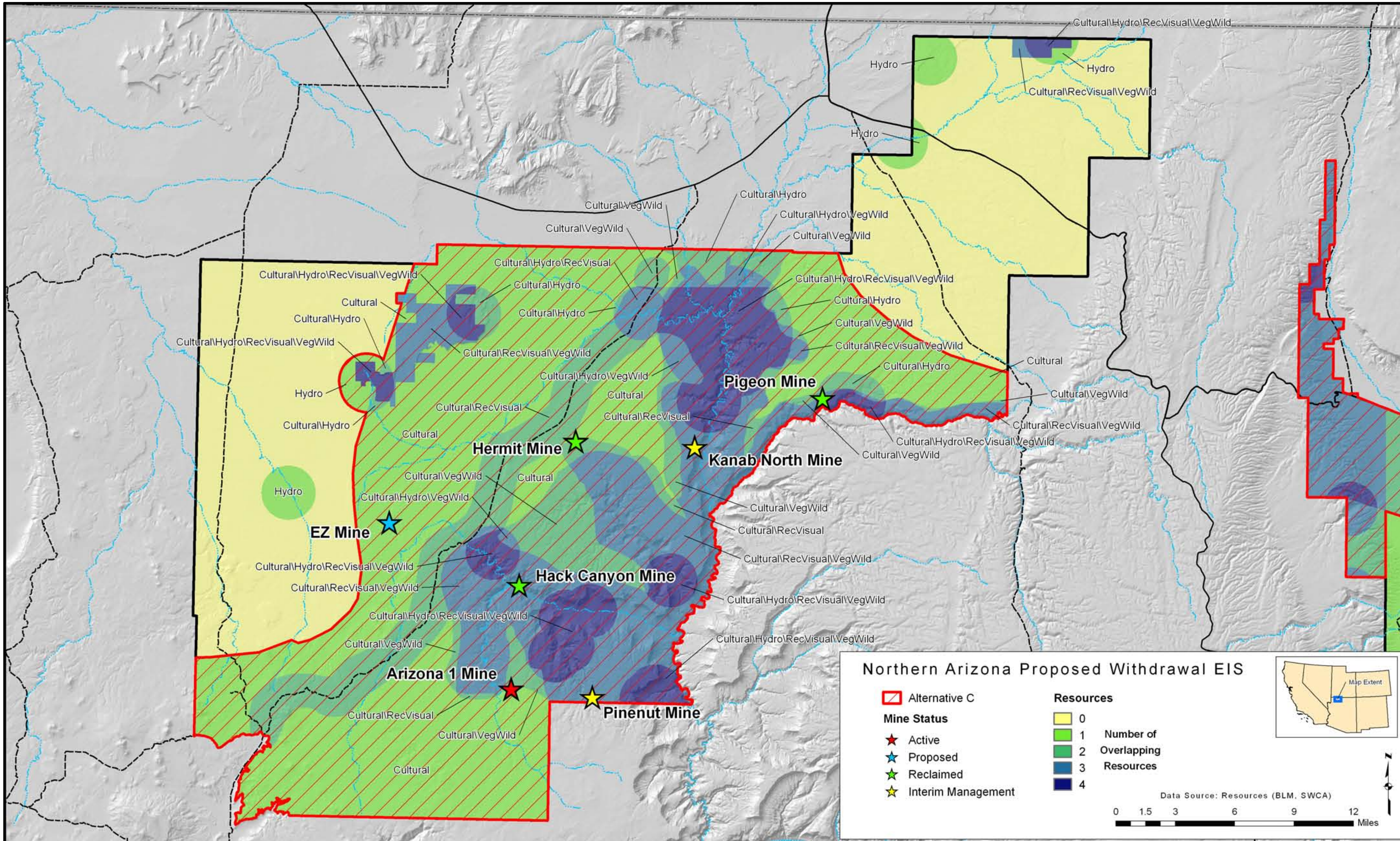

Figure 2.4-2. Alternative C partial withdrawal boundary: North Parcel.

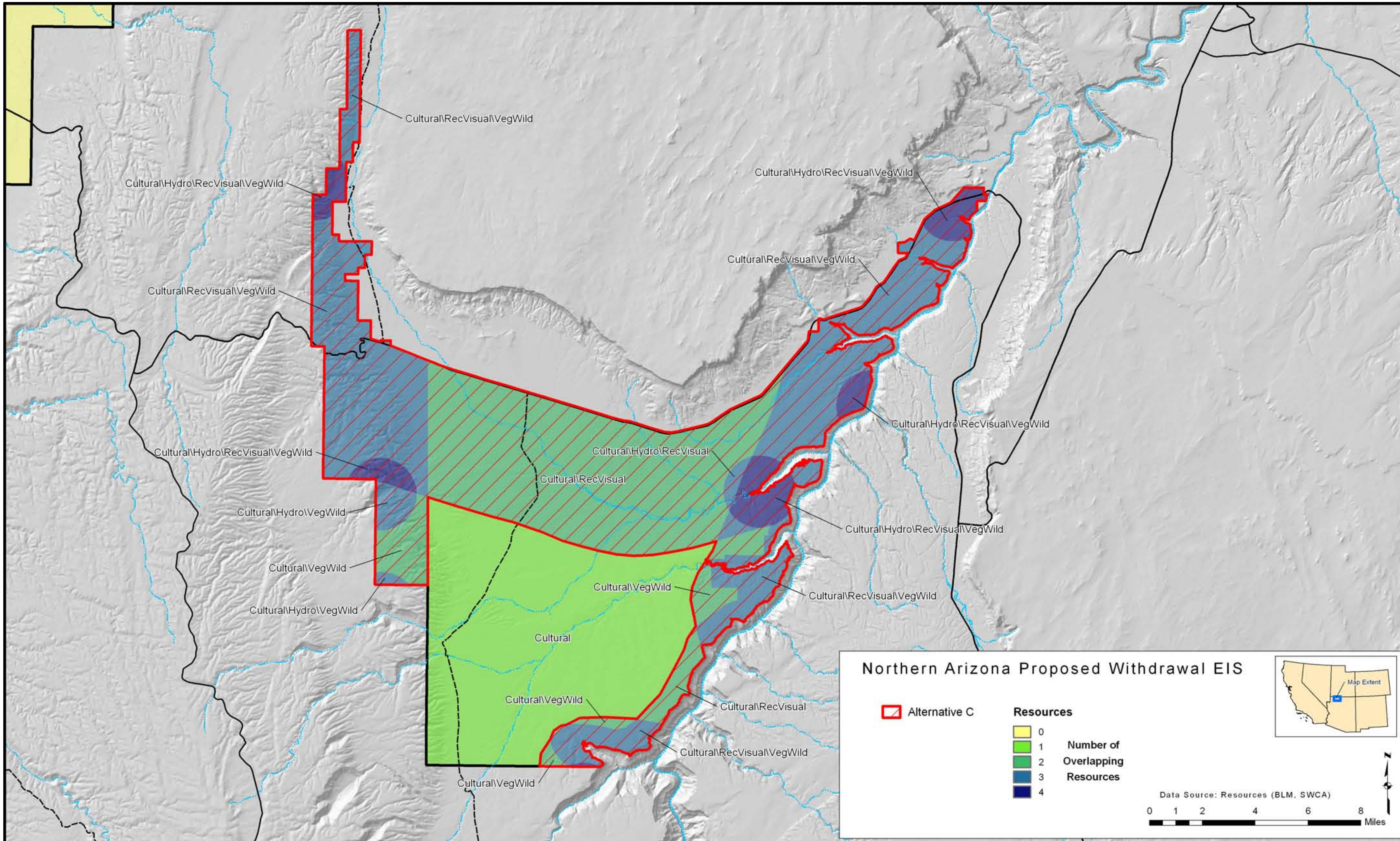

Figure 2.4-3. Alternative C partial withdrawal boundary: East Parcel.

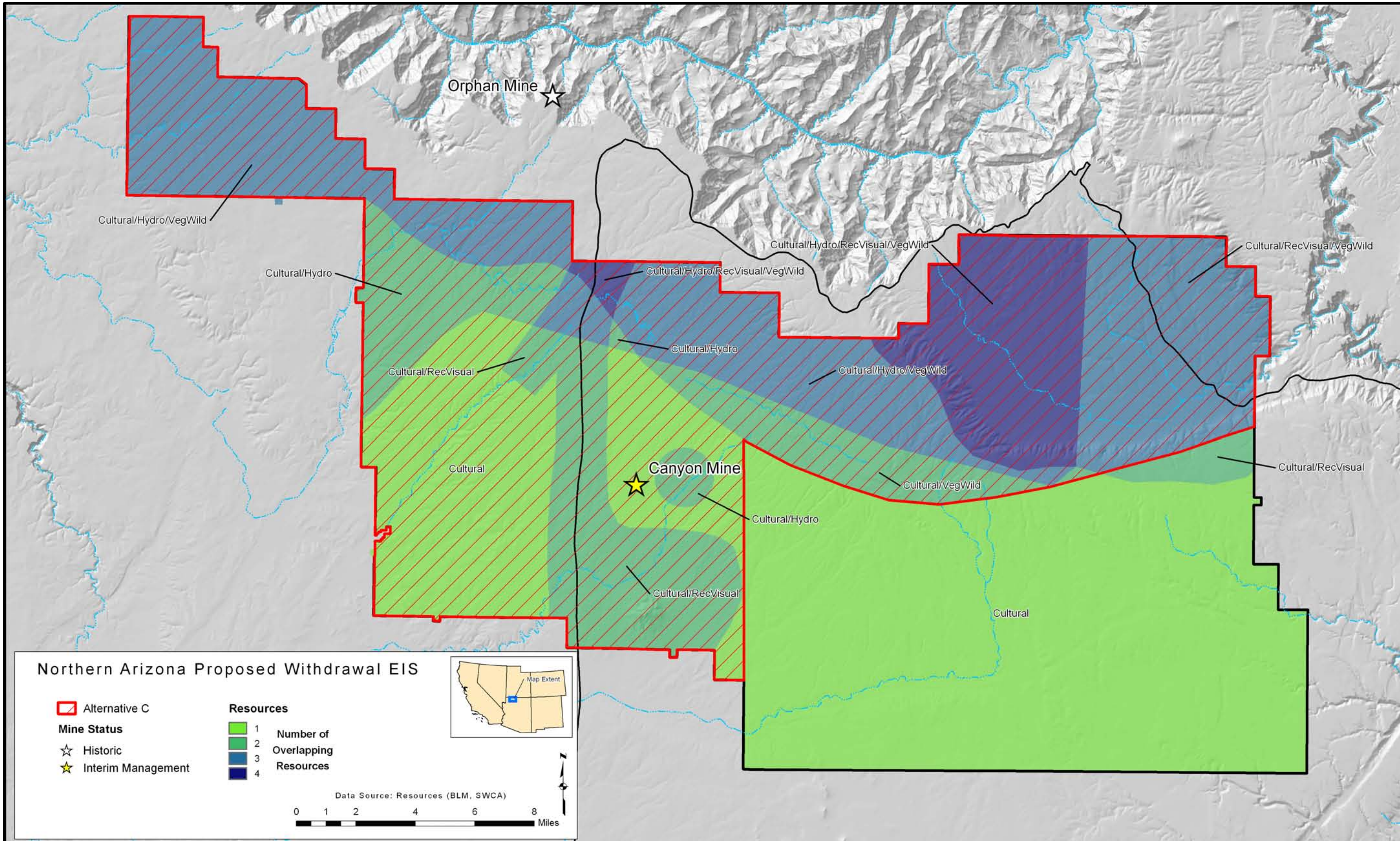

Figure 2.4-4. Alternative C partial withdrawal boundary: South Parcel.

If the mineral examination determines that the mining claims involved in the notice or plan of operations are valid, i.e., held by a discovery of a valuable mineral deposit under the Mining Law, then the notice or plan of operations would continue to be processed in accordance with the regulations at 43 CFR 3809. If the mineral examination determined that the mining claims were not valid, then the BLM would not approve the plan of operations or allow notice-level activities to proceed and would institute contest proceedings against the subject mining claims.

On National Forest System lands, the Forest Service would follow essentially the same procedure as explained above for BLM lands. Although there are no specific regulations, the Forest Service would not accept a notice of intent nor approve a plan of operations unless and until the subject mining claims were examined and determined to be valid under the Mining Law as of July 21, 2009, and remain valid.

Alternative C—Reasonably Foreseeable Future Activity

Reasonably foreseeable mineral exploration and development operations under Alternative C are expected to be considerably more limited than under Alternative A since more than two-thirds of the area would be withdrawn. On lands included in the Alternative C withdrawal, the only development in addition to the currently approved operations within the withdrawn area would be on existing mining claims determined to be valid as of July 21, 2009. Outside the area that would be withdrawn in this alternative, new mining claims could be located and exploration and development could proceed the same as on any BLM or National Forest System land open to operation of the Mining Law.

Based on confirmed breccia pipe occurrence, as well as uranium resource estimates made by the USGS for the area, the RFD scenario estimates that 18 underground uranium mines could be developed within the area over the next 20 years. This includes both the area that would be withdrawn under this alternative and the portion of the segregation area that would not be withdrawn under this alternative as shown in Figures 2.4-2 through 2.4-4. An approved plan of operations would be required for each new mine that would include detailed project planning and NEPA review, as described above.

In the North Parcel, there are three existing uranium mines—Pinenut, Arizona 1, and Kanab North—with an additional 10 new uranium mines that could be developed over the next 20 years. The total estimated surface disturbance as a result of exploration and development is 320 acres in the North Parcel over 20 years. It is estimated that 119,425 ore haul trips could occur as a result of mining in the North Parcel.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 137 mgal of water could be required for all the mine operations in the North Parcel over 20 years.

A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-7. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

In the East Parcel, there are no existing mines, although one new mine is predicted over the next 20 years, based on the RFD scenario. The total estimated surface disturbance is 54 acres from exploration and development over 20 years. It is estimated that 11,120 ore haul trips could occur as a result of mining in the East Parcel.

The new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 11 mgal of water would be required for mine operations in the East Parcel.

Table 2.4-7. Reasonably Foreseeable Future Activity, Alternative C, North Parcel

Alternative C (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	94	5 projects/year
Acres disturbed for exploration (1.1 acres/project)	103	5 acres/year
Predicted mining projects (3 existing + 10 new)	13	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	200	10 acres/year
Number of ore haul trips (25 tons ore/trip)	119,425	5,971 trips/year
Miles of new power lines (parallel to access roads)	9.1	0.5 mile/year
Miles of new roads for new mine access	9.1	0.5 mile/year
Total acres disturbed for exploration and development	320	16 acres/year
Water usage (10.5 mgal/mine)	137	7 mgal/year

A breakdown by the type of activity that could occur in the East Parcel is shown below in Table 2.4-8. Because of the low level of activity (essentially one mine), it is likely that the mining disturbance would occur within a 4- to 5-year time frame, rather than being spread out over 20 years.

Table 2.4-8. Reasonably Foreseeable Future Activity, Alternative C, East Parcel

Alternative C (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	28	1 project/year
Acres disturbed for exploration (1.1 acres/project)	31	2 acres/year
Predicted mining projects (1 new)	1	–
Acres new disturbance for mining (20 acres/mine)	20	–
Number of ore haul trips (25 tons ore/trip)	11,120	2,240 trips/year/mine
Miles of new power lines (parallel to access roads)	1.2	–
Miles of new roads for new mine access	1.2	–
Total acres disturbed for exploration and development	54	–
Water usage (10.5 mgal/mine)	11	~2 mgal/year/mine

In the South Parcel, there is one existing mine, the Canyon Mine, which is operating under interim management approved as a part of their plan of operation. An additional three new mines are likely to occur somewhere in that portion of the parcel that would not be withdrawn under this alternative over the next 20 years, based on the RFD scenario. The total estimated surface disturbance from exploration and development is 158 acres in the South Parcel over 20 years. It is estimated that 36,180 ore haul trips could occur as a result of mining in the South Parcel. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 42 mgal of water could be required for mine operations in the South Parcel over 20 years.

A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-9. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

Table 2.4-9. Reasonably Foreseeable Future Activity, Alternative C, South Parcel

Alternative C (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	85	4 projects/year
Acres disturbed for exploration (1.1 acres/project)	94	5 acres/year
Predicted mining projects (1 existing + 3 new)	4	–
Acres new disturbance for mining (20 acres/mine)	60	3 acres/year
Number of ore haul trips (25 tons ore/trip)	36,180	1,809 trips/year
Miles of new power lines (parallel to access roads)	1.8	–
Miles of new roads for new mine access	1.8	–
Total acres disturbed for exploration and development	158	8 acres/year
Water usage (10.5 mgal/mine)	42	2 mgal/year

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3 at the end of this chapter compares the amount of activity predicted by the RFD scenario for each alternative.

2.4.5 Alternative D: Partial Withdrawal

Alternative D—Area Withdrawn

Alternative D is the withdrawal from location and entry under the Mining Law of the federal locatable mineral estate underlying approximately 133,241 acres of BLM land, 165,042 acres of National Forest land, 881 acres of state lands, and 1,517 acres of private lands in the North, East, and South parcels, subject to valid existing rights. This is only a portion of the area proposed to be withdrawn under Alternative A, the Proposed Action, and a smaller area than what would be withdrawn under Alternative C, another partial withdrawal alternative. The private and state lands within the Alternative D withdrawal area with non-federal mineral estate would not be subject to the proposed withdrawal. However, if these lands were ever acquired by the federal government through means such as sale or exchange, they would be subject to the withdrawal and closed to locatable mineral exploration and development.

The location of new mining claims would be prohibited within the Alternative D withdrawal area. Exploration or development operations on BLM and National Forest System land on existing mining claims under notices or plans of operation submitted after the effective date of the withdrawal would not be able to proceed unless the involved mining claim were determined to be valid under the Mining Law as of the date of the segregation, July 21, 2009.

This alternative would withdraw only those contiguous areas with the highest concentration of natural resources. The remaining areas would stay open to locatable mineral exploration and development. Under Alternative D, the withdrawal of 300,681 acres amounts to approximately 30% of the total area being proposed for withdrawal under Alternative B (20% of the North Parcel, 42% of the East Parcel, and 41% of the South Parcel).

In the North Parcel, a total of 111,198 acres would be withdrawn under this alternative, including the Kanab Creek ACEC. The areas with the concentrations of cultural, biological, recreational, visual, and hydrologic resources to be withdrawn would include the area immediately adjacent to Kanab Creek, Grama Canyon, Hack Canyon, and Snake Gulch. The Alternative D withdrawal boundaries and identified areas of resource occurrence within the North Parcel are shown in Figure 2.4-5.

In the East Parcel, the 56,232 acres that would be withdrawn under this alternative include the areas with concentrations of cultural, biological, recreational, visual, and hydrologic resources. The area that would be withdrawn under this alternative is adjacent to Marble Canyon and the interface area between the Kaibab National Forest and Vermilion Cliffs National Monument. The Alternative D withdrawal boundaries and the identified areas of resource occurrence within the East Parcel are shown in Figure 2.4-6.

In the South Parcel, the 133,251 acres that would be withdrawn under this alternative include the contiguous area with the highest concentrations of cultural, biological, recreational, visual, and hydrologic resources. The area that would be withdrawn encompasses the northern portion of the Tusayan Ranger District north of the groundwater divide, including the Coconino Rim. The Alternative D withdrawal boundaries and areas of resource occurrence within the South Parcel are shown in Figure 2.4-7.

Alternative D—Locatable Mineral Operating Requirements

Locatable mineral operations would continue to be managed under the operating requirements described above for Alternative A. A key difference under Alternative D is that, within the Alternative D withdrawal area, the BLM and Forest Service would only process new notices and plans of operation on mining claims located prior to July 21, 2009, and where it was determined that the mining claim was valid before the withdrawal and remains valid.

On BLM land, existing mining claims in the withdrawn area would be subject to provisions of 43 CFR 3809.100(a), which states, "After the date on which the lands are withdrawn from appropriation under the mining laws, BLM will not approve a plan of operations or allow notice-level operations to proceed until BLM has prepared a mineral examination report to determine whether the mining claim was valid before the withdrawal, and whether it remains valid." During the preparation of a mineral examination, activities would be limited to sampling and testing in order to verify the presence of a discovery or to perform required annual assessment work. The time frame listed in the regulations for responding to a notice or plan of operations would be suspended pending the results of the mineral examination.

If the mineral examination determines that the mining claims involved in the notice or plan of operations are valid, i.e., held by a discovery of a valuable mineral deposit under the Mining Law, then the notice or plan of operations would continue to be processed in accordance with the regulations at 43 CFR 3809. If the mineral examination determined that the mining claims were not valid, then the BLM would not approve the plan of operations or allow notice-level activities to proceed and would institute contest proceedings against the subject mining claims.

On National Forest System lands, the Forest Service would follow essentially the same procedure as explained above for BLM lands. Although there are no specific regulations, the Forest Service would not accept a notice of intent nor approve a plan of operations unless and until the subject mining claims were examined and determined to be valid under the Mining Law as of July 21, 2009.

Alternative D—Reasonably Foreseeable Future Activity

Reasonably foreseeable mineral exploration and development operations under Alternative D are limited, compared with those described under Alternative A, since about one-third of the area would be withdrawn. On lands included in the Alternative D withdrawal, the only development in addition to the currently approved operations within the withdrawn area would be on existing mining claims determined valid as of July 21, 2009. Outside the area that would be withdrawn in this alternative, new mining claims could be located and exploration and development could proceed the same as on any BLM or National Forest System land open to operation of the Mining Law.

Based on confirmed breccia pipe occurrence, as well as uranium resource estimates made by the USGS for the area, the RFD scenario estimates that 26 underground uranium mines could be developed within the area over the next 20 years. This includes both the area that would be withdrawn under this alternative and the portion of the withdrawal area in the Proposed Action that would not be withdrawn under this alternative, as shown in Figures 2.4-5 through 2.4-7. An approved plan of operations would be required for each new mine and would include detailed project planning and NEPA review, as described above.

In the North Parcel, there are three existing uranium mines—Pinenut, Arizona 1, and Kanab North—with an additional 17 new uranium mines that could be developed over the next 20 years. The total estimated surface disturbance from exploration and development is 688 acres in the North Parcel over 20 years. It is estimated that 197,265 ore haul trips could occur as a result of mining in the North Parcel.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 210 mgal of water could be required for mine operations in the North Parcel over 20 years.

A breakdown by the type of activity that could occur in the North Parcel is shown below in Table 2.4-10. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

In the East Parcel, there are no existing mines, although one new mine is possible over the next 20 years, based on the RFD scenario. The total estimated surface disturbance from exploration and development is 54 acres in the East Parcel over 20 years. It is estimated that 11,120 ore haul trips could occur as a result of mining in the East Parcel.

The new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 11 mgal of water would be required for mine operations in the East Parcel.

A breakdown by the type of activity that could occur in the East Parcel is shown below in Table 2.4-11. Because of the low level of activity, essentially one mine, it is likely the mining disturbance would occur within a 4- to 5-year time frame, rather than being spread out over 20 years.

In the South Parcel, there is one existing mine, the Canyon Mine, which has been partially developed and is operating under interim management approved as a part of their plan of operation, with an additional four new uranium mines likely to occur somewhere in the portion of the parcel that would not be withdrawn under this alternative over the next 20 years, based on the RFD scenario. The total estimated surface disturbance from exploration and development is 209 acres in the South Parcel over 20 years. It is estimated that 47,300 ore haul trips could occur as a result of mining in the South Parcel. It is assumed that trucks hauling ore would not be able to transit Grand Canyon National Park.

Each new mine would likely require a deep production well for operational water during the average 5-year life span of the mine. Water would be drawn from the Redwall-Muav aquifer. It is estimated that a total of 53 mgal of water could be required for mine operations in the South Parcel over 20 years.

A breakdown by the type of activity that could occur in the South Parcel is shown below in Table 2.4-12. Because reclamation occurs once exploration or development is concluded, not all the disturbance shown below would occur at the same time.

The RFD scenario in Appendix B explains in detail how the above estimates of reasonably foreseeable future activity were determined. Table 2.7-3 at the end of this chapter compares the amount of activity predicted by the RFD scenario for each alternative.

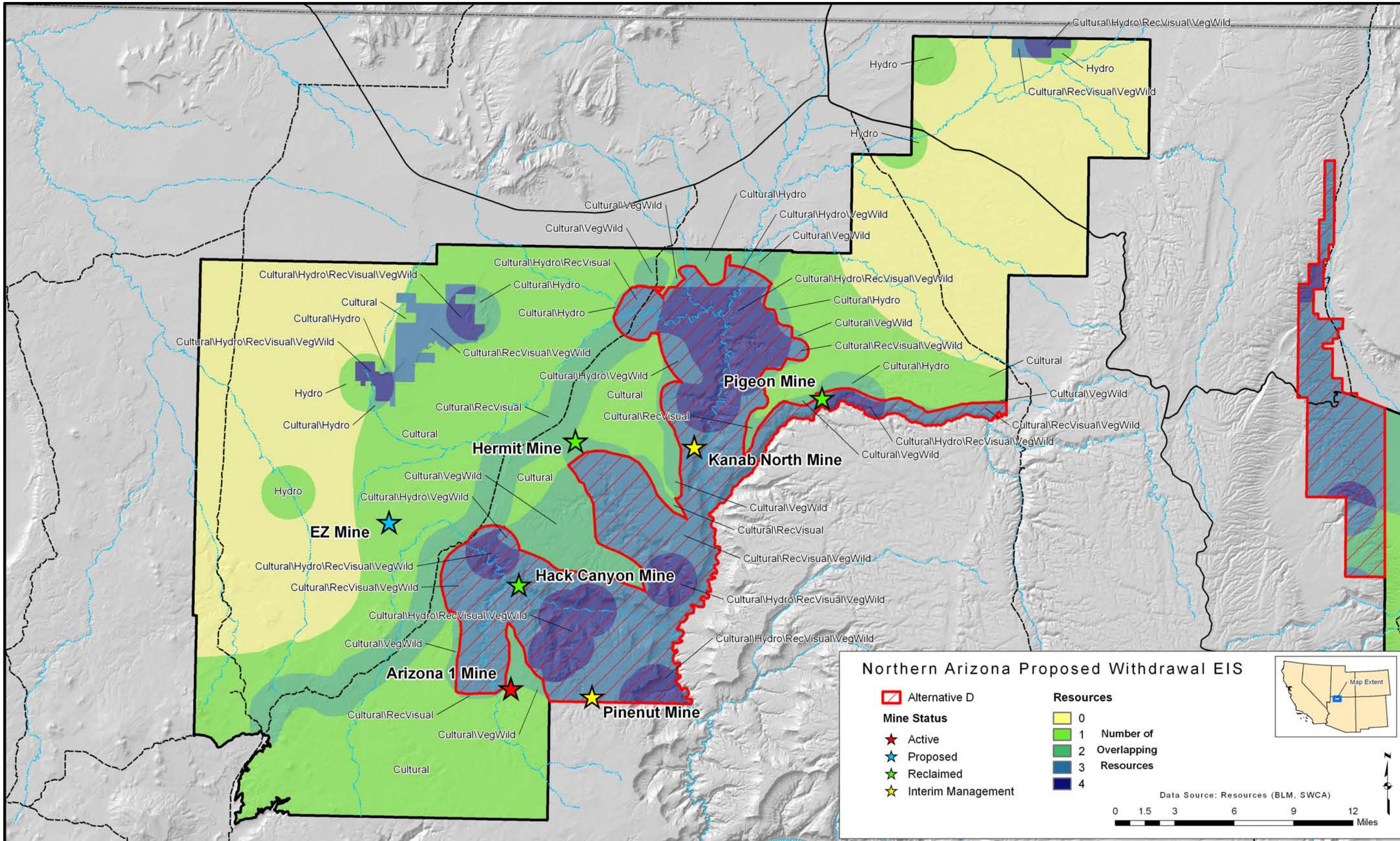

Figure 2.4-5. Alternative D partial withdrawal boundary: North Parcel.

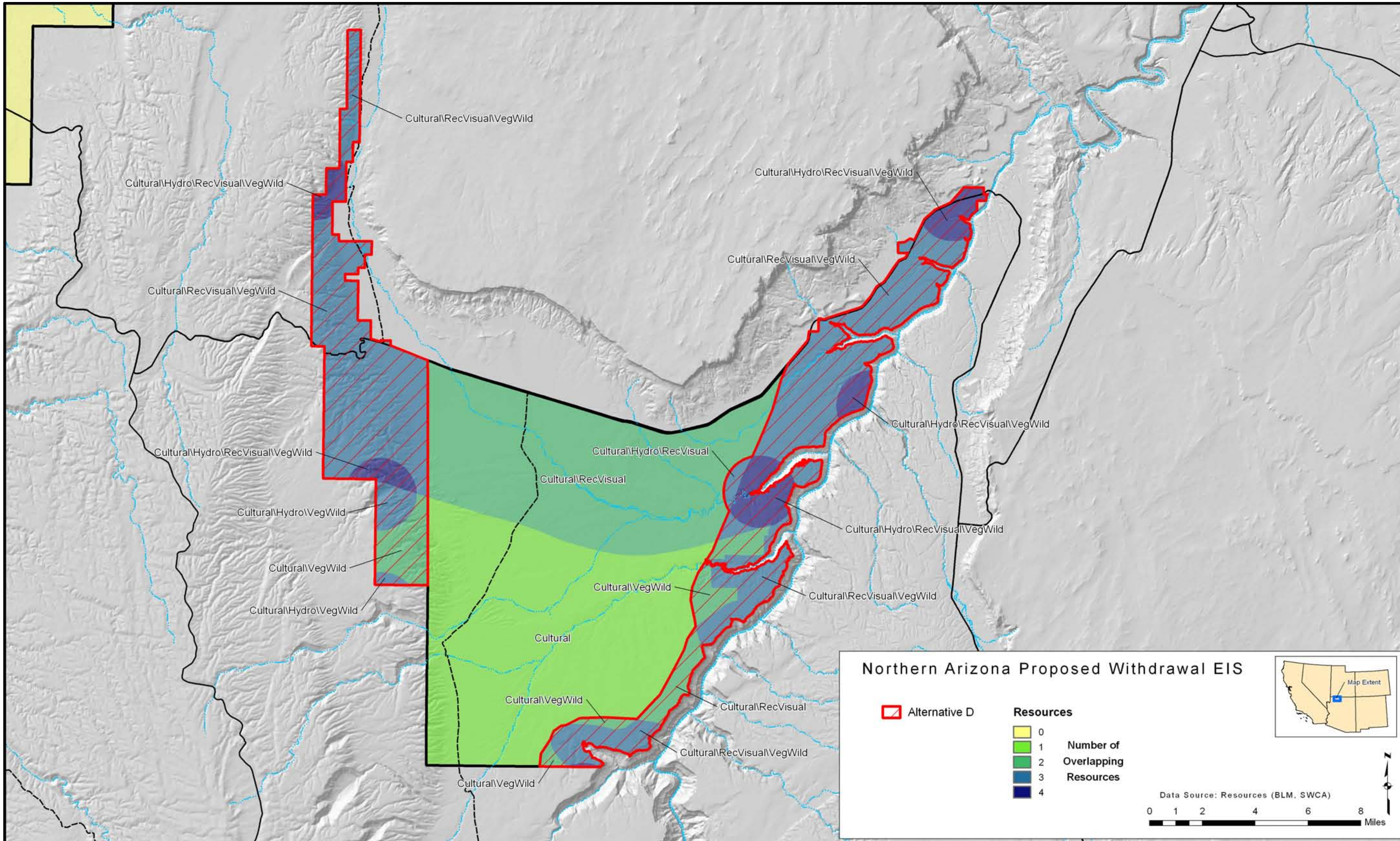

Figure 2.4-6. Alternative D partial withdrawal boundary: East Parcel.

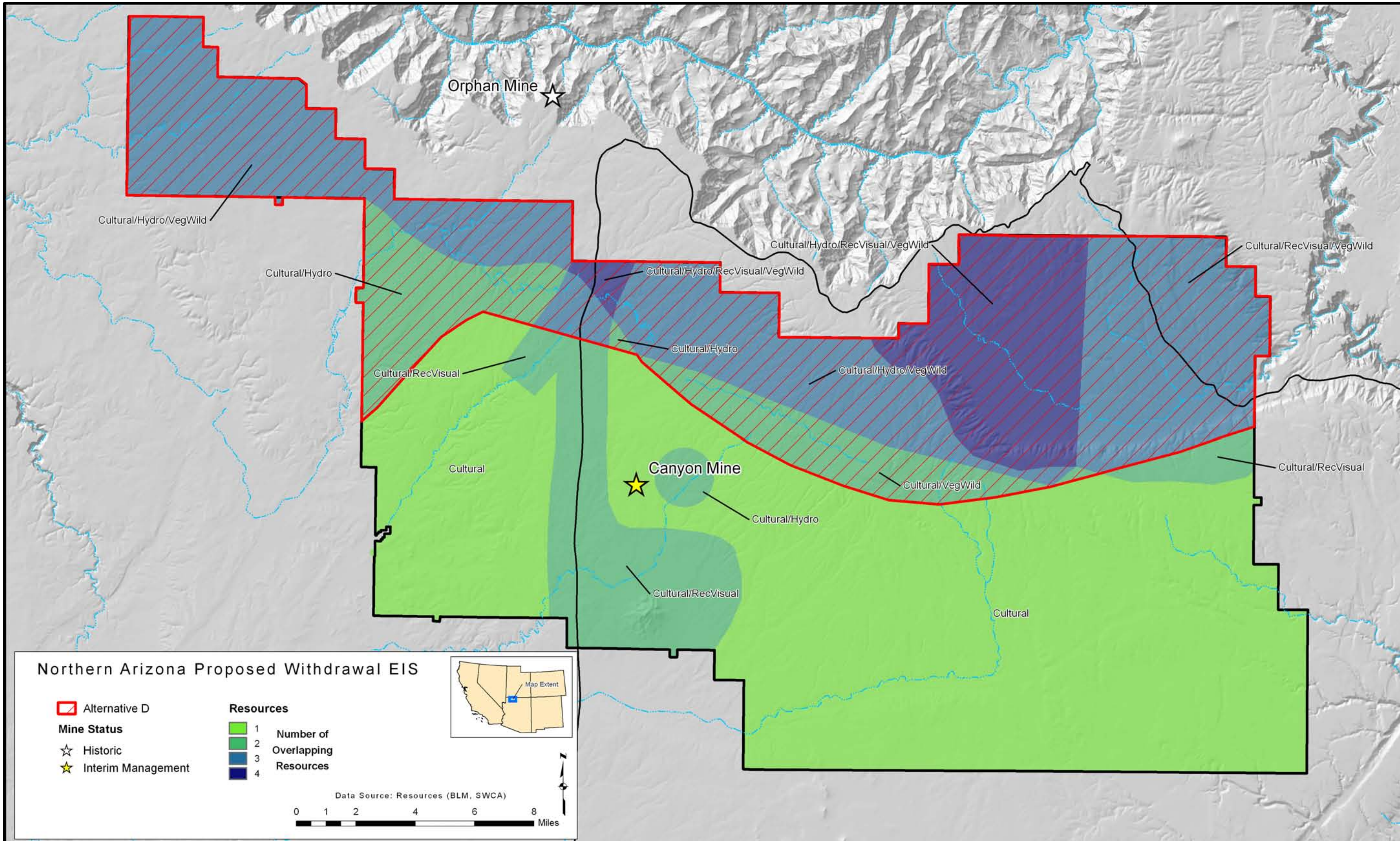

Figure 2.4-7. Alternative D partial withdrawal boundary: South Parcel.

Table 2.4-10. Reasonably Foreseeable Future Activity, Alternative D, North Parcel

Alternative D (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	290	15 projects/year
Acres disturbed for exploration (1.1 acres/project)	319	16 acres/year
Predicted mining projects (3 existing + 17 new)	20	1 mine/year
Acres new disturbance for mining (20 acres/mine)	340	17 acres/year
Number of ore haul trips (25 tons ore/trip)	197,265	9,863 trips/year
Miles of new power lines (parallel to access roads)	15.5	0.8 mile/year
Miles of new roads for new mine access	15.5	0.8 mile/year
Total acres disturbed for exploration and development	688	34 acres/year
Water usage (10.5 mgal/mine)	210	11 mgal/year

Table 2.4-11. Reasonably Foreseeable Future Activity, Alternative D, East Parcel

Alternative D (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	28	1 project/year
Acres disturbed for exploration (1.1 acres/project)	31	2 acres/year
Predicted mining projects (1 new)	1	–
Acres new disturbance for mining (20 acres/mine)	20	–
Number of ore haul trips (25 tons ore/trip)	11,120	2,240 trips/year/mine
Miles of new power lines (parallel to access roads)	1.2	–
Miles of new roads for new mine access	1.2	–
Total acres disturbed for exploration and development	54	–
Water usage (10.5 mgal/mine)	11	~2 mgal/year/mine

Table 2.4-12. Reasonably Foreseeable Future Activity, Alternative D, South Parcel

Alternative D (Partial Withdrawal)—Activity Levels	Over 20 Years	Average
Predicted exploration projects (~5 drill holes/project)	113	6 projects/year
Acres disturbed for exploration (1.1 acres/project)	124	6 acres/year
Predicted mining projects (1 existing + 4 new)	5	<1 mine/year
Acres new disturbance for mining (20 acres/mine)	80	4 acres/year
Number of ore haul trips (25 tons ore/trip)	47,300	2,365 trips/year
Miles of new power lines (parallel to access roads)	2.4	–
Miles of new roads for new mine access	2.4	–
Total acres disturbed for exploration and development	209	10 acres/year
Water usage (10.5 mgal/mine)	53	3 mgal/year

2.5 CUMULATIVE ACTIONS

All existing and anticipated exploration and development operations are included as part of the RFD scenarios used to predict reasonably foreseeable future actions and activities. The three mines within the area proposed for withdrawal (Canyon, Pinenut, and Kanab North) are under interim management, consistent with their approved plans of operation. Arizona 1 is the only uranium mining operation currently in production within the area proposed for withdrawal. All four of these mines are included in the RFD analysis (see Appendix B).

The BLM is currently reviewing a plan of operations for mining of the EZ-1, EZ-2, and What deposits in the North Parcel (Figure 2.4-5, labeled EZ MINE). These deposits are proximally located and are planned to be mined from a single mine location. Potential development of these deposits is included as part of the RFD scenarios (see Appendix B). Site-specific analysis, findings, and decisions regarding the EZ-1, EZ-2, and What plan of operations will be made by BLM after preparation of a separate, project-specific environmental analysis is completed. A site-specific analysis of that plan of operations is not within the scope of the current EIS.

On October 10, 2008, the Kaibab National Forest published a *Federal Register* NOI to prepare an EIS on the proposed exploration of 24 mining claims in the South Parcel held by VANE Minerals, Inc. (VANE). VANE must prove valid existing rights prior to the July 21, 2009, segregation in order to conduct exploration. However, VANE subsequently withdrew the plan of operations. The Forest Service is not currently reviewing any plans of operation within the area proposed for withdrawal. Potential exploration and possible mine development of these claims is included as part of the RFD scenarios (see Appendix B). A site-specific analysis of the VANE exploration plan of operations is not within the scope of the current EIS.

Other reasonably foreseeable, non-mineral-related actions that could contribute to cumulative impacts, such as recreational use, OHV use, and road construction, are presented and analyzed in the individual resource sections in Chapter 4, where the potential for a specific cumulative impact is identified.

2.6 PREFERRED ALTERNATIVE IDENTIFICATION

The CEQ regulations at 40 CFR 1502.14(e) and Department of Interior regulations at 43 CFR 46.425 direct that an EIS "identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference." According to CEQ, the agency's preferred alternative "is the alternative that the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors" (CEQ 1981:Question 4). BLM has not identified a preferred alternative in this DEIS and is soliciting public comments and input with respect to the identification of a preferred alternative. Based on a review of public comments, BLM will identify a preferred alternative in the Final EIS.

For actions presented in this EIS, the decision-maker is the Secretary of the Interior. The EIS is being prepared to objectively provide the decision-maker with a range of reasonable alternatives, each analyzed to a comparable level of detail. The preferred alternative could be any one of the alternatives presented in the Draft EIS, or some combination or minor variation of the alternatives presented. In accordance with NEPA [40 CFR 1502.9(1)], a preferred alternative within the spectrum of alternatives analyzed in the Draft EIS will not require supplementation (CEQ 1981:Question 29b).

2.7 COMPARISON OF ALTERNATIVES

Table 2.7-1 identifies the approximate number of acres of federal locatable mineral estate, by alternative and by proposed withdrawal parcel, that could be withdrawn for a period of 20 years from the location of new mining claims under the Mining Law. Table 2.7-2 identifies the locatable mineral exploration and development operating requirements by agency (i.e., BLM or Forest Service). Table 2.7-3 identifies the RFD-related activities that are anticipated under each alternative over 20 years.

2.8 IMPACT SUMMARY COMPARISON

Table 2.8-1 provides a comparison of the potential environmental effects of Alternatives A through D. A detailed description of the environmental effects is provided in Chapter 4.

Table 2.7-1. Federal Locatable Mineral Estate (Acres) Subject to Withdrawal by Alternative and by Parcel

Proposed Withdrawal Parcel	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 Withdrawn		Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn	
North	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	523,922	BLM	334,724	BLM	101,797
		FS*	7,919	FS	7,919	FS	7,919
		State	4,204	State	4,204	State	801
		Private	18,079	Private	9,249	Private	681
East	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	102,432	BLM	65,125	BLM	31,444
		FS	31,273	FS	24,359	FS	24,359
		State	0	State	0	State	0
		Private	749	Private	749	Private	429
South	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	0	BLM	0	BLM	0
		FS	321,157	FS	205,616	FS	132,764
		State	80	State	80	State	80
		Private	961	Private	961	Private	407
Total Acres of Federal Locatable Mineral Estate to Be Withdrawn:	None	*Surface Ownership*		*Surface Ownership*		*Surface Ownership*	
		BLM	626,354	BLM	399,849	BLM	133,241
		FS	360,349	FS	237,894	FS	165,042
		State	4,284	State	4,284	State	881
		Private	19,789	Private	10,959	Private	1,517
		Total:	**1,010,776**	**Total:**	**652,986**	**Total:**	**300,681**

Note: FS = Forest Service.

Table 2.7-2. Locatable Mineral Exploration and Mine Operating Requirements

Agency	Alternatives A through D
BLM	Use and occupancy regulations at 43 CFR 3715; and surface management regulations at 43 CFR 3809. Major provisions include the following: • Surface use must be reasonably incident to mining, prospecting, and milling operations. • If the area is withdrawn, the mining claims involved must have valid existing rights. • Exploration disturbing less than 5 acres can usually be conducted under a notice. • All mining requires an approved plan of operations involving NEPA analysis and public comment. • All activity must prevent unnecessary or undue degradation, which requires complying with applicable state and federal environmental protection laws; meeting the performance standards in the BLM regulations for the protection or air, cultural, water, and wildlife resources; and isolating and controlling toxic or deleterious materials. • Exploration- and development-related disturbance must be reclaimed in accordance with the reclamation plan. • All operators must provide the BLM with a financial guarantee covering the full cost of reclaiming the operation in accordance with the reclamation plan. • The BLM can inspect operations for compliance with the regulations and issue administrative enforcement orders in cases of noncompliance. If a plan of operations meets the above requirements, it would be approved.
Forest Service	Surface management regulations at 36 CFR 228A. Major provisions include the following: • Surface use must be reasonably incident to mining, prospecting, and milling operations. • If the area is withdrawn, the mining claims involved must have valid existing rights. • Operators proposing exploration or small-scale mining submit an NOI and may be allowed to conduct operations without a plan of operations if the proposed disturbance is not considered significant. • Mining operations entailing significant disturbance require an approved plan of operations involving NEPA analysis and public comment. • All activity must comply with applicable state and federal environmental protection laws; meeting the performance standards in the Forest Service regulations for the protection of air, cultural, water, and wildlife resources; and isolating and controlling toxic or deleterious materials. • Exploration- and development-related disturbance must be reclaimed in accordance with the reclamation plan. • All operators must provide the Forest Service with a reclamation bond covering the full cost of reclaiming the operation in accordance with the approved reclamation plan. • The Forest Service can inspect operations for compliance with the regulations and issue administrative enforcement orders in cases of noncompliance. If a plan of operations meets the above requirements, it would be approved.

Table 2.7-3. Reasonably Foreseeable Future Locatable Mineral Operations by Alternative (anticipated over 20 years)

Activity	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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Predicted exploration projects				
North Parcel	504	10	94	290
East Parcel	56	0	28	28
South Parcel	168	1	85	113
Subtotal	*728*	*11*	*207*	*431*
Acres disturbed for exploration				
North Parcel	554	11	103	319
East Parcel	62	0	31	31
South Parcel	185	1	94	124
Subtotal	*801*	*12*	*228*	*474*

Table 2.7-3. Reasonably Foreseeable Future Locatable Mineral Operations by Alternative (anticipated over 20 years), Continued

Activity	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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Predicted mining projects				
North Parcel	21	10	13	20
East Parcel	2	0	1	1
South Parcel	7	1	4	5
Subtotal	*30*	*11*	*18*	*26*
Acres disturbed for mining				
North Parcel	360	140	200	340
East Parcel	40	0	20	20
South Parcel	120	0	60	80
Subtotal	*520*	*140*	*280*	*440*
Number of ore haul trips required				
North Parcel	208,385	86,065	119,425	197,265
East Parcel	22,240	0	11,120	11,120
South Parcel	69,540	2,820	36,180	47,300
Subtotal	*300,165*	*88,885*	*166,725*	*255,685*
Miles of new power lines				
North Parcel	16.4	6.4	9.1	15.5
East Parcel	2.4	0	1.2	1.2
South Parcel	3.6	0	1.8	2.4
Subtotal	*22.4*	*6.4*	*12.1*	*19.1*
Miles of new roads for mine access				
North Parcel	16.4	6.4	9.1	15.5
East Parcel	2.4	0	1.2	1.2
South Parcel	3.6	0	1.8	2.4
Subtotal	*22.4*	*6.4*	*12.1*	*19.1*
Total acres disturbed for exploration and development over 20 years				
North Parcel	945	163	320	688
East Parcel	107	0	54	54
South Parcel	312	1	158	209
Subtotal	*1,364*	*164*	*532*	*951*
Water usage (mgal) over 20 years				
North Parcel	221	105	137	210
East Parcel	21	0	11	11
South Parcel	74	11	42	53
Subtotal	*316*	*116*	*190*	*274*

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative

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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Air Quality and Climate (4.2)				
Release of particulates	Over a 20-year period approximately 17,645 tons of PM_{10} and 2,532 tons of $PM_{2.5}$ would be emitted to the atmosphere during mine operation activities. Emissions would be the greatest under this alternative.	Over a 20-year period approximately 6,786 tons of PM_{10} and 956 tons of $PM_{2.5}$ would be emitted to the atmosphere. Emissions would be the least under this alternative.	Over a 20-year period approximately 10,160 tons of PM_{10} and 1,472 tons of $PM_{2.5}$ would be emitted to the atmosphere.	Under Alternative D, over a 20-year period, approximately 15,514 tons of PM_{10} and 2,214 tons of $PM_{2.5}$ would be emitted to the atmosphere.
Increase in regional haze	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park. Inconclusive	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park. Inconclusive	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park. Inconclusive	A more refined modeling analysis would be required to determine potential impacts on Grand Canyon National Park. Inconclusive
Geology and Mineral Resources (4.3)				
Change in underground geological conditions	Number of ore deposits mined: *30. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change.*	Number of ore deposits mined: *11. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change.*	Number of ore deposits mined: *18. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change.*	Number of ore deposits mined: *26. Underground geological impacts and associated effects on groundwater are not able to be determined without site-specific studies.* Potential for subsidence and alteration of geology or topography: *no change*
Availability of mineral resources	Approximately 33,155 tons U_3O_8 mined over a 20-year time frame.	Approximately 4,147 tons U_3O_8 mined over a 20-year time frame.	Approximately 14,647 tons U_3O_8 mined over a 20-year time frame.	Approximately 26,647 tons U_3O_8 mined over a 20-year time frame.
Water Resources (4.4)				
Perched aquifer springs quantity and quality of water	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 13.2%.* *Potential impact:* 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. East Parcel: *Probability of impact: 1.3%.* *Potential impact:* 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 South Parcel: *Probability of impact: 0.2 %.* *Potential impact:* 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	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 5.4 %.* *Potential impact:* 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. East Parcel: *Probability of impact: 0%.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells. South Parcel: *Probability of impact: 0 %.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells.	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 6.6%.* *Potential impact:* 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. East Parcel: *Probability of impact: 0%.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells. South Parcel: *Probability of impact: 0 %.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells.	Impact duration: *1 year to more than 5 years.* North Parcel: *Probability of impact: 10.9%.* *Potential impact:* 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. East Parcel: *Probability of impact: 0%.* *Potential impact:* No new mines would be located within the groundwater drainage areas that support perched aquifer springs and wells. South Parcel: *Probability of impact: 0.3 %.* *Potential impact:* 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 quantity and quality of water	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 11. East Parcel: Impacts could vary from no mines located where they may affect wells, to 1. South Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 4.	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 5. East Parcel: No mines located where they may affect wells. South Parcel: Impacts could vary from no mines located where they may affect wells, to 1.	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 7. East Parcel: Impacts could vary from no mines located where they may affect wells, to 1. South Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 2.	Impact duration: *1 year to more than 5 years.* North Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 10. East Parcel: Impacts could vary from no mines located where they may affect wells, to 1. South Parcel: Impacts could vary from no mines located where they may affect wells, to as many as 3.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Water Resources, continued				
Deep aquifer springs quantity of flow	Impact duration: *More than 5 years.* North Parcel: 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. (more than 0% to less than 5%) East Parcel: 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. (more than 0% to less than 5%) South Parcel: *For Havasu and Blue Springs,* 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. (more than 0% to less than 5%) *For South Rim springs* The total anticipated volume of water withdrawn from mine-related R-aquifer wells would be from 0% to more than 10% of the estimated aggregate flow from R-aquifer springs located downgradient from mine production wells. (0% to more than 10%)	Impact duration: *More than 5 years.* North Parcel: 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. (more than 0% to less than 5%) East Parcel: 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. (0%) South Parcel: *For Havasu Springs only:* 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. (more than 0% to less than 5%) *For all other springs:* 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. (0%)	Impact duration: *More than 5 years.* North Parcel: 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. (more than 0% to less than 5%) East Parcel: 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. (more than 0% to less than 5%) South Parcel: *For Havasu Springs only:* 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. (more than 0% to less than 5%) *For all other springs:* 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. (0%)	Impact duration: *More than 5 years.* North Parcel: 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. (more than 0% to less than 5%) East Parcel: 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. (more than 0% to less than 5%) South Parcel: *For Havasu Springs only:* 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. ((more than 0% to less than 5%) *For all other springs:* 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. (0%)
Deep aquifer springs water quality	Impact duration: *More than 5 years.* North Parcel: From no, to at least1 mine might contribute impacted water to the R-aquifer. If any impact would occur, 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) at the Kanab and Showerbath spring complex. East Parcel: From no to at least1 mine might contribute impacted water to the R-aquifer. If any impact would occur, 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) at the Fence Fault spring complex. South Parcel: *For Havasu and Blue Springs,* From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For South Rim springs.* From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic).	Impact duration: *More than 5 years.* North Parcel: From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, 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) at the Kanab and Showerbath spring complex. East Parcel: No mines would contribute impacted water to the R-aquifer. South Parcel: *For Havasu Springs only:* From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For all other springs:* No mines would contribute impacted water to the R-aquifer.	Impact duration: *More than 5 years.* North Parcel: From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, 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) at the Kanab and Showerbath spring complex. East Parcel: From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, 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) at the Fence Fault spring complex. South Parcel: *For Havasu Springs only:* From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For all other springs:* No mines would contribute impacted water to the R-aquifer.	Impact duration: *More than 5 years.* North Parcel: From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, 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) at the Kanab and Showerbath spring complex. East Parcel: From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, 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) at the Fence Fault spring complex. South Parcel: *For Havasu Springs only:* From no to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. *For all other springs:* No mines would contribute impacted water to the R-aquifer.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Water Resources, continued				
Deep aquifer wells water quantity, including Tusayan wells in South Parcel	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels 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.	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels 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.	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels 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.	Impact duration: *1 year to more than 5 years.* North Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. East Parcel: No decrease in water levels in non-mine R-aquifer wells would occur, because no such wells are assumed to occur in the parcel. South Parcel: Decrease in water levels 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.
Deep aquifer wells water quality, including Tusayan wells in South Parcel	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.	Impact duration: *More than 5 years.* North Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. East Parcel: No mines would contribute impacted water to non-mine R-aquifer wells, because no such wells are assumed to occur in the parcel. South Parcel: From none to at least 1 mine might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic might exceed ambient levels and drinking water standards (30 µg/L uranium or 10 µg/L arsenic) at non-mine R-aquifer wells.
Surface water quantity	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 13.2% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. Reduction might be large if flow is supported by impacted perched aquifer springs, which have a probability of 1.3% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. South Parcel: *Perennial Streams:* Reduction would not be expected to be detectable where flow is supported by Havasu and Blue Springs. Reduction would range from 0% to more than 10% where flow is supported by South Rim springs. Reduction might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.2% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams*: Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 5.4% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: No water quantity impacts to perched aquifer springs that support surface water flow, and no surface disturbance would occur as a result of mining-related activities. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, reduction would not be expected to be detectable. No reduction would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams*: Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 6.6% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No reduction would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, reduction would not be expected to be detectable. No reduction would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams*: Reduction could range from undetectable where flow is supported by R-aquifer springs to large if supported by impacted perched aquifer springs, which have a probability of 10.9% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No reduction would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would generally not be expected to be detectable. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, reduction would not be expected to be detectable. No reduction would occur where flow is supported by Blue Springs or South Rim springs. Reduction might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.3% of being impacted. *Ephemeral Streams:* Changes would generally not be expected to be detectable, but where mining-related disturbances occur in or adjacent to areas of steep topography, changes might be detectable and extend beyond the immediate vicinity of disturbed areas.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn**	**Alternative D** **Partial Withdrawal** **20 Years** **~300,000 Acres Withdrawn**
Water Resources, continued				
Surface water quality, including surface water runoff from active mines	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 13.2% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 1.3% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. South Parcel: *Perennial Streams:* Where flow is supported by Havasu and Blue Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. Where flow is supported by South Rim springs, changes could range from no change to changes that might result in exceedance of drinking water standards. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.2% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 5.4% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: No 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. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. No changes would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 6.6% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No changes would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. No changes would occur where flow is supported by Blue Springs, South Rim springs, or perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels.	Impact duration: *1 year to more than 5 years.* North Parcel: *Perennial Streams:* Impacts could range from no change to changes that might result in exceedance of ambient levels where flow is supported by R-aquifer springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 10.9% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas. East Parcel: *Perennial Streams:* No perennial streams receive flow from R-aquifer springs except the Colorado River; see Resource Category/Issue for Colorado River water quantity and quality below. No changes would occur where flow is supported by perched aquifer springs. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels. South Parcel: *Perennial Streams:* Where flow is supported by Havasu Springs, impacts could range from no change to changes that would not be expected to result in exceedance of ambient levels. No changes would occur where flow is supported by Blue Springs or South Rim springs. Changes might be large if flow is supported by impacted perched aquifer springs, which have a probability of 0.3% of being impacted. *Ephemeral Streams:* Changes would not be expected to result in exceedance of ambient levels; where mining-related disturbances occur in or adjacent to areas of steep topography, such changes might extend beyond the immediate vicinity of disturbed areas.
Surface water stream function	Impact duration: *1 year to more than 5 years.* All three parcels: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas.	Impact duration: *1 year to more than 5 years.* North Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas. East Parcel: No surface disturbance would occur as a result of mining-related activities. South Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function.	Impact duration: *1 year to more than 5 years.* North Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas. East and South Parcels: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function.	Impact duration: *1 year to more than 5 years.* North and South Parcels: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function, but where mining-related disturbances occur in or adjacent to areas of steep topography, small changes in morphology and function might extend beyond the immediate vicinity of disturbed areas. East Parcel: Changes in runoff and sediment loads would generally not be expected to result in adverse impacts stream morphology and function.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Water Resources, continued				
Virgin River water quantity and quality	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *More than 5 years.* North Parcel: Water quantity impacts could vary from none to a reduction of less than 0.5% of the estimated aggregate flow from R-aquifer springs located along the Virgin River in northwest Arizona. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
Colorado River water quantity and quality	Impact duration: *1 year to more than 5 years.* All parcels: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *1 year to more than 5 years.* North Parcel: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels. East Parcel: *no impact.* No water quantity or water quality impacts to perched or R-aquifer springs that support surface water flow, and no surface disturbance would occur as a result of mining activities. South Parcel: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *1 year to more than 5 years.* All parcels: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.	Impact duration: *1 year to more than 5 years.* All parcels: Water quantity impacts could vary between 0% and 0.002% of the average minimum flow in the Colorado River. Water quality impacts could vary from no mine to at least one mine which might contribute impacted water to the R-aquifer. If any impact would occur, the resultant concentration of uranium or arsenic would not be expected to exceed estimated ambient levels.
Soil Resources (4.5)				
Disturbance of soil resources	Impact duration: *More than 5 years all three parcels.* Disturbance acreage: North Parcel, 945 acres; East Parcel, 107 acres; and South Parcel, 312 acres. Disturbance relative to respective parcel area: *≤0.17%.*	Impact duration: *More than 5 years North and South Parcels, No impact East Parcel.* Disturbance acreage: North Parcel, 163 acres; East Parcel, 0 acres; and South Parcel, 1 acre. Disturbance relative to respective parcel area: *≤0.03%.*	Impact duration: *More than 5 years all three parcels.* Disturbance acreage: North Parcel, 320 acres; East Parcel, 54 acres; and South Parcel, 158 acres. Disturbance relative to respective parcel area: *≤0.06%.*	Impact duration: *More than 5 years all three parcels* Disturbance acreage: North Parcel, 668 acres; East Parcel, 54 acres; and South Parcel, 209 acres. Disturbance relative to respective parcel area: *≤0.12%.*
Loss of soil productivity	Area of disturbance: Impact duration: *More than 5 years* Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area. Potential for increased erosion: *All three parcels* Impact duration: *1 to 5 years.* Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances.	Area of disturbance: Impact duration: *1 to 5 years.* Anticipated soil disturbance in each proposed withdrawal parcel would vary from none to less than 1% of the parcel area. Potential for increased erosion: Impact duration: *1 to 5 years.* North Parcel: Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances. East Parcel: Soil erosion would be at the regional baseline soil loss rate. South Parcel: Increased erosion and sedimentation would be expected to be limited to the immediate vicinity of roadways, power lines, drill sites, and mine sites.	Area of disturbance: Impact duration: *More than 5 years* Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area. Potential for increased erosion: Impact duration: *1 to 5 years.* North Parcel: Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances. East and South Parcels: Increased erosion and sedimentation would be expected to be limited to the immediate vicinity of roadways, power lines, drill sites, and mine sites.	Area of disturbance: Impact duration: *More than 5 years* Anticipated soil disturbance in each proposed withdrawal parcel would be less than 1% of the parcel area. Potential for increased erosion: Impact duration: *1 to 5 years.* North and South Parcels: Where soils are sensitive to erosion, increased erosion and sedimentation could range from being limited to the immediate vicinity of roadways, power lines, drill sites, and mines, to possibly extending beyond the immediate vicinity of these disturbances. East Parcel: Increased erosion and sedimentation would be expected to be limited to the immediate vicinity of roadways, power lines, drill sites, and mine sites. Increased sensitivity to wind erosion in some areas might result in substantially increased rates of erosion if disturbance occurs in those areas.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn**	**Alternative D** **Partial Withdrawal** **20 Years** **~300,000 Acres Withdrawn**
Soil Resources, continued				
Soil contamination	Potential for constituent distribution: Impact duration: *More than 5 years for all three parcels.* Impacts at 30 mine sites (21 in North Parcel, 2 in the East Parcel, and 7 in the South Parcel) could range from: 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 remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: 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.	Potential for constituent distribution: Impact duration: *More than 5 years* North Parcel: Impacts at 10 mine sites could range from: 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 remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: 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. East Parcel: Impacts at 0 mine sites would be: Levels of contaminants in soil would be expected to be at background levels. South Parcel: Impacts at 1 mine site would be: 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 remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites.	Potential for constituent distribution: Impact duration: *More than 5 years* North Parcel: Impacts at 13 mine sites could range from: Concentrations of uranium and arsenic in soil expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: 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. East Parcel and South Parcels: Impacts at 1 mine site in the East Parcel and 4 mine sites in the South Parcel would be: 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 remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites.	Potential for constituent distribution: Impact duration: *More than 5 years* North and South Parcels: Impacts at 20 mine sites in the North Parcel and 5 mine sites in the South Parcel could range from: Concentrations of uranium and arsenic in soil expected to be at or above regional background levels off site, but generally at or below applicable remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites; To: 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. East Parcel: Impacts at 1 mine site in the East Parcel would be: 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 remediation standards; levels exceeding standards would be expected to be limited to the immediate vicinity of mine sites.
Vegetation Resources (4.6)				
Disturbance of vegetation	Impact duration: *More than 5 years.* Impacts on vegetation are possible depending on the location of mine facilities. Impacts could vary from changes in overall density and diversity of vegetation resources not being measurable or apparent to being measurable but not apparent. Impacts to density and diversity of aquatic and terrestrial habitats could be measurable but not apparent. Estimated acres of disturbance: 1,432	Impact duration: *More than 5 years.* Impacts to vegetation are expected to not be measurable or apparent Impacts on density and diversity of aquatic and terrestrial habitats are not anticipated to be measurable or apparent. Acres disturbed represent an approximate 88% decrease from Alternative A. Estimated acres of disturbance: 203	Impact duration: *More than 5 years.* Impacts to vegetation are expected to not be measurable or apparent. Impacts on density and diversity of aquatic and terrestrial habitats are not anticipated to be measurable or apparent. Acres disturbed represent an approximate 61% decrease from Alternative A. Estimated acres of disturbance: 604	Impact duration: *More than 5 years.* Impacts on vegetation are possible depending on the location of mine facilities. Impacts could vary from changes in overall density and diversity of vegetation resources not being measurable or apparent to being measurable but not apparent. Impacts to density and diversity of aquatic and terrestrial habitats could be measurable but not apparent. Acres disturbed represent an approximate 30% decrease from Alternative A. Estimated acres of disturbance: 1,065
Vegetation productivity	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.	Impact duration: *More than 5 years.* Impacts on the productivity of aquatic and terrestrial habitats are expected to not be measurable or apparent; Indirect impacts on wildlife and soil stability are not anticipated to be measurable or apparent.
Fish and Wildlife Resources (4.7)				
Wildlife habitat (aquatic and terrestrial habitats)	Impact duration: *More than 5 years.* Impacts on aquatic and terrestrial habitats are anticipated and would depend on the location of mines. Overall water quality and quantity impacts on area seeps, springs, and other water bodies could vary from not being measurable or apparent to measurable and apparent.	Impact duration: *More than 5 years.* Impacts are anticipated on aquatic and terrestrial habitats and on overall water quality and quantity impacts of area seeps, springs, and other water bodies. These impacts are not anticipated to be measurable or apparent. Acres disturbed represents an approximate 88% decrease from Alternative A.	Impact duration: *More than 5 years.* Impacts are anticipated on aquatic and terrestrial habitats and on overall water quality and quantity impacts of area seeps, springs, and other water bodies. These impacts are not anticipated to be measurable or apparent. Acres disturbed represents an approximate 61% decrease from Alternative A.	Impact duration: *More than 5 years.* Impacts on aquatic and terrestrial habitats are anticipated and depend on the location of mines. Overall water quality and quantity impacts of area seeps, springs, and other water bodies are anticipated to be measurable but not apparent. Acres disturbed represents an approximate 30% decrease from Alternative A.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Fish and Wildlife Resources, continued				
Chemical and radiation impacts	Impact duration: *More than 5 years.* Uranium and its decay constituents may impact individual animals (including possible mortality); impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts in the vicinity of sensitive aquatic and terrestrial habitats, such as Kanab Creek Canyon, are afforded greater protection under Alternative B than under Alternative A. Increases may impact individuals (including possible mortality); impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Alternative C affords greater protection than Alternative A. Reductions in aquatic and terrestrial habitat quality and quantity may impact individuals (including possible mortality); impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts are anticipated to be reduced in the vicinity of sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative D affords greater protection than Alternative A. Reductions in aquatic and terrestrial habitat quality and quantity may impact individuals (including possible mortality); however, impacts are not anticipated to alter overall fish and wildlife populations.
Habitat fragmentation	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated. Magnitude would depend on the location of mines and on the magnitude of water quality and quantity impacts on area seeps, springs, and other water bodies due to mining. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated. Magnitude would depend on the location of mines and on the magnitude of water quality and quantity impacts on area seeps, springs, and other water bodies due to mining. Impacts near sensitive aquatic and terrestrial habitats, such as Kanab Creek, are afforded greater protection under Alternative B than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts would not be measurable or apparent and are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter overall fish and wildlife populations.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter overall fish and wildlife populations.
Special Status Species (4.8)				
Special status species habitat (aquatic and terrestrial habitats)	Impact duration: *More than 5 years.* Magnitude would depend on the location of mines and on the magnitude of water quality and quantity impacts on area seeps, springs, and other water bodies due to mining. Impacts to habitats could vary from effects to individual animals and effects to habitat that are neither measurable nor detectable, to having effect on individuals and have the potential to be both measurable and apparent.	Impact duration: *More than 5 years.* Impacts on both aquatic and terrestrial habitats and impacts and on water quality and quantity of seeps, springs, and other water bodies are anticipated; however, these impacts are not anticipated to be measurable or apparent. Acres disturbed represents an 88% decrease, compared with Alternative A.	Impact duration: *More than 5 years.* Impacts on both aquatic and terrestrial habitats are anticipated; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. However, these impacts are not anticipated to be measurable or apparent. Acres disturbed represents a 61% decrease compared with Alternative A.	Impact duration: *More than 5 years.* Impacts on both aquatic and terrestrial habitats are anticipated; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies; however, these impacts are anticipated to be measurable but not apparent. Acres disturbed represents a 30% decrease compared with Alternative A.
Chemical and radiation impacts	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soil are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations.	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soils are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations. Impacts near sensitive aquatic and terrestrial habitats, such as Kanab Creek, are afforded greater protection under Alternative B than Alternative A.	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soils are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations. Because approximately 2/3 of the proposed withdrawal area would be withdrawn, impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A.	Impact duration: *More than 5 years.* Increases in the level of uranium and its decay constituents in water and soils are anticipated that would be neither measurable nor apparent. Increases may impact individuals (including possible mortality); however, impacts are not anticipated to alter special status species populations. Because approximately1/3 of the proposed withdrawal area would be withdrawn, impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative D affords greater protection than Alternative A.
Habitat fragmentation	Impact duration: *More than 5 years.* Impacts on unfragmented habitat (acres) are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of a mine and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Increased fragmentation may impact individuals (including possible mortality); however, impacts are not anticipated to alter populations of special status fish and wildlife species.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of the mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts near sensitive aquatic and terrestrial habitats, such as Kanab Creek are afforded greater protection under Alternative B than Alternative A. Increased fragmentation may impact individuals (including possible mortality); however, impacts are not anticipated to alter populations of special status fish and wildlife species.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative C affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); Impacts are not anticipated to alter populations of special status fish and wildlife species.	Impact duration: *More than 5 years.* Impacts on unfragmented habitat (acres) are anticipated that would be neither measurable nor apparent; the magnitude of specific impacts would depend on the location of mines and overall water quality and quantity impacts on area seeps, springs, and other water bodies. Impacts are anticipated to be reduced near sensitive aquatic and terrestrial habitats, such as Kanab Creek, Alternative D affords greater protection than Alternative A. Increased fragmentation may impact individuals (including possible mortality); however, impacts are not anticipated to alter populations of special status fish and wildlife species.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Visual Resources (4.9)				
Conformance with BLM Visual Resource Management class objectives	Impact duration: *More than 5 years.* No withdrawal of sensitive visual designations: Class I, Class II, Preservation, High. Degrees of contrast and impact vary and are specific to each project and from each viewpoint. Impacts could vary from: Project-related visual impacts 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 To: Project-related impacts 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).	Impact duration: *More than 5 years.* Withdrawal of all sensitive visual designations: Class I, Class II, Preservation, High. Would not produce obvious changes in landscape contrasts.	Impact duration: *More than 5 years.* Withdrawal of approximately 88% of sensitive visual designations: Class I, Class II, Preservation, High. Project-related visual impacts 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.	Impact duration: *More than 5 years.* Withdrawal of approximately 53% of sensitive visual designations: Class I, Class II, Preservation, High. Project-related visual impacts 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.
Conformance with Forest Service visual objectives	Impact duration: *From 1 to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts 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 To: Project-related impacts 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).	Impact duration: *From less than 1 year to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts 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. To: 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.	Impact duration: *From less than 1 year to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts 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. To: 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.	Impact duration: *From 1 to more than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. From: Project-related visual impacts 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. To: Project-related impacts 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).
Conformance with Park visual objectives from key observation points	Impact duration: *More than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts 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. To: 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.	Impact duration: *More than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Would not produce obvious changes in landscape contrasts. To: Project-related visual impacts 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.	Impact duration: *More than 5 years* Degrees of contrast and impact vary and are specific to each viewpoint. Project-related visual impacts 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.	Impact duration: *More than 5 years.* Degrees of contrast and impact vary and are specific to each viewpoint. Impacts could vary: From: Project-related visual impacts 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. To: 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.
Changes in night sky	Impact duration: *More than 5 years* Given the quality of the dark night skies in the area, minimal increases in night lighting could impact the areas night skies. 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.	Impact duration: *More than 5 years.* Reduction in projected mining and associated activities as compared to Alternative A would result in decreased visual impacts to the night sky.	Impact duration: *More than 5 years.* Reduction in projected mining and associated activities as compared to Alternative A would result in decreased visual impacts to the night sky.	Impact duration: *More than 5 years.* There is some reduction in projected mining and associated activities as compared to Alternative A that would result in some decreased visual impacts to the night sky.
Soundscapes (4.10)				
Noise disruption from exploration or development activity	Impacts to soundscapes are dependent on mine and haul road locations. If mines or roads are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.	Impacts to soundscapes are dependent on mine and haul road locations. If they are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.	Impacts to soundscapes are dependent on mine and haul road locations. If they are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.	Impacts to soundscapes are dependent on mine and haul road locations. If they are near sensitive areas such as wilderness or Grand Canyon National Park would have a greater impact than those farther away. Sounds from mines and haul roads could be above ambient noise levels within 1.5 miles if unattenuated by vegetation or terrain.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Cultural Resources (4.11)				
Disturbance of historic and prehistoric sites	Impact duration: *Exceeds 5 years* 2,655 known sites, as well as undiscovered sites, are located in areas subject to direct and indirect impacts from three existing mines and a projected number of 26 new mines and 728 exploration projects that would disturb 1,364 acres. Assessment of impacts would require site-specific analysis. Direct impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.	Impact duration: *Exceeds 5 years* 2,655 known sites are in areas withdrawn from new mining claims and exploration. Sites would be subject to direct and indirect impacts limited to development of valid existing claims. Projected development includes 11 new mines and 11 exploration projects that would disturb 164 acres. Impacts would be largely in the North Parcel, with no new mining or exploration in the East Parcel and a single mine in the South Parcel. Assessment of impacts would require site-specific analysis. Direct adverse impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.	Impact duration: *Exceeds 5 years* 2,018 known sites in the proposed withdrawal area would be subject to direct and indirect impacts limited to development of valid existing claims. 637 sites outside the withdrawn areas would also be subject to impacts from new exploration activities, claims, and mines. Projected development includes 18 mines and 207 exploration projects that would disturb 532 acres. The proposed withdrawn areas include zones known to have high densities of important cultural resources. Assessment of impacts would require site-specific analysis. Direct adverse impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.	Impact duration: *Exceeds 5 years* 1,230 known sites in the proposed withdrawal area would be subject to direct and indirect impacts limited to development of valid existing claims. 1,425 sites outside the withdrawn areas would also be subject to impacts from new exploration activities, claims, and mines. Projected development includes 26 mines and 431 exploration projects that would disturb 951 acres. Assessment of impacts would require site-specific analysis. Direct adverse impacts would be mitigated through established regulations and procedures of avoidance and mitigation. Impacts could result in loss of NRHP eligibility. If avoidance is not possible. Visual and auditory (indirect): Impact duration: From 1 to 5 years in most cases though selected resources eligible for the NRHP under criterion A could lose integrity depending on the extent of alteration of the setting.
American Indian Resources (4.12)				
Effect on Known Traditional Cultural Properties (TCP)	Impact duration: *More than 5 years* Project-related impacts would result in loss of resource and/or functional use of resource such as Red Butte and other traditional cultural properties.	Impact duration: *More than 5 years* Would avoid adverse effects to Red Butte and other traditional cultural properties.	Impact duration: *More than 5 years* Would avoid adverse effects to Red Butte and other traditional cultural properties.	Impact duration: *More than 5 years* Project-related impacts would result in loss of resource and/or functional use of resource such as Red Butte and other traditional cultural properties.
Disturbance of places of traditional cultural practices and uses	Types of known resources in project area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, and camps. *All three parcels:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Long-term direct impacts* *Visual and auditory (indirect) impacts:* Impact duration: *1 to 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Short-term* *Visual impacts from power lines:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.	Types of known resources in the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, and camps. *North Parcel primarily in area along Kanab Creek.* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Long-term direct impacts.* *East Parcel:* Would avoid resource. *South Parcel:* Impact duration: *More than 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual and auditory (indirect) impacts on North and South parcels:* Impact duration: *1 to 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual impacts from power lines on North and South parcels:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.	Types of known resources in the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, and camps. Types of known resources outside the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, and camps. *North Parcel primarily in area along Kanab Creek.* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *East Parcel in area excluded for withdrawal:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Long term* *South Parcel:* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual and auditory (indirect) impacts on all three parcels:* Impact duration: *More than 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual impacts from power lines on North and East parcels*: Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.	Types of known resources in the proposed withdrawal area: landscapes, trails, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, and camps. Types of known resources outside the proposed withdrawal area: landscapes, trails, springs, creeks, ceremonial sites, traditional territories, ranges and use areas, resource procurement areas, and camps. *All three parcels since the majority of resources would be outside the withdrawal boundaries:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource. *Visual and auditory (indirect) impacts:* Impact duration: *1 to 5 years* Project-related impacts would occur but resources would retain existing characteristics vital to their cultural functions and uses by American Indians. *Visual impacts from power lines:* Impact duration: *More than 5 years* Project-related impacts that would result in loss of resource and/or functional use of resource.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
American Indian Resources (4.12), continued				
Protection of tribal trust resources or assets	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*	Impact duration: *More than 5 years* There are no tribal trust resources or assets within the proposed withdrawal area. *Possible indirect impacts of unknown magnitude on Havasupai Springs, which is outside the proposed withdrawal area.*
Wilderness (4.13)				
Designated wilderness	Changes in the land's wilderness characteristics: No discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. Impact duration: *1 to 5 years* Greatest amount of mineral activity estimated; highest risk of impacts on wilderness characteristics. *Impacts could vary from:* Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. 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. To: 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 mining related development within wilderness. 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.	Changes in the land's wilderness characteristics: No discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. Impact duration: *1 to 5 years* Least amount of mineral activity; lowest risk for impacts on wilderness characteristics: Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining-related development within wilderness. 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.	Changes in the land's wilderness characteristics: No discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts to wilderness characteristics. Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. 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.	Changes in the land's wilderness characteristics: No discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. Outstanding opportunities for solitude and primitive and unconfined recreation would be maintained. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts to wilderness characteristics. Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. 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.
NPS proposed wilderness	Changes in the land's wilderness characteristics: Impacts would have no discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Most mineral activity estimated; highest risk of impacts on wilderness characteristics. *Impacts could vary from:* Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. 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. To: 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 mining related development within wilderness. 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.	Changes in the land's wilderness characteristics: Impacts would have no discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Least amount of mineral activity; lowest risk for impacts on wilderness characteristics: Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. 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.	Changes in the land's wilderness characteristics: Impacts would have no discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts on wilderness characteristics. Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. 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.	Changes in the land's wilderness characteristics: Impacts would have no discernible effect on wilderness character. Natural conditions would prevail. There would be no mining related development within wilderness. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation. Impact duration: *1 to 5 years* Less mineral activity than Alternative A; less risk for impacts on wilderness characteristics. Impacts would be slightly detectable within limited areas of the wilderness. Natural conditions would predominate. There would be no mining related development within wilderness. 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.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Recreation (4.14)				
Visitor use	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would be: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along Highway 64: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would experience: To retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along Highway 64: To retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would be: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along Highway 64: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* Impacts to visitor use of remote and undeveloped areas, and users accessing adjacent primitive areas, would be: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences. Impact from mining haul trucks to Grand Canyon visitor traffic along Highway 64: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.
Roads and access	Impact duration: *More than 5 years* The 22.4 miles of new mining-related roads would benefit driving for pleasure and would increase the road density more than the other alternatives. Impact would be: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* The 6.4 miles of new mining-related roads would benefit driving for pleasure and would increase the existing road density the least of the 4 alternatives. Impact would be: To retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The 12.1 miles of new mining-related roads would benefit driving for pleasure. Impact would be: To retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The 19.1 miles of new mining-related roads would benefit driving for pleasure and would increase the road density more than any other action alternative, but less than alternative A. Impact would be: To partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.
Primitive recreation opportunity	Impact duration: *More than 5 years* The increase of 22.4 miles of roads could adversely impact users seeking primitive recreation opportunities in adjacent areas. No primitive settings occur within the Alternative A area. Impacts would partially retain the existing character of the recreation setting, and would not dominate the recreation opportunity for the desired recreation experiences.	Impact duration: *More than 5 years* The increase of 6.4 miles of roads could adversely impact users seeking primitive recreation opportunities in adjacent areas, although minimally. No primitive settings occur within the Alternative B proposed withdrawal area. Impacts would retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The increase of 12.1 miles of roads could adversely impact users seeking primitive recreation opportunities in adjacent areas, although minimally. No primitive settings occur within the Alternative C proposed withdrawal area. Impacts would retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.	Impact duration: *More than 5 years* The increase of 19.1 miles of roads could adversely impact users seeking primitive recreation opportunities in adjacent areas. No primitive settings occur within the Alternative D proposed withdrawal area. Impacts would retain the existing character of the recreation setting and create a low level of change in the recreation opportunity or desired experiences.
Social Conditions (4.15)				
Demographics	Impact duration: *More than 5 years* Population increase is estimated to be 332 individuals + families, over a five-county area. Overall, the increase in population would not produce obvious changes in demographics since the population change would be a very small percentage of the total population in the 5-county area (0.13%). The effect in Kanab or Fredonia would be amplified as their populations could increase by about 51 workers and their families.	Impact duration: *More than 5 years* Population increase is estimated to be 121.9 individuals + families over a five-county area. Overall, the increase in population would not produce obvious changes in demographics since the population change would be a very small percentage of the total population in the 5-county area (0.05%). The effect in Kanab or Fredonia would also be small as their populations might increase by just an estimated 21 workers with their families.	Impact duration: *More than 5 years* Population increase is estimated to be 161.95 individuals + families over a five-county area. Overall, the increase in population would not produce obvious changes in demographics since the population change would be a very small percentage of the total population in the 5-county area (0.07%). The effect in Kanab or Fredonia would also be small as their populations might increase by just an estimated 34 workers with their families.	Impact duration: *More than 5 years* Population increase is estimated to be 288.1 individuals + families, over a five-county area. Overall, the increase in population would not produce obvious changes in demographics since the population change would be a very small percentage of the total population in the 5-county area (0.12%). The effect in Kanab or Fredonia would be amplified as their populations could increase by about 49 workers and their families.
Stakeholder values–mineral activity support	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; most gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Would retain the existing character of the stakeholder values, but would create a low level of change which would not alter the perception of the Grand Canyon region for stakeholders (either residents or visitors).	Impact duration: *More than 5 years* Least amount of mineral activity; fewer gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Impacts on social conditions that would adversely affect stakeholders, but can be mitigated.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Impacts on social conditions that would adversely affect stakeholders, but can be mitigated.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer gains for individuals and communities who benefit from mineral activity. Impact is expected to be: Impacts on social conditions that would adversely affect stakeholders, but can be mitigated.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Social Conditions (4.15), continued				
Stakeholder values–withdrawal support	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; greatest amount of impacts for individuals and communities who support withdrawal. Impact is expected to be: 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.	Impact duration: *More than 5 years* Least amount of mineral activity; less severe impacts for individuals and communities who support withdrawal. Impact is expected to be: Alternative B includes some mineral activity (primarily in the North Parcel); however, less estimated activity than under Alternative A so individuals and groups who support mineral withdrawal would be more (positively) impacted.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer impacts for individuals and communities who support withdrawal. Impact is expected to be: Alternative C includes some mineral activity (concentrated in the North Parcel); however, less estimated activity than under Alternatives A or D. Individuals and groups who support mineral withdrawal would be more (positively) impacted than in Alternatives A or D, but less than C.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; fewer impacts for individuals and communities who support withdrawal. Impact is expected to be: Alternative D includes some mineral activity (concentrated in the North Parcel); however, less estimated activity than under Alternative A, but more than in B or C. Individuals and groups who support mineral withdrawal would be more (positively) impacted than Alt A, but less than B or C.
Health safety risks	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; highest risk of health impacts, although health risks are not expected to elevate above current conditions. Impact is expected to be: Would retain the existing character of the public health and safety, but would create a low level of change.	Impact duration: *More than 5 years* Least amount of mineral activity; lowest risk for health impacts. Impact is expected to be: Would not produce obvious changes in public health and safety.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; less risk for health impacts. Impact is expected to be: Would not produce obvious changes in public health and safety, although it may be greater than Alternative B.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; less risk for health impacts. Impact is expected to be: Would retain the existing character of the public health and safety, but would create a low level of change.
Human safety risks	Impact duration: *More than 5 years* Greatest amount of mineral activity estimated; highest risk of human safety impacts on conditions that would adversely affect stakeholders, but can be mitigated.	Impact duration: *More than 5 years* Least amount of mineral activity; lowest risk for human safety impacts. Would not produce obvious changes in public health and safety.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; less risk for human safety impacts. Would retain the existing character of the public health and safety, but would create a low level of change.	Impact duration: *More than 5 years* Less mineral activity than Alternative A; some risk of human safety impacts on conditions that would adversely affect stakeholders, but can be mitigated.
Environmental justice	Impact duration: *More than 5 years* Nine communities and four tribes in the analysis area meet EPA criteria for consideration under environmental justice rules. Conditions create a low level of change but no measurable impacts to identified groups.	Impact duration: *More than 5 years* Nine communities and four tribes in the analysis area meet EPA criteria for consideration under environmental justice rules. Conditions create a low level of change but no measurable impacts to identified groups.	Impact duration: *More than 5 years* Nine communities and four tribes in the analysis area meet EPA criteria for consideration under environmental justice rules. Conditions create a low level of change but no measurable impacts to identified groups.	Impact duration: *More than 5 years* Nine communities and four tribes in the analysis area meet EPA criteria for consideration under environmental justice rules. Conditions create a low level of change but no measurable impacts to identified groups.
Economic Conditions (4.16)				
Energy resources available	Impact duration: *More than 5 years* Potential economic value of uranium mined over 20 years: $2.91 billion. Impacts vary from: Beneficial impacts on economic conditions that would affect economic conditions for residents, employees, and local and regional economies To: Beneficial 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.	Impact duration: *More than 5 years* Potential economic value of uranium mined over 20 years: $364.9 million. Impact is expected to be: Beneficial impacts on economic conditions that would retain the existing economic conditions, taxes and revenues, employment, recreation economics, 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.	Impact duration: *More than 5 years* Potential economic value of uranium mined over 20 years: $1.28 billion. Beneficial impacts on economic conditions that would affect economic conditions for residents, employees, and local and regional economies with tourist-driven economies, but can be mitigated or offset by economic gains from mining activity.	Impact duration: *More than 5 years* Potential economic value of uranium mined over 20 years: $2.34 billion. Impacts vary from: Beneficial impacts on economic conditions that would affect economic conditions for residents, employees, and local and regional economies To: Beneficial 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.
Effects on economic activity from tourism	Impact duration: *More than 5 years* Overall regional tourist activity and associated employment will not be affected. Economic value of tourism would be expected to remain at $3.52 billion per year, (in 2008 dollars), or $70.4 billion over 20 years. Impact expected: 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 is unlikely to be effected Would not produce obvious changes in existing economic activity, taxes and revenues, employment, recreation economics, road condition and maintenance, or energy resources.	Impact duration: *More than 5 years* Overall regional tourist activity and associated employment will not be affected. Economic value of tourism would be expected to remain at $3.52 billion per year, (in 2008 dollars), or $70.4 billion over 20 years. Impact expected: Would not produce obvious changes in existing economic activity, taxes and revenues, employment, recreation economics, road condition and maintenance, or energy resources.	Impact duration: *More than 5 years* Overall regional tourist activity and associated employment will not be affected. Economic value of tourism would be expected to remain at $3.52 billion per year, (in 2008 dollars), or $70.4 billion over 20 years. Impact expected: Would not produce obvious changes in existing economic activity, taxes and revenues, employment, recreation economics, road condition and maintenance, or energy resources.	Impact duration: *More than 5 years* Overall regional tourist activity and associated employment will not be affected. Economic value of tourism would be expected to remain at $3.52 billion per year, (in 2008 dollars), or $70.4 billion over 20 years. Impact expected: Would not produce obvious changes in existing economic activity, taxes and revenues, employment, recreation economics, road condition and maintenance, or energy resources.

Table 2.8-1. Summary of Potential Environmental Impacts by Alternative (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 Withdrawn	Alternative D Partial Withdrawal 20 Years ~300,000 Acres Withdrawn
Economic Conditions (4.16), continued				
Effects on economic activity from mineral development	Impact duration: *More than 5 years* Direct industry employment: Total regional economic output over 20 years: $3.39 billion. Overall, the increase in direct employment would not produce obvious changes in economic conditions for residents and local and regional economies since the change would be a very small percentage of the total employment in the 5-county area (0.4%). The effect in Kanab or Fredonia would be amplified as their employment opportunities would increase disproportionately from the rest of the region.	Impact duration: *More than 5 years* Total regional economic output over 20 years: $1.24 billion. Overall, the increase in direct employment would produce no changes in economic conditions for residents and local and regional economies since the change would be a very small percentage of the total employment in the 5-county area (0.05%). The effect in Kanab or Fredonia would also be small.	Impact duration: *More than 5 years* Total regional economic output over 20 years: $2.03 billion. Overall, the increase in direct employment would produce no changes in economic conditions for residents and local and regional economies since the change would be a very small percentage of the total employment in the 5-county area (0.07%). The effect in Kanab or Fredonia would also be small.	Impact duration: *More than 5 years* Total regional economic output over 20 years: $2.94 billion. Overall, the increase in direct employment would not produce obvious changes in economic conditions for residents and local and regional economies since the change would be a very small percentage of the total employment in the 5-county area (0.12%). The effect in Kanab or Fredonia would be amplified as their employment opportunities would increase disproportionately from the rest of the region.
Road condition and maintenance	Mining companies would be responsible for maintenance of unpaved public roads used to haul ore. Would not produce obvious changes in existing road condition and maintenance.	Mining companies would be responsible for maintenance of unpaved public roads used to haul ore. Would not produce obvious changes in existing road condition and maintenance.	Mining companies would be responsible for maintenance of unpaved public roads used to haul ore. Would not produce obvious changes in existing road condition and maintenance.	Mining companies would be responsible for maintenance of unpaved public roads used to haul ore. Would not produce obvious changes in existing road condition and maintenance.

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Chapter 3

AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter describes the affected environment, with a focus on the existing resources and uses that could be affected by the Proposed Action and alternatives presented in Chapter 2. The affected environment is the baseline against which each alternative is evaluated in Chapter 4 in terms of the potential impacts to the human environment. The affected environment description will vary by resource and is not confined to the proposed withdrawal area for all resources or issues. For example, air quality and water quality issues necessitate describing a large area to account for potential downwind or downstream concerns, whereas addressing issues associated with a specific plant species may be limited to a very discrete location within the proposed withdrawal area.

The affected environment is presented by first profiling the physical setting and conditions, followed by describing the biological resources, and culminating with a description of those uses and resources related to human activities. A systematic, comprehensive approach such as this better reveals the relationships that make up the human environment, both in terms of the natural and physical environment and the relationship of people to that environment [40 CFR 1508.14].

The affected environment discussed in this chapter is divided into sections covering the following: 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. Relevant environmental conditions and human uses in the study area have been identified and described using geographic information system (GIS) data, literature searches, electronic searches, interviews, and information provided by the BLM, Forest Service, NPS, USGS, USFWS, other federal and state agency managers and resource specialists, tribal representatives, county officials, and other sources as identified in this chapter and in Chapter 6, Literature Cited.

For each resource category, the relevant issues from Chapter 1 are presented in Table 3.1-1, along with one or more “resource condition indicators.” These resource condition indicators have been developed to provide an issue-focused analysis of potential impacts from the proposed withdrawal or alternatives, which will be presented in Chapter 4. The information presented in Chapter 3 does not describe impacts, but rather describes the existing environment with an emphasis on the present value of these resource condition indicators.

3.1.1 General Setting

The BLM manages public lands under the authority of the Federal Land Policy and Management Act of 1976 [43 USC 1701–1787]. FLPMA provides direction for land use planning, administration, range management, rights-of-way, designated management areas, and prevention of unnecessary or undue degradation.

The Forest Service manages federal lands under the authority of the National Forest Management Act of 1976, which restructured and amended the Forest and Rangeland Renewable Resources Planning Act of 1974. NFMA requires the Secretary of Agriculture to assess National Forest System lands, develop a management program based on multiple-use, sustained-yield principles, and implement a management plan for each unit of the Forest Service.

3.1.2 Areas of Critical Environmental Concern

The BLM portions of the proposed withdrawal (North and East parcels) contain administratively designated areas known as ACECs. ACECs contain one or more resources that require special management and protection to maintain the value(s) of the area and its resources. ACECs may contain important cultural or scenic values, special status species, and/or habitat for these species. ACECs are not closed to mineral entry, but all mining activities above casual use require a plan of operations.

There are three ACECs within the North Parcel: Johnson Springs, Kanab Creek, and Moonshine Ridge. There is one ACEC in the East Parcel: Marble Canyon. There are no ACECs in the South Parcel, as these lands are managed by the Forest Service.

Johnson Springs ACEC was designated to protect cultural resources and the threatened Siler pincushion cactus. The ACEC encompasses 3,444 acres; the southern portion of the ACEC is within the North Parcel.

Kanab Creek ACEC was designated for protection of cultural values, the endangered southwestern willow flycatcher (*Strix occidentalis lucida*), and riparian areas. This ACEC encompasses 13,148 acres and is located entirely within the North Parcel.

Moonshine Ridge ACEC was designated to protect cultural resources and the threatened Siler pincushion cactus (*Pediocactus sileri*). The ACEC encompasses 9,310 acres and is located entirely within the North Parcel.

Marble Canyon ACEC was designated to protect cultural resources and the endangered Brady pincushion (*Pediocactus bradyi*) cactus. The ACEC encompasses 11,797 acres and is located entirely within the East Parcel.

Information on the values for which these ACECs were designated is presented later in this chapter.

3.1.3 National Monuments

There are two national monuments adjacent to the proposed withdrawal area: Grand Canyon–Parashant National Monument is adjacent to the North Parcel, and Vermilion Cliffs National Monument is adjacent to the East Parcel.

Grand Canyon–Parashant National Monument: This monument is jointly managed by the BLM and NPS. The monument encompasses more than 1 million acres of remote and unspoiled public lands. It was designated to protect biological, historical, and archaeological resources.

Vermilion Cliffs National Monument: This monument is managed by the BLM. The monument encompasses 294,000 acres. It was designated to protect unique geological resources such as the Paria Plateau, Vermilion Cliffs, Coyote Buttes, and Paria Canyon. The Vermilion Cliffs National Monument is closed to mineral entry under the 1872 Mining Law.

Upon designation, lands within both monuments were withdrawn from location, entry, and patent under the mining laws, subject to valid existing rights. No active mining claims currently exist in either monument, but non-federal mineral estate is not subject to that withdrawal.

3.1.4 Grand Canyon National Park

Grand Canyon National Park is adjacent to each of the proposed withdrawal parcels. Although first afforded federal protection in 1893 as a Forest Reserve and later as a National Monument, Grand Canyon did not achieve National Park status until 1919, three years after the creation of the NPS. Grand Canyon National Park is a world heritage site and an international icon. The Park is dominated by the Grand Canyon (or Canyon), a twisting, 1-mile deep, 277-mile-long gorge formed during some 6 million years of geological activity and erosion by the Colorado River on the upraised earth's crust. The river divides the Park into the North and South rims, which overlook the approximately 10-mile-wide canyon. Grand Canyon National Park encompasses 1,217,403.32 acres (NPS 1995). The Park is closed to mineral entry under the 1872 Mining Law.

3.1.5 Game Preserves

In 1906, President Theodore Roosevelt established the Grand Canyon National Game Preserve, generally located between the North and East parcels on the Kaibab Plateau (although a small portion of the preserve does extend into the northern areas of the South parcel). The reason for establishment of the preserve was concerns about the extirpation of game species through unregulated hunting. The preserve is managed by the Forest Service in accordance with the Kaibab LRMP/ROD (Forest Service 1988). The Grand Canyon Game Preserve is closed to mineral entry. More information on the Grand Canyon Game Preserve can be found in Section 3.7, Fish and Wildlife.

3.1.6 Indian Reservations

Navajo Nation

The Navajo Reservation was formed under the Navajo Treaty of 1868, and extends into the states of Utah, Arizona, and New Mexico. The reservation encompasses 27,635 square miles; the portion located in Arizona covers 11.6 million acres. While the lands of the Navajo Nation are not contiguous but "checker-boarded," the Navajo Reservation is the largest reservation under Native American jurisdiction in the United States. The current population in the Navajo Nation surpasses 250,000 people. Upon the discovery of oil on Navajo land in the early 1920s, the modern system of tribal government was established to provide a formal government entity to interact with American oil companies. This tribal government was officially recognized by the federal government in 1923 (Navajo Nation 2008).

Pursuant to the Indian Reorganization Act of 1934, only private claims established prior to the formation of the reservation (1880) are considered valid; therefore the reservation itself is withdrawn from mineral entry. Even for private valid claims, however, the Navajo Nation is closed to uranium activity. On April 29, 2005, Navajo President Joe Shirley signed the Diné Natural Resources Protection Act of 2005, which was passed by the Navajo Nation Council on April 19, 2005. This law is based on the Fundamental Laws of the Diné, as codified in Navajo statutes, and clearly states, "No person shall engage in uranium mining and processing on any sites within Navajo Indian Country."

Havasupai Tribe

The Havasupai Reservation was established by the executive orders of June 8 and November 23, 1880, with an original size of 3,058 acres. By executive order in 1882, all but 518 acres at the bottom of the canyon were designated public land. However, on January 3, 1976, Public Law 93-620 returned the original acreage, added 185,019 acres surrounding the original lands and an additional 95,300 acres of traditional use area north of the reservation. Pursuant to the Indian Reorganization Act of 1934, only private claims established prior to the formation of the reservation (1880) are considered valid; therefore the reservation itself is withdrawn from mineral entry. The 95,300 acres of additional traditional use lands are also withdrawn.

The Havasupai Reservation is situated in Coconino County at the southwest corner of Grand Canyon National Park. There are approximately 650 enrolled tribal members; approximately 340 members live in Supai Village—Havasupai tribal headquarters—in the 3,000 foot deep Havasu (Cataract) Canyon. The Tribe is governed by an elected seven-member Tribal Council (ADOC 2009d).

Kaibab Paiute Tribe

The Kaibab Paiute Indian Reservation was formally established by EO 1786 on October 16, 1907, which was superseded by EO 2667 on July 17, 1917. Pursuant to the Indian Reorganization Act of 1934, only private claims established prior to the formation of the reservation (1907) are considered valid; therefore, the reservation itself is withdrawn from mineral entry.

The reservation encompasses 120,413 acres in Arizona Strip country, including about 107,000 acres in Mohave County and about 13,000 acres in the southeastern part of the reservation in Coconino County. The reservation is composed of five villages: Kaibab, Steamboat, Juniper Estates, Six-Mile, and Redhills. The vast majority of the land is undeveloped. The Tribe is governed by a seven-person Tribal Council (ADOC 2008). Uranium has been found on or near the reservation (Bureau of Indian Affairs 1979).

3.1.7 Resource Condition Indicators

The resource condition indicators listed in Table 3.1-1 represent quantifiable measures of change that have been used to guide the impacts analysis presented in Chapter 4, Environmental Consequences. These indicators evolved through many iterations of impact analysis and are based on the original "relevant issues for detailed analysis" identified early in the EIS process through agency and public scoping (see Table 1.5-1).

Table 3.1-1. Resource Condition Indicators

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.2 Air Quality		
Quantity of criteria and hazardous air pollutants	The emissions from the emergency backup generator and the ore, waste rock unloading, and fugitive dust emissions from unpaved haul road travel associated with the Arizona 1 Mine are presented in Table 3.2-6. Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] and are not to exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (Arizona Department of Environmental Quality [ADEQ] 2010b).	*Indicator*: Quantity of criteria and hazardous air pollutants emitted under each alternative.
Regulatory requirements	Each individual mine will be required to obtain an air quality permit. The permit is the mechanism to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air.	*Indicator*: PSD: >250 tons per year (tpy) of a criteria pollutant. *Indicator*: Federal Hazardous Air Pollutant (HAP) Source: >25 tpy combined or >10 tpy of a regulated HAP. *Indicator*: ADEQ Class I Source: >100 tpy to <250 tpy of a criteria pollutant *Indicator*: ADEQ Class II Source: >2 tpy to <100 tpy of a criteria pollutant.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.2 Air Quality, continued		
NAAQS	As shown in Table 3.2-5 and Figure 3.2-2, the ambient air concentration data obtained from monitors in or near the air quality study area were below the NAAQS. However, based on data obtained from the Grand Canyon National Park, the annual fourth-highest 8-hour ozone concentrations have flat trends nonetheless have values that are very close to 8-hour ozone standard (0.075 part per million [ppm]) and sometimes over it (NPS Public Use Statistics Office 2010).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern. The EPA recommends that this proposed “secondary” standard be in the range of 7 to 21 ppm-hours.	*Indicator*: Comparison of measured and/or modeled air pollutant concentrations with applicable thresholds (i.e., NAAQS).
Prevention of significant deterioration (PSD) increment	The PSD increments establish the maximum increase in pollutant concentration allowed above the baseline level.	*Indicator*: PSD is the mechanism that protect Class I areas.
GHGs	Qualitative and/or quantitative evaluations of potential contributing factors within the planning area will be included in Chapter 4 where appropriate and practicable.	*Indicator*: The quantity of GHG emission emitted under each alternative.
Air Quality Related Values – Visibility	The NPS has classified the visibility at the Grand Canyon National Park as a stable moderate concern. The standard visual ranges for the three Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors in Grand Canyon National Park range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days.	*Indicator*: Discussion of visibility impacts and comparison of measured or modeled values with applicable thresholds.
3.3 Geology and Mineral Resources		
Change in underground geological conditions	Mining of uranium deposits would alter conditions underground that could allow uranium and other minerals to be mobilized, entering the groundwater system. Conversely, mining of uranium deposits could remove a potential source of long-term contamination.	*Indicator*: Number of ore deposits mined. *Indicator*: Chemical quality of water discharge at springs that issue from perched groundwater zones. *Indicator*: Chemical quality of water discharge at springs that issue from the regional R-aquifer system. *Indicator*: Potential for subsidence and alteration of geology or topography.
Availability of mineral resources	Providing a domestic source of mineral resources is one of the legitimate uses of public lands. Restrictions or closures individually and cumulatively decrease this ability.	*Indicator*: Uranium resource endowment available for development. *Indicator*: Cumulative amount of high-potential uranium resources on lands withdrawn from exploration and development. *Indicator*: Availability of high mineral potential lands within the withdrawal area *Indicator*: Amount of uranium mined as percentage of domestic demand, domestic production, global demand, and global production.
Depletion of uranium resources	Mining these uranium deposits in the near future depletes domestic resources that may be needed later for energy production or national security purposes.	*Indicator*: Amount of uranium mined as percent of known domestic resources. *Indicator*: Depletion of uranium resources within proposed withdrawal area.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.4 Water Resources		
Dewatering or contamination of shallow perched aquifers	Mining of some uranium deposits would penetrate near-surface aquifers and could dewater them. The resulting water loss could affect nearby springs or shallow water wells. If mineral extraction occurs within the perched aquifer horizon, dissolved minerals could enter the perched aquifer where the perching layer is re-established by mine reclamation.	*Indicator*: The assumed number of perched aquifer springs and wells that might have water quantity or quality impacts as a result of mining related activities within the groundwater drainage area of the perched aquifers.
Contamination of deep regional aquifers by metals dissolved from mined ore deposits	Mine drainage might carry dissolved minerals downward and increase the levels of metals in the deep groundwater aquifers (e.g., Redwall-Muav limestone aquifer). This could occur both during mining and after mine closure and potentially affect downgradient water quality.	*Indicator*: The assumed number of active or reclaimed mines that might contribute impacted water to the deep aquifer, the assumed rate of mine drainage that might occur, and the assumed uranium and arsenic concentrations that might occur in the mine drainage. *Indicator*: The predicted concentrations of uranium and arsenic that might occur at deep aquifer springs if the assumed mine drainage would occur and mix with the deep aquifer spring flow.
Depletion of deep aquifer spring flow or well yields from operation of deep mine wells	Groundwater withdrawals from the deep aquifer by mine supply wells could intercept groundwater that supplies springs or could cause water level drawdown in deep non-mine wells.	*Indicator*: The predicted amount of groundwater pumping to supply uranium mining activities as a percent of flow from deep aquifer springs that might be impacted. Also, the predicted changes in groundwater level at deep non-mine wells that might be caused by mine wells.
Contamination or loss of the city of Tusayan water supply	The potential for the Tusayan city water supply to be affected by nearby uranium exploration or mineral exploration and development.	*Indicator*: The predicted changes in groundwater level and water quality at the deep city of Tusayan wells as a result of activities related to uranium mining.
Contamination of municipal water supplies derived from the Colorado River	The potential for elevated uranium and other metals, in either surface water or groundwater, to enter the Colorado River and affect the major downstream municipalities' primary source of drinking water.	*Indicator*: The assumed quality and quantity of water with elevated uranium and arsenic levels that might result from uranium mining activities and enter the Colorado River. *Indicator*: The predicted change in water quality to the Colorado River that might result from the above occurrences.
Impairment of watershed and surface stream function	Changes in sediment loads and/or perennial and ephemeral stream discharge resulting from potential increased erosion and alteration of drainage patterns related to road, drill site, and mine site development.	*Indicator*: The amount of soil (area) that would be disturbed. *Indicator*: Estimated extent and degree of increased erosion (soil loss).
Contamination of surface runoff from active or reclaimed mines	Surface runoff from active or reclaimed mine sites could contain elevated uranium and other metals that would affect downstream water quality.	*Indicator*: Estimated uranium and arsenic levels in surface runoff.
3.5 Soil Resources		
Disturbance of soil resources	Soil resources in the area are valuable and could be difficult to re-establish once disturbed by exploration and mining.	*Indicator*: The amount of soil (area) that would be disturbed.
Loss of soil productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil productivity, creating potential short-term, long-term, and cumulative environmental impacts on soils and overall watershed function.	*Indicator*: The amount of soil (area) that would be disturbed. *Indicator*: Estimated extent and degree of increased erosion (soil loss).
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.	*Indicator*: Extent of projected concentrations of uranium and arsenic compared to background levels and Soil Remediation Level standards.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.6 Vegetation Resources		
Disturbance of vegetation	Vegetation in the area are could be difficult to re-establish once disturbed or contaminated by exploration and mining.	*Indicator*: The amount of vegetation that would be disturbed and/or contaminated.
Vegetation productivity	Erosion on disturbed or reclaimed lands could result in long-term loss of soil cover and vegetation productivity.	*Indicator*: The estimated loss in vegetation productivity (in Animal Unit Months). *Indicator*: The anticipated time required to return the disturbed or contaminated area to vegetative productivity.
3.7 Fish and Wildlife Resources		
Wildlife habitat	Issues associated with wildlife habitat include fragmentation of habitat by roads, noise from exploration or mining activities that disrupts wildlife, wildlife disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator*: Acres and type of habitat lost and duration of loss. *Indicator*: Changes in migratory or foraging behavior. *Indicator*: Avoidance or adaptation of species to noise source/visual intrusion. *Indicator*: Acres of habitat loss due to establishment of invasive species caused by mineral activities.
Wildlife populations	Potential loss of critical wildlife winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Wildlife mortality	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality.	*Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity.
3.8 Special Status Species Resources		
Special status species habitat	Issues associated with special status species habitat include fragmentation of habitat by roads, noise from exploration or mining activities that disrupts species, species disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator*: Acres and type of habitat lost and duration of loss. *Indicator*: Changes in migratory or foraging behavior. *Indicator*: Avoidance or adaptation of species to noise source/visual intrusion. *Indicator*: Acres of habitat loss due to establishment of invasive species caused by mineral activities.
Special status species populations	Potential loss of critical special status species winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Special status species mortality	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality.	*Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.9 Visual Resources		
Changes in regional visual quality	Mineral exploration and development could release pollutants, which could increase regional haze (see Air Quality issue) and result in changes in visibility, affecting the scenic quality of the region.	*Indicator*: The extent of the predicted change in regional haze attributable to mineral exploration and development is noticeable.
Visual intrusion to Park visitors	Exploration and development activity may be visible to Park visitors from key viewpoints within the Park. This could detract from the visitors' experience.	*Indicator*: Consistency with and conformance to Park visual objectives from key viewpoints within Grand Canyon National Park. *Indicator*: Visual contrast of anticipated activity from these Park viewpoints.
Visual intrusion to public outside the Park	Exploration and development activity may be visible to the public from key viewpoints in the Proposed withdrawal area. This could detract from the visitors' experience.	*Indicator*: Consistency with and conformance to designated BLM Visual Resource Management class objectives *Indicator*: Consistency with and conformance to Forest Service scenic quality management or integrity objectives. *Indicator*: Visual contrast of anticipated activity from key viewpoints in the Proposed withdrawal area. *Indicator*: Qualitative analysis of the potential changes to darkness of the night sky in the Proposed withdrawal area and Grand Canyon National Park.
3.10 Soundscapes		
Noise disruption from exploration or development activity	The areas subject to noise effects and the intensity of sound from these activities need to be evaluated for each proposed site and all associated operations. Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park.	*Indicator*: The decibel level due to exploration and mining equipment *Indicator*: The distance and direction between the source and receiver and for the evaluation of noise attenuation to baseline sound levels. *Indicator*: Comparison measured or modeled values with applicable rules, policies, or orders established by the Federal Land Managers. *Indicator*: Comparison of specified values to regulations established by the EPA and the U.S. Department of Transportation.
3.11 Cultural Resources		
Disturbance of historic and prehistoric sites	Surface disturbance associated with exploration or development activity could expose and cause damage to archaeological sites. Visual and atmospheric changes could adversely affect the integrity of site settings and cultural landscapes. It may not be possible to mitigate all adverse effects through scientific data recovery.	*Indicator*: The anticipated number of sites known, and unknown if possible, that could be disturbed by mining and exploratory activities. *Indicator*: The anticipated number of the above sites disturbed where information or artifacts would be lost or destroyed.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.12 American Indian Resources		
Disturbance of traditional cultural practices and uses	Exploration and development activity could affect the integrity of religiously and culturally significant sites and landscapes and could disrupt traditional practices and uses. Such practices include ceremonial activities, gathering of plants or other natural resources, and use of springs and trails. Tribes have expressed concerns about potential disturbance and contamination of culturally important resources.	*Indicator*: Number and types of traditional cultural use areas, sacred sites, cultural landscapes, and trails that could be disturbed by mining and exploratory activities. *Indicator*: Number of acres of total possible disturbance by mining and exploratory activities. *Indicator*: Proximity of traditional use areas to anticipated exploration and development activity. *Indicator*: Types of auditory or visual disruptions would occur in the traditional use area.
Effect on TCPs	Surface disturbance associated with exploration or development activity could disrupt the setting or integrity of TCPs such as the Red Butte area on the Tusayan Ranger District or other TCPs located in or near the parcels.	*Indicator*: The proximity and size of possible surface, visual, or auditory disturbance to, or within, identified TCPs.
Protection of tribal trust resources or assets	Tribal trust resources and assets are property, or property rights or interests, actually owned by a tribe. These may include property or rights located on- or off-reservation. As a trustee for the tribes, the federal government has the responsibility to preserve and protect tribal trust resources and assets from loss or degradation. One trust resource issue is the potential contamination of Havasu Springs and the economic impact of reduced tourism for the Havasupai Tribe if the springs were to be contaminated.	*Indicator*: Location and nature of tribal trust resource or asset. *Indicator*: Manner and degree to which the resource or asset would be degraded or consumed.
3.13 Wilderness Resources		
Wilderness areas	Congressionally designated wilderness is already withdrawn from entry and location under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to designated wilderness areas, which may affect the wilderness characteristics.	*Indicator*: Changes in wilderness characteristics untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.
3.14 Recreation		
Access and transportation	Development of roads for mining operations could both facilitate access for some recreational users and provide too much public access in areas currently used for more primitive recreation.	*Indicator*: Road density in terms of linear road miles by road type and designated recreation area and visitor use.
Primitive recreation opportunities	Changes in amount of exploration and development activity could change visual and auditory conditions, which in turn could affect primitive recreation opportunities in the area.	*Indicator*: The proximity of recreation settings and opportunities suitable for primitive recreational use to RFD and the expected auditory and visual intrusion to the desired recreation experience.
3.15 Social Conditions		
Demographics	There could be changes in population levels associated with decreased exploration and development activity under a proposed withdrawal. Likewise, the continued mineral development in the absence of a proposed withdrawal could involve local population increases as additional workers are required.	*Indicator*: The current and projected population for counties and communities in the study area.

Table 3.1-1. Resource Condition Indicators (Continued)

Resource Category/ Issue	Description of Relevant Issue	Resource Condition Indicator(s)
3.15 Social Conditions, continued		
Stakeholder values	Stakeholder values may be affected by changes in land management related to the proposed withdrawal areas.	*Indicator*: Public comments during scoping indicating general support for the withdrawal or support for exploration and development activity (and no withdrawal).
Public health effects	The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport.	*Indicator*: Estimated number of haul trips through local communities. *Indicator*: Potential exposure, public health risk, from single incident, effectiveness of cleanup, and total anticipated incidents.
Environmental justice	The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. Environmental justice is the equitable distribution of proposed withdrawal benefits and risks with respect to low-income or minority populations. In the case of uranium mining in the proposed withdrawal area, it is the distribution of the proposed withdrawal benefits, primarily economic, compared with the distribution of the proposed withdrawal impacts, such as pollution or risk of pollution, that is the issue.	*Indicator*: Identification of populations considered low income and/or minority in the proposed withdrawal area that would either be adversely affected or benefit from the activity. *Indicator*: Distribution of proposed withdrawal risks or adverse effects on the above populations. *Indicator*: Distribution of proposed withdrawal benefits to the above populations. *Indicator*: Comparison of minority/low-income populations' risks and benefits with those for non-minority/non-low-income populations.
3.16 Economic Resources		
Energy resources available	The withdrawal of uranium deposits in the study area would remove a potential source of energy production, which would then be replaced by energy produced from other sources, either additional mining elsewhere, imports of uranium from foreign sources, or production from equivalent amounts of other sources like coal, petroleum, natural gas, wind power, or solar.	*Indicator:* Value of energy produced from study area. *Indicator:* Equivalent amount of other energy-producing commodity represented by uranium production.
Effects on economic activity from tourism	Tourism represents a large component of the economic activity for many communities in the region and for the states. The manner and degree to which continued mining could change the nature and quality of the natural resources that attract tourism is an issue.	*Indicator*: Visitor user days and value per visitor user days to tourist destinations, primarily Grand Canyon National Park, but also National Forest System and BLM lands.
Effects on economic activity from mineral development	Mineral exploration and development represents a large component of the economic activity for many communities in the region. The manner and degree to which the proposed withdrawal could directly change the economic activity in the area, particularly in smaller communities, is an issue.	*Indicator*: Number of persons in the region directly and indirectly employed by the uranium mining industry. *Indicator*: Local and state revenue from property and income taxes directly tied to uranium mineral exploration and development.
Road condition and maintenance	The use of road systems to service mine operations requires increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access. Increased exploration and development activity could presumably increase funding from property and use taxes at the same time at which maintenance needs increase. Conversely, decreases in activity mean less maintenance, along with less potential revenue.	*Indicator*: Number of haul trips anticipated on major public use roads over the next 20 years. *Indicator*: Required maintenance level on public roads systems used for mineral operations. *Indicator*: The net change in funding available for road maintenance.

3.2 AIR QUALITY

This section provides an assessment of ambient air quality in the proposed withdrawal study area (Figure 3.2-1). The air quality of a given airshed or region is determined by the topography, meteorology, location of sources of air pollutants (type and quantity), and combination of air pollutants. The calculated or measured concentrations of various pollutants are then compared with established standards to evaluate the impact of a given source on regional air quality.

The purpose of this assessment is to determine the ambient air quality within the proposed withdrawal area. For the purposes of evaluating air quality resource impacts associated with the proposed withdrawal, the geographic extent of the air quality study area was assumed to extend 31 miles (50 km) from the boundaries of the proposed withdrawal area. A 31-mile radius was chosen in order to be consistent with minimum air quality analysis required for major source air quality permitting. Specifically, when conducting an air quality impact analysis for a major emission source, the analysis considers the geographical area located within at least a 31-mile radius. The region of influence is the total area in which measurable impacts of the proposed action are evaluated and may extend well beyond 31 miles from the proposed withdrawal boundaries.

3.2.1 Climate and Meteorology

The three proposed withdrawal parcels are located in northwestern Arizona within the Colorado Plateau, which is characterized by highlands to the north and lowlands to the south and west. The Colorado Plateau contains many unique geographical features (e.g., river narrows, natural bridges, slot canyons, etc.), including Grand Canyon. Six of the seven North American life zones are represented within the Colorado Plateau; only sub-tropic is absent. The Colorado Plateau contains a variety of plant life, from desert-type vegetation in the low-lying rocky areas to forests of ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*) and aspen (*Populus* sp.) in the higher elevations (BLM 1999).

The proposed withdrawal parcels are managed by the BLM Arizona Strip District and the Forest Service Kaibab National Forest–Tusayan Ranger District. The North and East parcels are almost entirely BLM lands, located north of the Colorado River, with small portions of the Kaibab National Forest in each. The South Parcel is entirely National Forest System lands (Kaibab National Forest–Tusayan Ranger District) located south of the Colorado River. All three of the proposed withdrawal parcels border the Grand Canyon National Park, managed by the NPS.

The northwestern portion of Arizona has four defined seasons (e.g., summer, fall, winter, and spring) and is at significantly higher elevation than the lower desert regions in southern Arizona, with an appreciably cooler climate that consists of cold winters and relatively mild summers. Air temperatures vary considerably both diurnally and annually throughout the area and can vary greatly depending on elevation, as evidenced by the monitoring data. During summer, the average air temperature in degrees Fahrenheit (°F) ranges from the mid-40s to the mid-70s, with highs reaching the low 100s. In comparison, the average minimum temperature in winter generally ranges from the mid- to high 10s to the high 30s, with the average maximum temperature reaching the high 50s and low 60s. Cold air systems originating from the northern United States and Canada occasionally make their way into Arizona, bringing temperatures below 0°F to the northern portions of the state. There are several climatic elements that have an impact on air quality. These elements include winds, temperature, and precipitation. Table 3.2-1 summarizes the meteorological conditions in and near the proposed withdrawal area.

Precipitation amounts tend to be highest in the winter months, ranging from approximately 0.5 inch (Houserock, Arizona) to 3.17 inches (Bright Angel Ranger Station, Arizona), and lowest in the spring months, ranging from 0.3 inch (Houserock) to 1.91 inches (Bright Angel Ranger Station). Not all of the

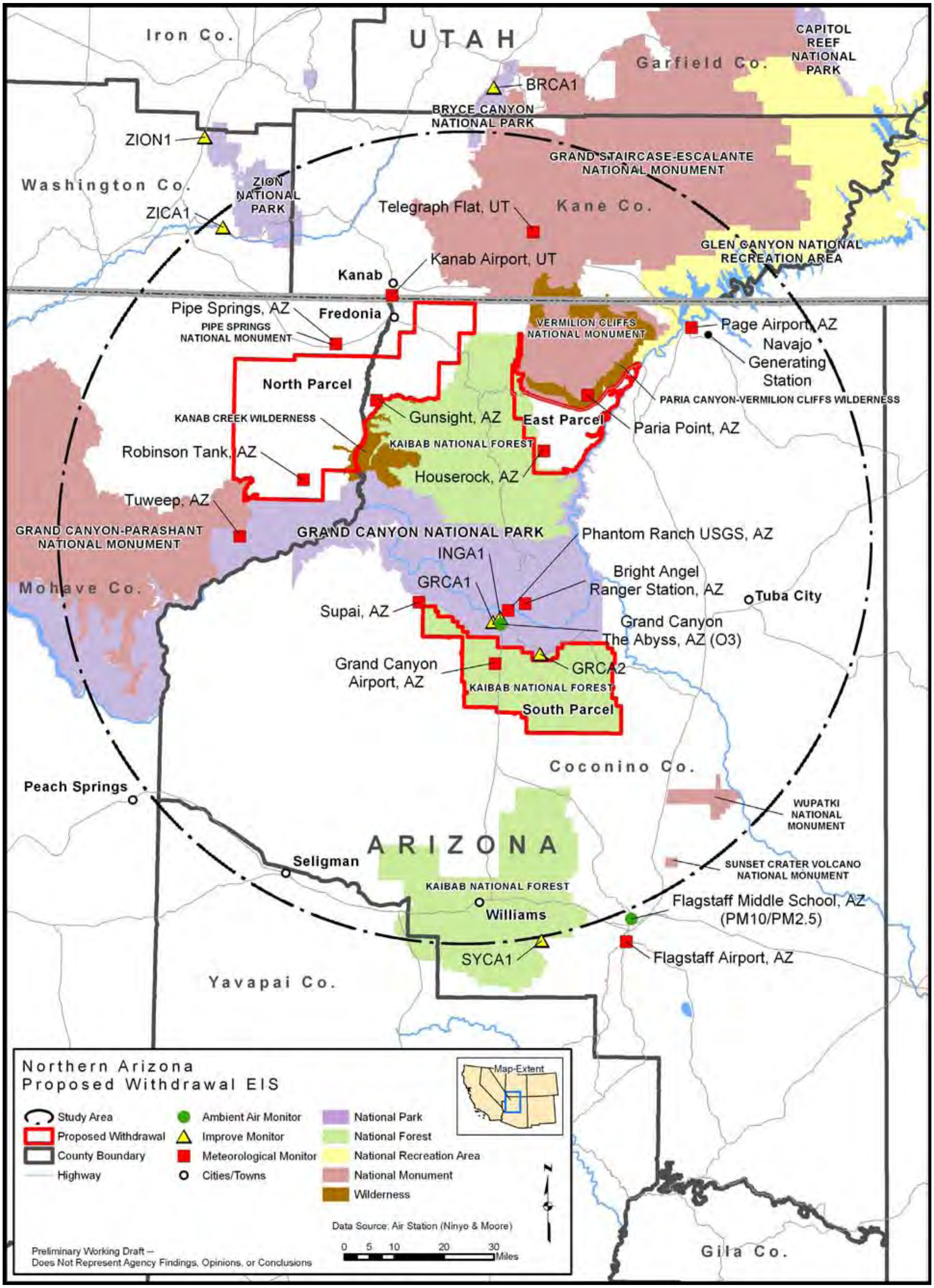


Figure 3.2-1. Air quality.

meteorological monitoring stations record snowfall during the winter months; the annual average accumulation ranges from 0.3 inch (Phantom Ranch, Arizona) to 136.7 inches (Bright Angel Ranger Station, Arizona).

Based on Table 3.2-1, average wind speeds tend to be highest during the spring and summer months, ranging from approximately 6.0 miles per hour (mph) (Page Airport, Arizona) to 9.5 mph (Kanab Airport, Utah) and lowest during the winter and fall months, ranging from approximately 3.5 mph (Page Airport, Arizona) to 6.7 mph (Kanab Airport, Utah).

Table 3.2-1. Meteorological Conditions in and near the Proposed Withdrawal Air Quality Study Area

Monitor Locations (Arizona)	Approximate Distance and Direction from the Nearest Proposed Withdrawal Parcel	Winter Average	Spring Average	Summer Average	Fall Average	Annual Average/ Total
Mean Monthly Maximum Temperature Average (°F)*						
Bright Angel Ranger Station	10 miles N	39.1	53.0	75.1	57.7	**56.2**
Gunsight	(In withdrawal area)	62.0	82.4	100.3	83.3	**82.0**
Houserock	(In withdrawal area)	61.5	82.3	99.3	81.8	**81.2**
Paria Point	(In withdrawal area)	56.0	76.1	93.7	76.7	**75.6**
Phantom Ranch	7 miles N	59.0	82.1	103.7	82.1	**81.8**
Pipe Springs National Monument	3 miles N	50.0	69.5	92.0	72.1	**70.9**
Robinson Tank	(in withdrawal area)	62.6	81.6	99.8	83.6	**81.9**
Supai	18 miles NW	55.1	76.3	96.8	76.6	**76.2**
Telegraph Flat–Kanab 17E Utah	18 miles N	57.2	79.6	98.1	80.3	**78.8**
Tuweep	18 miles S	51.6	68.9	91.8	73.2	**71.4**
Mean Monthly Minimum Temperature Average (°F)*						
Bright Angel Ranger Station	10 miles N	17.5	27.6	44.3	31.3	**30.2**
Gunsight	(In withdrawal area)	14.7	27.8	52.4	30.4	**31.3**
Houserock	(In withdrawal area)	19.0	31.2	55.3	34.3	**35.0**
Paria Point	(In withdrawal area)	10.9	23.7	49.2	26.2	**27.5**
Phantom Ranch	7 miles N	38.7	55.0	74.3	57.2	**56.3**
Pipe Springs National Monument	3 miles N	23.1	35.9	55.8	39.1	**38.5**
Robinson Tank	(In withdrawal area)	5.7	21.3	44.0	23.1	**23.5**
Supai	18 miles NW	31.3	46.0	64.7	47.9	**47.5**
Telegraph Flat–Kanab 17E Utah	18 miles N	6.6	21.1	42.1	24.8	**23.7**
Tuweep	18 miles S	28.9	40.8	61.8	45.7	**44.3**
Mean Monthly Precipitation Average (inches)*						
Bright Angel Ranger Station	10 miles N	3.17	1.91	1.66	1.65	**25.19**
Gunsight	(In withdrawal area)	0.8	0.5	0.7	0.8	**8.4**
Houserock	(In withdrawal area)	0.5	0.3	0.8	0.9	**7.4**
Paria Point	(In withdrawal area)	0.7	0.7	0.9	0.9	**9.8**
Phantom Ranch	7 miles N	0.89	0.59	0.82	0.90	**9.61**
Pipe Springs National Monument	3 miles N	1.06	0.80	0.88	0.91	**10.94**
Robinson Tank	(In withdrawal area)	0.9	0.4	0.6	0.5	**6.9**
Supai	18 miles NW	0.73	0.54	0.95	0.64	**8.59**
Telegraph Flat–Kanab 17E Utah	18 miles N	0.8	0.5	0.6	0.9	**8.1**
Tuweep	18 miles S	1.11	0.79	1.20	0.88	**11.95**

Table 3.2-1. Meteorological Conditions in and near the Proposed Withdrawal Air Quality Study Area (Continued)

Monitor Locations (Arizona)	Approximate Distance and Direction from the Nearest Proposed Withdrawal Parcel	Winter Average	Spring Average	Summer Average	Fall Average	Annual Average/ Total
Mean Monthly Snowfall Average (inches)*						
Bright Angel Ranger Station	10 miles N	26.6	13.4	0.1	5.5	**136.7**
Gunsight	(In withdrawal area)	–	–	–	–	–
Houserock	(In withdrawal area)	–	–	–	–	–
Paria Point	(In withdrawal area)	–	–	–	–	–
Phantom Ranch	7 miles N	0.2	0.0	0.0	0.0	**0.3**
Pipe Springs National Monument	3 miles N	1.9	0.6	0.0	0.4	**8.6**
Robinson Tank	(In withdrawal area)	–	–	–	–	–
Supai	18 miles NW	0.5	0.0	0.0	0.0	**1.7**
Telegraph Flat–Kanab 17E Utah	18 miles N	–	–	–	–	–
Tuweep	18 miles S	2.0	0.6	0.0	0.2	**8.5**
Average Wind Speed (miles per hour)†						
Flagstaff Airport	42 miles S	6.6	8.0	5.9	5.8	**6.6**
Grand Canyon Airport	(In withdrawal area)	6.2	7.6	6.1	5.8	**6.4**
Kanab Airport	10 miles N	6.7	9.5	7.7	6.6	**7.6**
Page Airport	13 miles NE	3.5	6.4	6.0	4.3	**5.0**

Sources: Western Regional Climate Center (2010a, 2010b).

Note: – = No data available; N = North; NE = Northeast; NW = Northwest; S = South; SW = Southwest

* For mean monthly temperature, mean monthly precipitation, and mean monthly snowfall, the period used for Bright Angel Ranger Station is 1925–2009; for Gunsight, 1994–2010; for Houserock, 1994–2010; for Paria Point, 1994–2010; for Pipe Springs National Monument 1993-2005; for Phantom Ranch, AZ 1966-2005; for Robinson Tank, 1986–2010; for Supai, 1899–1987; for Telegraph Flat–Kanab 17E, Utah, 1987–2010, and for Tuweep, 1941–1985.

† For average wind speed values, averages are based on data collected between 1996 and 2006.

The closest meteorological monitoring station to the proposed withdrawal area is the station located at Grand Canyon Airport, Arizona, within the South Parcel. Wind data collected at the Grand Canyon Airport indicate the prevailing winds are generally from the south-southwest, with significant winds from the northeast in winter with the average annual wind speed approximately 6.4 mph. The daily average peak gust at the Grand Canyon Airport are 25.4 mph with maximum peaks exceeding 60 mph (peak gust of 62 mph recorded on December 13, 2008) (Western Regional Climate Center 2010b).

Wind events near the proposed withdrawal can be extreme, as evidenced by the closure of Interstate 40 (I-40), east of Flagstaff, on numerous occasions in 2010 as a result of blowing dust from sustained winds exceeding 50 mph. As of June 16, 2010, the maximum recorded wind gust at the Flagstaff Airport for the calendar year 2010 was measured at 55 mph. From 2009 through 2006, the maximum gust wind measured, at the Flagstaff Airport, ranged from 56 to 59 mph (Weather Underground 2010).

In the absence of strong prevailing winds, wind movement within the valleys, canyons, and gulches within northern Arizona is extremely complex. The terrain features suggest there is a daily exchange of downslope and upslope flows oriented along the terrain feature axes, which are controlled by surface heating and cooling. Downslope, or drainage flows, which last longer, occur during the evening, night, and early morning hours, while the upslope flows occur during midday, the warmest part of the day (Bowman 2010).

Atmospheric stability is another important factor of meteorology that determines air pollution concentrations. When the atmosphere is stable, emitted pollutants tend to remain within a few hundred feet of the surface (close to the emission sources), and begin to diffuse horizontally across the surface. When the atmosphere is unstable, air pollution is free to mix with the atmosphere , and can vertically rise 1,000 feet or more, and be carried away in the prevailing wind. Therefore, the depth of this “mixing” area is very important when considering the impacts of air pollution on the region of influence.

Within the proposed withdrawal area atmospheric stability depends on the season. During the summer, the frequency of stable and unstable conditions of the atmosphere is relatively equal.

3.2.2 Legal and Regulatory Requirements

The following subsections identify federal, state, and local laws and regulations that are applicable to the proposed withdrawal, provide an evaluation of the study area, and analysis of the potential proposed withdrawal impacts.

Federal Laws and Regulations

Since 1970, the CAA and subsequent amendments have provided the authority and framework for EPA regulations of ambient air and pollutant emission sources. The CAA is the primary federal legislation controlling air quality standards and also includes special provisions to help protect air quality in national parks and other federal lands. The CAA gives federal land managers certain responsibilities and opportunities to participate in decisions being made by regulatory agencies that might affect air quality in federally protected areas.

The EPA regulations promulgated pursuant to the authority provided under the CAA established requirements for monitoring, controlling, and documenting activities that would affect ambient air concentrations of certain pollutants that may endanger public health or welfare. Specifically, these regulations have the overall objective of achieving and maintaining adherence to appropriate standards for ambient air quality, which are referred to as NAAQS.

National Ambient Air Quality Standards

As stated above, the CAA established the NAAQS for six criteria pollutants. These pollutants are carbon monoxide (CO), lead (or Pb), nitrogen dioxide (NO_2), particulate matter with a nominal aerodynamic diameter of less than 10 micrometers (PM_{10}) and fine particulates with a nominal aerodynamic diameter of less than 2.5 micrometers ($PM_{2.5}$), ozone (or O_3), and sulfur dioxide (SO_2). These standards are defined in terms of threshold concentration (e.g., milligrams per cubic meter [mg/m^3], micrograms per cubic meter [$\mu g/m^3$], or parts per million [ppm]) measured as an average for specified periods (averaging times). Short-term standards (i.e., 1-hour, 8-hour, or 24-hour averaging times) were established for pollutants with acute health effects; long-term standards (i.e., annual averaging times) were established for pollutants with chronic health effects.

The NAAQS were set at levels to provide an ample margin of safety to protect both public health and the environment. The primary standards are “health effects” standards and were adopted to protect public health, including “sensitive” populations such as asthmatics, children, and the elderly. The secondary standards are “quality of life standards” and were adopted to protect public welfare against decreased visibility as well as damage to animals, crops, vegetation, and buildings. The secondary standards are the same as, or less stringent than, the primary standards.

Effective May 27, 2008, the EPA promulgated a new 8-hour average O_3 concentration of 0.075 ppm. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentration measured at each monitoring location within an area over each year must not exceed 0.075 ppm. The primary and secondary NAAQS for the criteria pollutants are presented in Table 3.2-2.

Geographic areas commonly referred to as airsheds, which may not coincide with political boundaries, are designated attainment, non-attainment, or unclassified areas for each of the six criteria pollutants covered by the NAAQS. Areas in which levels of a criteria pollutant measure below the NAAQS are designated “attainment” areas. However, when a designated air quality area or airshed within a state exceeds the NAAQS that area may be designated a “non-attainment” area. Typically, non-attainment areas are urban regions and/or areas with higher-density industrial development. The given status of an area is designated separately for each criteria pollutant; one area may have all three classifications.

To determine whether an area meets the NAAQS, air monitoring networks have been established and are used to measure ambient air quality concentrations. Monitoring sites are typically located in areas where high concentrations occur within a region and where an exceedance is expected to occur.

Table 3.2-2. National Ambient Air Quality Standards

Pollutant	Averaging Period	Primary Standard	Secondary Standard
CO	1-hour	35 ppm (40 mg/m^3)	–
	8-hour	9 ppm (10 mg/m^3)	–
Pb	Rolling 3-Month Average	0.15 µg/m^3	0.15 µg/m^3
	Quarterly Average	1.5 µg/m^3	1.5 µg/m^3
NO_2	1-hour	0.100 ppm	0.100 ppm
	Annual	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)
PM_{10}	24-hour	150 µg/m^3	150 µg/m^3
$PM_{2.5}$	24-hour	35 µg/m^3	35 µg/m^3
	Annual	15.0 µg/m^3	15.0 µg/m^3
O_3	1-hour	0.12 ppm	0.12 ppm
	8-hour	0.08 ppm (1997 standard)	0.08 ppm (1997 standard)
	8-hour	0.075 ppm (2008 standard)	0.075 ppm (2008 standard)
SO_2	3-hour	–	0.5 ppm (1,300 µg/m^3)
	24-hour	0.14 ppm	–
	Annual	0.03 ppm	–

Sources: EPA (2010a–i).

Air pollution emitted in one area (e.g., North Parcel) is not bound by the parcel boundaries and could spread out and become distributed across the airshed. Air pollutants have the potential to disperse over large geographic areas. For this reason, air pollution levels are generally similar across a given airshed. The boundaries of an airshed can be difficult to determine due to changing meteorological conditions. Topographical features such as, ridges and mountains may prevent the circulation of air and hold pollution within their boundaries. However, weather conditions can change on a daily basis, and features that obstruct the movement of air on some days may represent no barrier at all when a weather front pushes through.

The proposed withdrawal parcels are located in Coconino and Mohave counties, which are designated as being in attainment for all criteria pollutants as defined under the EPA NAAQS.

An unclassified designation indicates that the status of attainment has not been verified through data collection. When permitting new sources, an unclassified area is treated as an attainment area (ADEQ 2010a).

Class I and Class II Areas

Clean air designations were established under the CAA Title I, Part C, Prevention of Significant Deterioration (PSD) of Air Quality. Specific provisions are included in federal, state, and county air quality regulations to preserve the pristine air quality in Class I areas.

Designation as a Class I area allows only very small increments of new pollution above already existing air pollution levels. Generally, the Class I air quality/land use classification is the designation for clean, pristine airsheds and would permit little or no development and signifies a goal, which is implemented by requiring the most stringent controls on air pollutant sources. The Class II designation is applied to all other clean air areas that are in attainment of the NAAQS, where development is permitted under the authority of the state. Class I areas include national parks larger than 6,000 acres, and wilderness areas larger than 5,000 acres that were in existence before August 1977.

However, certain areas deserving of preservation, established by the Wilderness Act of 1964, may be designated Class II “Wilderness,” and state or county requirements or permitting policies may be promulgated to protect air quality in these areas. Except for fires and wind erosion, the potential for adverse air quality impacts is from human-caused pollutants transported into these areas by gradient and/or local winds. Class II areas include all other areas of the country that are not Class I.

The proposed withdrawal parcels are designated as Class II for criteria pollutants. One federally designated Class I area, the Grand Canyon National Park, borders the proposed withdrawal parcels (see Figure 3.2-1). There are several other Class I and II areas in close proximity to the proposed withdrawal parcels, including Zion (approximately 21 miles to the north) and Bryce Canyon (approximately 30 miles to the north) national parks, located in Utah (all Class I); Glen Canyon and Lake Mead national recreation areas; Grand Canyon–Parashant, Pipe Springs, Wupatki, Grand Staircase–Escalante, Vermilion Cliffs, and Sunset Crater Volcano national monuments; and Paria Canyon–Vermilion Cliffs and Kanab Creek wilderness (Class II) (see Figure 3.2-1).

Prevention of Significant Deterioration

In addition to the NAAQS discussed above, the EPA promulgated PSD regulations to further protect and enhance air quality. PSD review is a pollutant-specific review and a federally mandated program. This PSD review applies to new emission sources in areas designated attainment or unclassified, and it applies only to pollutants for which a project is considered a potential major contributor. The PSD provisions use an incremental approach and are intended to help maintain good air quality in areas that attain the NAAQS and to provide special protections for areas of special natural recreational, scenic, or historic value, such as national parks and wildlife areas.

PSD permits are required for major new stationary sources of emissions that emit 250 tons (100 tons for categorical sources) or more per year of an air pollutant. Uranium mining is not listed as one of the 28 designated categories. Therefore, the applicable PSD threshold is 250 tons per year. The main requirements of the PSD review process are to demonstrate that projects would do the following:

- Incorporate best available demonstrated control technology (BADCT);
- Evaluate existing ambient air quality in the area of the project;

- Demonstrate that the project would not cause or significantly contribute to a violation of the NAAQS or PSD increments;
- Determine the impacts on soils, vegetations, and visibility for Class I areas;
- Evaluate the air quality impacts resulting from indirect growth associated with the project; and
- Provide for public involvement.

The PSD regulations at the federal and state levels define numerical values for "increments" that are maximum allowable increases in predicted ambient concentrations at any location. The regulations also define the predicted concentrations that trigger an ambient monitoring requirement for a given project.

"Increments" are maximum increases in ambient concentrations allowed in an area above the baseline concentration. Class I increments have been established for PM_{10}, SO_2, and NO_2 and are listed in Table 3.2-2. These represent the maximum increases in ambient pollutant concentrations allowed over baseline concentrations. Complete consumption of an increment would impose a restriction to growth for the affected area. It does not necessarily indicate an adverse health impact.

The "significant impact levels" (SILs) and "monitoring de minimis concentrations" are numerical values that represent thresholds of insignificance (i.e., de minimis, modeled source impacts or monitored ambient concentrations, respectively). The SIL and monitoring de minimis concentration thresholds are used as screening tools by a major source subject to PSD to determine the level of analysis and data gathering required for a PSD permit application.

PSD regulations state that, in the event the screening-level analysis yields ground-level concentrations that exceed a defined SIL concentration, then a refined air quality analysis must be completed. If the significance analysis modeled impacts are greater than the de minimis levels, a refined analysis would be performed based on at least one year of on-site meteorological data and site-specific topography. In this analysis, existing and permitted sources of pollutants within the region of influence must be considered to evaluate the PSD Class I and Class II increments consumed by the project in conjunction with the background pollutant sources. If modeling shows an increase in ambient concentrations of air pollution by an amount less than the de minimis levels the source is exempted from the site-specific ambient monitoring data requirement.

If and when the regulatory authority reaches a preliminary decision to authorize construction of each proposed major new source, it must provide notice of the preliminary decision and an opportunity for the general public, industry, and others that may be affected by the emissions of the major source to comment before issuing a final decision.

In the context of PSD permitting requirements, a PSD increment evaluation and NAAQS evaluation are conducted to assess potential cumulative impacts on air quality. The PSD increment analysis is used to estimate the degradation of air quality caused by construction of manmade sources of air pollution after certain baseline dates. For PSD baseline purposes, a baseline date is the submittal date of the first completed PSD permit application in a particular area. The NAAQS evaluation, which includes background pollutant concentrations, is used to estimate the total impacts of all natural and manmade sources of air pollution on air quality, compared with the pollutant concentrations at which human health or the environment could be impacted.

The maximum allowable PSD increments over baseline, SILs, and monitoring de minimis concentrations are summarized in Table 3.2-3.

Table 3.2-3. PSD of Air Quality Increments, Significant Impact Levels, and Monitoring de Minimis Concentrations

Pollutant	Averaging Time	PSD Increments Class I (μg/m^3)	PSD Increments Class II (μg/m^3)	SILs Class I (μg/m^3)	SILs Class II (μg/m^3)	Monitoring de Minimis Concentrations (μg/m^3)
PM_{10}	Annual	4	17	0.16	1	N/A
	24-hour	8	30	0.32	5	10
SO_2	Annual	2	20	0.08	1	N/A
	24-hour	5	91	0.2	5	13
	3-hour	25	512	1	25	N/A
NO_2	Annual	2.5	25	0.1	1	14
CO	8-hour	N/A	N/A	N/A	500	575
	1-hour	N/A	N/A	N/A	2,000	N/A

Source: 40 CFR 52.21.

Note: N/A = Not applicable.

Air Quality Related Values

In cases where a proposed project's emissions may adversely affect an area classified as a Class I area, additional review is conducted to protect the increments and special attributes of such an area defined as air quality related values (AQRVs). These AQRVs are scenic, cultural, physical, biological, ecological, or recreational resources that may be affected by a change in air quality as defined by the federal land manager for federal lands. AQRVs are applicable in NPS (Grand Canyon National Park), USFWS, Forest Service, and BLM Class I areas. The specific AQRVs of concern are dependent on a number of variables, including the evolving state of the science, project-specific pollutants, site-specific management concerns, and the existing condition of the AQRVs. Please refer to Section 3.2.3, Existing Air Quality, for a discussion of the specific AQRV, visibility.

In general, the assessment of these impacts is based on dispersion modeling covering both short-range and long-range transport of PM_{10}, SO_2, and NO_2. The AQRV analysis required for PSD permitting of new major sources includes consideration of potential impacts on visibility, acid rain, sensitive species, soils, flora, and fauna that are associated with air emissions of a proposed project.

New Source Performance Standards

The New Source Performance Standards promulgated by EPA pursuant to Section 111 of the CAA establish emission limitations, work-practice standards, and provisions for monitoring, recordkeeping, and reporting applicable to new stationary sources of criteria pollutants. The New Source Performance Standards are codified at 40 CFR 60. At first, 40 CFR 60, Subpart LL, Standards of Performance for Metallic Mineral Processing Plants, appeared to be applicable; however, upon further review, Subpart LL provided certain exemptions for facilities located in underground mines and uranium ore processing plants, including all facilities subsequent to and including beneficiation of uranium ore. Therefore, no New Source Performance Standards are applicable to uranium mining.

National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants include emission limitations, work-practice standards, and provisions for monitoring, recordkeeping, and reporting of hazardous air pollutants not covered by the NAAQS. These standards were promulgated pursuant to Section 112 of the CAA and are codified at 40 CFR Parts 61 and 63. The Part 63 standards apply to specific source categories and require affected facilities to implement maximum achievable control technology for specific hazardous air pollutants specified in each subpart.

Radon is a radioactive gas formed as part of the radioactive decay chain of uranium and is considered a hazardous air pollutant. Several subparts under Part 61 appear to potentially apply to uranium mining and processing activities. Those potentially applicable subparts are as follows:

- 40 CFR Part 61 Subpart B, National Emission Standards for Radon Emissions from Underground Uranium Mines;
- 40 CFR Part 61 Subpart T, National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings; and
- 40 CFR Part 61 Subpart W, National Emission Standards for Radon Emissions from Operating Mill Tailings.

It should be noted that all mined uranium ore is transported to and processed at the White Mesa Mill, located in Blanding, Utah. No uranium ore processing would occur within the proposed withdrawal area.

Clean Air Act Title V Permit Program

Under the federal operating permit program established by Title V of the 1990 CAA Amendments, federal, state, and local agencies delegated the authority to administer and enforce the program shall issue air quality operating permits to major stationary sources of air pollutant emissions. Under Title V, major sources are those with a potential to emit: 100 tons per year or more of any one regulated pollutant (PM_{10}; NO_x, SO_2, CO, volatile organic compounds [VOCs], and Pb), 10 tpy or more of any one hazardous air pollutant (HAPs), or 25 tpy or more of any two or more HAPs.

The implementing EPA regulations are codified at 40 CFR 70 and 71. Title V permits identify all applicable requirements under the act, create a “permit shield,” and establish requirements for monitoring, recordkeeping, reporting, and annual compliance certifications. ADEQ was delegated the authority to administer the Federal Title V permit program in all areas of Arizona except Maricopa, Pinal, and Pima counties and all areas within the borders of an Indian reservation. Therefore, any “major” uranium mining facilities would be required to submit a Title V air permit application to the ADEQ.

State Laws and Regulations

ADEQ has been delegated the authority to administer and enforce the CAA, federal, and state regulations and standards in Coconino and Mohave counties, Arizona (location of the proposed withdrawal parcels). The uranium processing site is located in Blanding, San Juan County, Utah. The Utah Department of Environmental Quality (UDEQ) enforces air quality regulations in that area (UDEQ 2010).

ARIZONA LAWS AND REGULATIONS

The proposed withdrawal parcels are located in Coconino and Mohave counties, Arizona. ADEQ air quality regulations are provided in Title 18, Chapter 2 of the Arizona Administrative Code (AAC) (Arizona Secretary of State 2010). These regulations establish ambient air quality standards for the state that are equivalent to the NAAQS. The AAC also includes promulgated emission limits and workplace standards for specific categorical sources that might be applicable to certain activities within the air quality study areas.

The EPA has delegated ADEQ the authority under the CAA to regulate air quality and issue air quality permits. This permitting process is the primary way that ADEQ balances environmental protection and economic development. The ADEQ Air Quality Division issues air quality permits to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air. Moreover, the permitting process allows citizens to stay informed and involved as these proposed air quality permitting decisions are made.

ADEQ receives the authority to require air modeling for new major sources and major modifications to existing sources from the AAC R18-2-407. Furthermore, the Arizona Revised Statutes (ARS) §49-422, describes the broad authority of the ADEQ Director in regards to the quantification of the air contaminants. This authority allows the Director to require a source of contaminants, by permit or executive order, to quantify its emissions of air pollution. Therefore, on a case-by-case basis, ADEQ also requires that permit applicants perform modeling analyses for both minor sources and minor modifications.

Global Climate Change

Climate change can be generally described as a shift in the average weather a given region experiences. These shifts can be measured by changes in temperature, wind patterns, precipitation, and storms. Global climate change is the change in the climate of the Earth. Climate change can occur naturally, as in the case of the ice ages, or as a result of human activities. The extent to which human-caused activities influence climate change has been the subject of extensive scientific inquiry in the past several decades.

The proposed alternatives would be a source of carbon dioxide (CO_2) and other GHGs, which could have an undetermined effect on local, regional, and global climate change. This analysis is unable to identify the specific impacts of the proposed alternatives GHG on global warming and climate change because there is insufficient information and numerous models, which produce widely divergent results.

Therefore, it is difficult to state with any certainty what impacts on global warming may result from GHG emissions, or to what extent the proposed alternatives would contribute to those climate change impacts. As a result, any attempt to analyze and predict the local or regional impacts of the proposed alternatives on GHG emissions cannot be done in any way that produces reliable results. On May 14, 2008, the Director of the USFWS noted, "The best scientific data available today do not allow us to draw a casual connection between GHG emissions from a given facility and effects posed to listed species or their habitats, nor are there sufficient data to establish that such impacts are reasonably certain to occur" (USFWS 2008).

Chapter 4 will quantify GHG emissions from combustion sources (both mobile and stationary sources) associated with the mining-related activities under each of the proposed alternatives.

3.2.3 Existing Air Quality

The following section describes the existing air quality within the proposed withdrawal area.

Background Air Quality and Regional Sources

There are many regional sources that may impact the Class I areas. Five permitted major point sources of air-pollutant emissions are located within 50 km (31 miles) of the proposed withdrawal area, with emissions greater than PSD thresholds (Table 3.2-4). A major source is categorized as a source that has the potential to emit more than 250 tons per year (tpy) for a PSD source, or 100 tpy for a categorical source of a criteria pollutant, or more than 10 tpy of any single hazardous air pollutant, or 25 tpy of any combination of hazardous air pollutants.

PSD sources are normally considered to have the potential for significant impacts, and more restrictive permitting requirements are generally imposed. Note that NO_x are produced during combustion, typically those that involve high combustion temperatures, and refer to nitric oxide (NO) and NO_2, respectively. Under current federal regulation [40 CFR 86, 87, 89, etc.], the affected sources listed in Table 3.2-4 will not report emissions until the first quarter of 2011, with the exception of CO_2 emissions reported by the Navajo Generating Station.

Table 3.2-4. PSD Sources Located within and near the Proposed Withdrawal Air Quality Study Area

Facility Name	Facility Type	Location in Arizona	Emissions (tpy)	Permitting Authority
El Paso Natural Gas Company – Seligman Compressor Station	Natural Gas Compressor Station	Seligman	CO – 19 NO_X – 165 PM_{10} – 4 $PM_{2.5}$ – 4 SO_2 – <1 VOCs – 4 Pb – <1	ADEQ
El Paso Natural Gas Company – Williams Compressor Station	Natural Gas Compressor Station	Williams	CO – 230 NO_X – 1,303 PM_{10} – 16 $PM_{2.5}$ – 16 SO_2 – 1 VOCs – 55 Pb – <1	ADEQ
Salt River Project – Navajo Generating Station	Electric Utility	Page	CO – 2,010 NO_X – 33,221 PM_{10} – 3,943 $PM_{2.5}$ – 2,817 SO_2 – 3,944 VOCs – 241 Pb – 0.07 CO_2 – 20.1 million	Navajo Nation Environmental Protection Agency
Chemical Lime Company – Nelson Lime Plant	Lime Plant	Peach Springs	CO – 639 NO_X – 599 PM_{10} – 480 SO_2 – 1,955 VOCs – 17 Pb – 0.0002	ADEQ
Transwestern Pipeline Company – Flagstaff Compressor Station	Natural Gas Compressor Station	Flagstaff	CO – 11 NO_X – 127 PM_{10} – 2 $PM_{2.5}$ – 2 SO_2 – 1 VOCs – 2 Pb – <1	ADEQ

Sources: ADEQ (2010c); EPA (2010k); Navajo Nation Environmental Protection Agency (2010); Western Regional Air Partnership (2010).

Note: Emissions include criteria pollutants (CO, NO_X, PM_{10}, $PM_{2.5}$, SO_2, VOCs, and Pb). Emissions data presented are for calendar year 2005 except for the Nelson Lime Plant, which are for calendar year 2008.

A minor source is categorized as a source having the potential to emit less than 100 tpy of a criteria pollutant, or less than 10 tpy of an individual hazardous air pollutant, or less than 25 tpy of any combination of HAPs. Minor sources located within 31 miles (50 km) of the proposed withdrawal parcels include smaller industrial and commercial operations. Additionally, there are numerous portable sources in the area, such as non-metallic mineral processing industries (e.g., portable crushing and screening plants, hot mix asphalt plants, and concrete batch plants) and the Arizona 1 Mine.

Mobile source emissions from vehicles consist of VOCs, NO_2, CO, PM_{10}, and $PM_{2.5}$, which may warrant consideration in an assessment of ambient air quality in the air quality study areas. Consideration of major traffic routes located within the air quality study areas may be reasonably limited to SR 64, which serves as the entrance to the South Rim of the Grand Canyon, and U.S. Route (U.S.) 89A through Fredonia, Arizona. Additionally, fugitive dust emissions are generated from traffic traveling on the unpaved Toroweap Road to the Tuweep district of Grand Canyon National Park. Based on information obtained from the National Park Service Public Use Statistics Office, the traffic counts in 2009 for the South District and Tuweep District were 1,122,886 and 8,659, respectively (NPS 2010).

The most recent EPA Emissions Inventory Report provides data for Coconino and Mohave counties, including statewide totals, shown in Table 3.2-5. The report summarizes criteria pollutant levels in tpy by source type. These data show that the emissions in Coconino and Mohave counties constitute a small percentage of the Arizona statewide totals.

Table 3.2-5. 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties and Arizona Statewide

Source	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs	Pb
Coconino County							
On-Road Vehicles	39,250	6,475	182	134	140	3,066	–
Electricity Generation	2,010	33,221	3,943	2,817	3,944	241	0
Non-road Equipment	12,989	3,509	204	192	269	2,933	2
Fossil Fuel Combustion	514	2,652	57	30	114	105	0
Industrial Processes	25	–	836	218	–	104	–
Fires	14,818	282	1,570	1,330	168	3,497	–
Waste Disposal	2,045	74	318	306	5	259	–
Residential Wood Combustion	348	4	48	48	1	75	–
Miscellaneous	7	0	2,045	207	–	735	0
Solvent Use	–	–	–	–	–	692	–
Road Dust	–	–	6698	594	–	–	–
Fertilizer and Livestock	–	–	–	–	–	–	–
Subtotal	*72,006*	*46,217*	*15,901*	*5,876*	*4,641*	*11,707*	*2*
Mohave County							
On-Road Vehicles	43,423	7,386	208	151	160	3,862	–
Electricity Generation	7	22	1	1	3	1	–
Non-road Equipment	23,633	4,339	284	270	356	6,413	1
Fossil Fuel Combustion	174	788	66	28	149	44	0
Industrial Processes	28	32	839	214	0	28	0
Fires	14,280	313	1,551	1,314	171	3,384	–
Waste Disposal	4,437	144	550	539	4	427	–
Residential Wood Combustion	278	4	39	39	1	60	–
Miscellaneous	10	0	3,857	412	–	920	0
Solvent Use	–	–	10	9	–	1,086	–
Road Dust	–	–	2,711	231	–	–	–
Fertilizer and Livestock	–	–	–	–	–	–	–
Subtotal	*86,270*	*13,028*	*10,116*	*3,208*	*844*	*16,225*	*1*

Table 3.2-5. 2005 Summary of Emissions by Source (in tpy) for Coconino and Mohave Counties and Arizona Statewide (Continued)

Source	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOCs	Pb
Arizona							
On-Road Vehicles	761,670	132,317	3,866	2,711	2,909	73,626	–
Electricity Generation	7,340	80,370	8,968	7,131	52,765	596	1
Non-road Equipment	458,730	64,553	5,062	4,789	6,344	50,563	33
Fossil Fuel Combustion	4,243	13,921	1,116	528	4,061	663	2
Industrial Processes	8,071	7,051	20,328	8,184	22,107	3,595	12
Fires	74,115	1,749	8,166	6,920	907	17,611	–
Waste Disposal	24,918	981	4,068	3,757	115	4,585	–
Residential Wood Combustion	15,231	183	2,097	2,066	28	3,200	–
Miscellaneous	348	33	70,344	8,635	3	19,736	0
Solvent Use	–	8	18	16	–	49,800	0
Road Dust	–	–	111,387	9,085	–	–	–
Fertilizer and Livestock	–	–	3,079	308	–	–	–
Subtotal	*1,354,666*	*301,166*	*238,499*	*54,130*	*89,239*	*223,975*	*48*
Coconino and Mohave County Percentage of Statewide Total	**11.7%**	**19.7%**	**10.9%**	**16.8%**	**6.1%**	**12.5%**	**6.3%**

Source: EPA (2010k).
Note: – = No data available.

The largest sources of NO_x and PM_{10} in Coconino and Mohave counties are on-road mobile and area sources. Area sources include small portable and stationary sources such as gas stations or wood burning.

The existing air quality in the area is expected to be typical of undeveloped regions in the western United States. Data collected in the area of the proposed withdrawal area is limited. Areas with limited ambient air quality data typically indicate that ambient pollutant levels are usually near or below detection limits. Locations vulnerable to decreasing air quality include the areas immediately surrounding surface-disturbing activities, such as energy and mineral development projects, farm tilling, and local population centers affected by residential emissions.

Specifically within the Grand Canyon National Park, peak ozone levels have been measured at just 1 part per billion (ppb) below the NAAQS. Particulate levels as measured by the Interagency Monitoring of Protected Visual Environments (IMPROVE) network are generally low, but episodic events (usually, but not always, associated with wildfires in Arizona and California) are significant. CO and NO_x levels have only been measured as part of special studies and were quite low (Martin et al. 2002). Based on 1-hour ozone concentration data obtained from the Grand Canyon National Park—The Abyss Monitor, the annual fourth-highest 8-hour ozone concentrations for 2007 through 2009 have been 69, 71, and 66 ppb, respectively (NPS Public Use Statistics Office 2010). The annual 4th-highest 8-hour ozone concentrations have flat trends, nonetheless the values are very close to the 8-hour ozone standard (0.075 ppm).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern.

Emissions from mining activities and trucks used for hauling the uranium ore to the processing areas are air quality issues. Other potential local sources of air pollution include agriculture, automobiles, generators, trains, and wood stoves/fireplaces (in winter). These sources typically generate and emit CO, NO_2, NO_x, VOCs, PM_{10}, and $PM_{2.5}$. Additionally, O_3, a highly reactive form of oxygen, forms when NO_x and VOC emissions from these sources react with sunlight on hot, still days. With the removal of leaded gasoline in the marketplace and the absence of industries such as nonferrous smelters and battery plants, airborne lead pollution is not an issue of concern in the area. In fact, the most recent lead concentration data are from Magna, Salt Lake County, Utah, for 2005, which is more than 300 miles from the proposed withdrawal parcels (EPA 2010j).

The proposed withdrawal parcels are classified as 'attainment areas' for all criteria pollutants. Only two state monitoring stations were identified within the approximately 50-km vicinity of the air quality study area. These two monitors report ambient concentrations of O_3, PM_{10}, and $PM_{2.5}$. Background air quality levels of CO, Pb, NO_2, and SO_2 were collected from the next-closest monitors that are outside the immediate 50-km air quality study area and are identified in Table 3.2-5. Refer to Figure 3.2-1 for the monitoring station locations. Concentrations are also graphically presented in Figure 3.2-2. As shown in Table 3.2-6 and Figure 3.2-2, all of the concentrations were below the NAAQS.

On August 31, 2009, the ADEQ issued a Class II Non-Title V Air Quality Permit to Denison for the operation of its Arizona 1 Mine, located approximately 35 miles south of Fredonia, Arizona. The Arizona 1 Mine is located on the BLM's Arizona Strip within the North Parcel. The Arizona 1 Mine began operations in December 2009. The proposed emissions from the emergency backup generator and the ore, waste rock unloading, and fugitive dust emissions from unpaved haul road travel associated with the Arizona 1 Mine are presented in Table 3.2-7. Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] and are not to exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (mrem) (ADEQ 2010b). To put the 10 millirem in context, a typical chest x-ray is approximately 10 millirem per film and smoking one and a half packs of cigarettes daily exposes an individual to approximately 1,300 millirem per year (Cancer Information Service 2001).

Table 3.2-6. 2008 Air Quality Monitor Data from the Air Quality Study Area

Pollutant	Averaging Period	Measured Concentration (Maximum Value)	Monitor Site ID/Name (County)	Source	Primary NAAQS
CO	1-hour	4.2 ppm	320030538	EPA	35 ppm (40 mg/m^3)
	8-hour	2.5 ppm	Las Vegas, NV (Clark County)		9 ppm (10 mg/m^3)
Pb*	Rolling 3-Month Average	–	–	–	–
	Quarterly Average	–	–	–	–
NO_2	1-hour	0.064 ppm	3200332002	EPA	0.100 ppm
	Annual	0.016 ppm	Las Vegas, NV (Clark County)		0.053 ppm (100 µg/m^3)
PM_{10}	24-hour	45 µg/m^3	04-005-1008 Flagstaff Middle School, AZ (Coconino County)	ADEQ	150 µg/m^3
$PM_{2.5}$	24-hour	13.5 µg/m^3	04-005-1008	ADEQ	35 µg/m^3
	Annual	5.92 µg/m^3	Flagstaff Middle School, AZ (Coconino County)		15.0 µg/m^3
O_3	1-hour	0.078 ppm	04-005-8001	ADEQ	0.12 ppm
	8-hour	0.073 ppm	Grand Canyon NP – The Abyss (Coconino County)		0.075 ppm (2008 standard)
SO_2	3-hour	0.002 ppm	320030539	EPA	0.5 ppm
	24-hour	0.002 ppm	Las Vegas, NV		0.14 ppm
	Annual	0.001 ppm	(Clark County)		0.03 ppm

Sources: ADEQ (2009f); EPA (2010j).

Note: – = No data available.

* Ambient lead monitoring data not available for the study area. Nearest monitoring occurs in Magna, Utah.

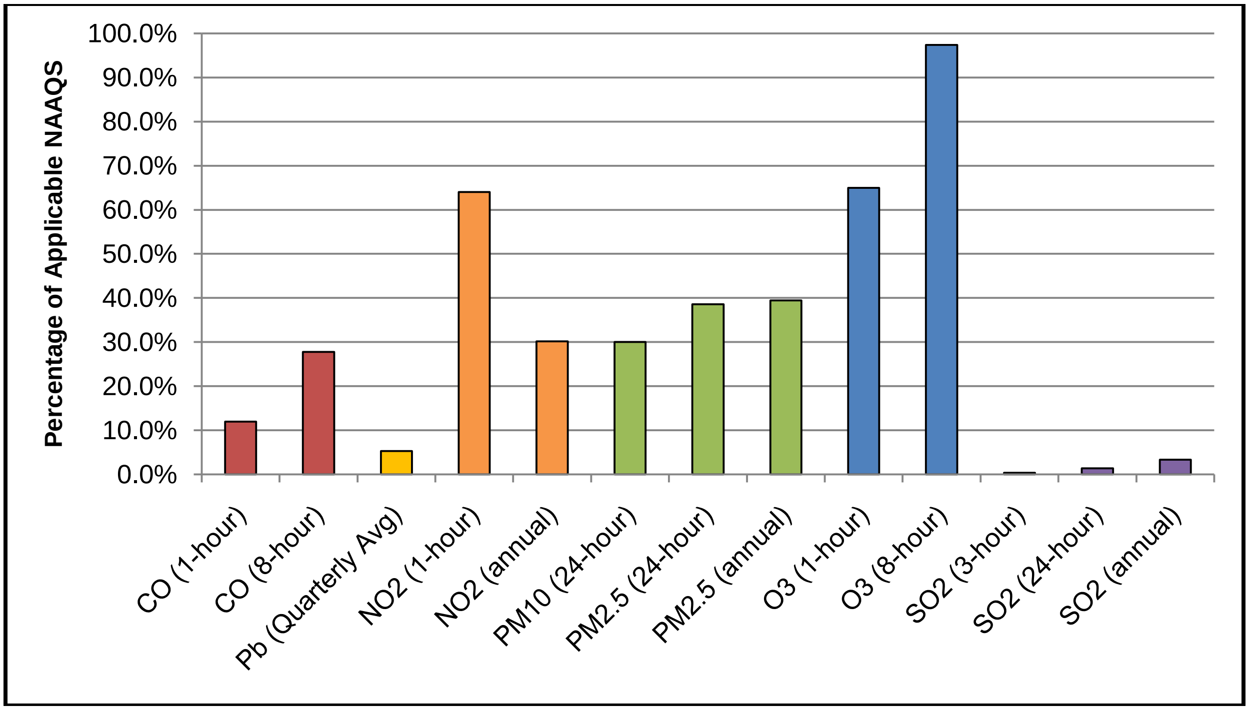


Figure 3.2-2. Background concentrations of criteria pollutants from the air quality study area.

Table 3.2-7. Arizona 1 Mine Potential to Emit (tpy)

CO	NO_x	PM_{10}*	$PM_{2.5}$	SO_2	VOCs	Radon†
0.28	1.3	324.44	5.7	0.08	0.38	–

Source: ADEQ (2010b).

Note: – = No data available.

* Includes fugitive emissions, which are not considered in PSD applicability.

† Potential to emit was based on permissible thresholds promulgated in 40 CFR 61.22.

The ADEQ-issued Air Quality Permit for the Arizona 1 Mine requires Denison to keep records of all emission related activities and submit for approval a dust control plan that requires them to monitor and track ongoing implementation of dust control measures. Additionally, radon emissions from the vent shaft must be monitored and sent to ADEQ for review.

ADEQ required Denison to conduct ambient air dispersion modeling to ensure that emissions from the Arizona 1 Mine would not cause or contribute to an exceedance of the federal NAAQS for particulate matter. ADEQ required that Denison include the 37 miles of unpaved road used by the haul trucks in this analysis.

Visibility

Visibility is the degree to which the atmosphere is transparent to visible light. It is an important air quality value, particularly in scenic and recreational areas. Scenic vistas in most U.S. parklands can be diminished by haze that reduces contrast, dilutes colors, and reduces the distinctness or visibility of distant landscape features. Visibility degradation in national park lands and forests is a consequence of broader, regional-scale visibility impairment from visibility-reducing particles and their precursors, which are often carried long distances to these remote locations (NPS 2007).

Sulfates, organic matter, elemental carbon (soot), nitrogen compounds, soil dust, and their interaction with water cause most anthropogenic visibility impairment. The causes and severity of visibility impairment vary over time and space, depending on meteorological conditions, sunlight, and the size and proximity of emission sources.

Visibility protection requirements are included in EPA PSD regulations requiring protection of AQRVs for Class I areas. In the PSD title of the CAA, "Congress declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution." More specifically, Congress expressed the national desire to preserve the ability to see long distances, entire panoramas, and specific features associated with the statutory Class I areas (NPS 2010). Meeting these visibility objectives occurs when "reasonable progress" is made toward achieving EPA's regional haze regulation goal of restoring natural background visibility conditions by 2064 (EPA 2003a).

The Cooperative Institute for Research in the Atmosphere operates a network of visibility monitoring stations in or near Class I areas and publishes IMPROVE data. The purpose of this monitoring is to identify and evaluate patterns and trends in regional visibility. Data from three IMPROVE monitors within Grand Canyon National Park show that fine ($PM_{2.5}$) and coarse (PM_{10}) particulates were the largest contributors to the impairment of visibility. These particulates impact the standard visual range for each monitor location. The standard visual range is the distance that can be seen in a given day. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park (GRCA1, GRCA2, and INGA1) range from 149 to 178 mile on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days (IMPROVE 2010).

A change in contrast of not more than 5% at sensitive view areas is considered acceptable. As discussed in the previous section, Bryce Canyon, Zion, and Grand Canyon national parks (all Class I) and Grand Canyon–Parashant National Monument, Glen Canyon and Lake Mead National Recreation Areas, and Paria Canyon–Vermilion Cliffs and Kanab Creek wilderness (Class II) are in close proximity to the proposed withdrawal parcels.

The State of Arizona has addressed both visibility and regional haze in the Class I areas within its State Implementation Plan (SIP). The Regional Haze SIP for the State of Arizona (ADEQ 2003) addresses visibility protection of Arizona's natural features using various long-term strategies addressing the clean air corridor, stationary sources, mobile sources, and fire programs.

More current information is available in the Air Quality Division Revision SIP for Regional Haze (ADEQ 2004). These documents contain measures addressing regional haze visibility impairment to ensure that the State makes reasonable progress toward national goals. The State has implemented long-term strategies to reduce regional haze resulting from various air pollution sources. Pollutant projections affecting regional haze, as identified in the 2004 revised SIP, include the following:

- A 36% decrease in Arizona sources and a 22% decrease for nine Grand Canyon Visibility Transport Commission region states' (Arizona, California, Colorado, Idaho, New Mexico, Nevada, Oregon, Utah, and Wyoming) SO_2 emissions between 1996 and 2018.
- A 16% decrease in Arizona sources and 32% decrease for nine Grand Canyon Visibility Transport Commission states' NO_x emissions between 1996 and 2018.
- A 3% decrease in Arizona sources and 3% increase for nine Grand Canyon Visibility Transport Commission region states' $PM_{2.5}$ emissions between 1996 and 2018.
- A 25% decrease in Arizona sources and 30% decrease for nine Grand Canyon Visibility Transport Commission region states' VOC emissions between 1996 and 2018.

- Visibility improvement for the 20% best and worst days for each of the Class I areas (Bryce Canyon, Zion, and the Grand Canyon) from the base year 1996 to the year 2018.

The State of Arizona's reduction in SO_2 is due primarily to the long-term reduction strategy for stationary sources of SO_2. The reduction in NO_X and $PM_{2.5}$ is due primarily to the implementation of new federal engine and fuel standards.

Resource Condition Indicators

Air quality related to uranium mining activities results from initial heavy-duty construction equipment operations/earthmoving (e.g., trucks backhoes, excavators, etc.) and long-term from production operations (e.g., ore/waste rock handling, travel on unpaved roads, etc.). To properly evaluate any potential air quality effects that could be caused by an individual proposed mine or a number of proposed mines, each mine would need to be evaluated/modeled using the specific mine site location, number and types of equipment, operation schedules, site-specific topography, and meteorological data.

Resource Condition Indicators

The air quality condition indicators to be evaluated in Chapter 4 of this assessment area as follows:

- Discussion of the potential increases in ambient concentrations in air pollutants associated with mine exploration and mining activities to determine compliance with applicable Federal, state, and local regulations;
- The estimated quantity of HAPs emitted under each alternative;
- Discussion of the potential increases in ambient concentrations in air pollutants associated with mine exploration and mining activities Comparison of the maximum NO_X, CO, PM_{10}, and SO_2 concentrations with the NAAQS;
- Discussion of potential increases in NO_X, CO, PM_{10}, and SO_2 concentrations with the PSD air quality increments;
- The estimated quantity of GHG emissions emitted under each alternative, and;
- Discussion of potential impacts in AQRVs relating to visibility.

To assess the current value of the resource condition indicators, the applicant of an individual proposed mine would be required to obtain an air quality permit from ADEQ. Depending on what class of permit would be required and/or the requests of the Department the applicant may be required to estimate its emissions and conduct modeling. The ADEQ Air Quality Division issues air quality permits to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air.

3.2.4 Current Value Resource Condition Indicators

The current value or condition of the air quality within the study area with respect to each of the resource condition indicators is presented in Table 3.2-8.

Table 3.2-8. Air Quality Resource Condition Indicators

Issue	Description of Relevant Issue	Resource Condition Indicator(s)
Quantity of criteria and hazardous air pollutants	The emissions from the emergency backup generator and the ore, waste rock unloading, and fugitive dust emissions from unpaved haul road travel associated with the Arizona 1 Mine are presented in Table 3.2-7. Radon-222 emissions from the underground uranium mining activities associated with the Arizona 1 Mine are limited by federal regulations [40 CFR 61.22] and are not to exceed those amounts that would cause any member of the public to receive in any one year an effective dose equivalent of 10 millirem (ADEQ 2010b).	Quantity of criteria and hazardous air pollutants emitted under each alternative.
Regulatory Requirements	Each individual mine will be required to obtain an air quality permit. The permit is the mechanism to ensure facilities are legally constructed and operated so that discharges to the ambient air are within the healthy standards and do not harm public health or cause significant deterioration in areas that presently have clean air.	PSD: > 250 tpy of a criteria pollutant Federal HAP Source: > 25 tpy combined or > 10 tpy of a regulated HAP ADEQ Class I Source: > 100 tpy to < 250 tpy of a criteria pollutant ADEQ Class II Source: > 2 tpy to < 100 tpy of a criteria pollutant
NAAQS	As shown in Table 3.2-6 and Figure 3.2-2, the ambient air concentration data obtained from monitors in or near the air quality study area were below the NAAQS. However, based on data obtained from the Grand Canyon National Park, the annual 4th-highest 8-hour ozone concentrations have flat trends nonetheless have values that are very close to 8-hour ozone standard (0.075 ppm) and sometimes over it (NPS 2010).The Grand Canyon National Park on-site monitoring had a W127 index value (maximum 3-month ppm-hours) of 18 ppm-hours. The air quality condition has been classified by the NPS as stable moderate concern. The EPA recommends that this proposed "secondary" standard be in the range of 7 to 21 ppm-hours.	Comparison of measured and/or modeled air pollutant concentrations with applicable thresholds (i.e., NAAQS).
PSD Increment	The PSD increments establish the maximum increase in pollutant concentration allowed above the baseline level.	PSD is the mechanism that protects Class I areas.
GHGs	Qualitative and/or quantitative evaluations of potential contributing factors within the planning area will be included in Chapter 4 where appropriate and practicable.	The quantity of GHG emission emitted under each alternative.
AQRVs – Visibility	The NPS has classified the visibility at the Grand Canyon National Park as a stable moderate concern. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days.	Discussion of visibility impacts and comparison of measured or modeled values with applicable thresholds.

3.3 GEOLOGY AND MINERAL RESOURCES

3.3.1 Geological Setting

Physiography

The proposed withdrawal area lies within the Colorado Plateau physiographic province in northern Arizona. The Colorado Plateau covers more than 130,000 square miles and is centered on the Four Corners area. The portion of the Colorado Plateau province that includes the proposed withdrawal area is characterized by predominantly sedimentary rock exposures; a regular, gently dipping surface; and plateaus over 7,000 feet above mean sea level (amsl) that have been incised in some places to depths over 5,000 feet by the tributaries to the Colorado River. Major structures that occur in the proposed withdrawal area include faults, anticlines, and monoclines. These structures often form the geographic boundaries for the numerous plateaus located throughout the area proposed withdrawal, and are shown in Figure 3.4-5 in Section 3.4, Water Resources.

The Colorado Plateau is known generally for unique geological features, including the widespread prevalence and color of exposed sedimentary units, the occurrence of isolated volcanic mountain complexes, and erosional features such as mesas, cliffs, escarpments, and incised stream canyons. While not within any of the parcels, the Grand Canyon dominates the geological setting and forms the partial geographic boundary of each parcel; the side tributary canyons to the Grand Canyon form the surface drainage network within the parcels.

The major geological structures and geographic features of the North Parcel include the Uinkaret and Kanab plateaus (see Figure 3.4-5). The Uinkaret Plateau extends east from the Hurricane fault zone to the Toroweap fault zone. The Kanab Plateau then extends east from the Toroweap fault zone to the Muav fault zone. These fault zones are largely northerly trending normal faults, downthrown to the west. The Kanab Plateau has also been dissected by Kanab Creek, a tributary to the Colorado River, as well as other tributaries to Kanab Creek, including Hack Canyon, Grama Canyon, and Snake Gulch.

House Rock Valley, where the East Parcel is located, is a geological basin bounded to the west by the East Kaibab monocline, which is the eastern edge of the Kaibab Plateau, to the north by the Vermilion Cliffs, which is the edge of the Paria Plateau, and to the southeast by Marble Canyon, part of the Colorado River gorge (see Figure 3.4-5).

The South Parcel lies completely within the Coconino Plateau, the largest of the plateaus within northern Arizona (see Figure 3.4-5). Major structural features within the South Parcel include the Grandview monocline, East Kaibab monocline, Cataract syncline, and Bright Angel fault.

The unique geological and topographic features of the Grand Canyon were cited as specific criteria for its designation as a World Heritage Site:

> Widely known for its exceptional natural beauty and considered one of the world’s most visually powerful landscapes. . . . Within park boundaries, the geologic record spans all four eras of the earth’s evolutionary history, from the Precambrian to the Cenozoic. The Precambrian and Paleozoic portions of this record are particularly well exposed in canyon walls and include a rich fossil assemblage. Numerous caves shelter fossils and animal remains that extend the paleontological record into the Pleistocene. (United Nations Educational, Scientific, and Cultural Organization 2010)

Stratigraphy

In terms of geology, the Colorado Plateau in northern Arizona is composed of relatively flat layers of sedimentary rocks of Paleozoic and Mesozoic age deposited on top of Precambrian basement rocks, although in some places more recent Tertiary volcanic activity has created isolated mountains or cinder cones (such as the San Francisco Peaks or Mt. Trumbull). The general stratigraphy of the Colorado Plateau is shown in Figures 3.4-3 and 3.4-4. Specific geological units are discussed in detail in Section 3.4, Water Resources, as the primary importance of these units is their influence on local and regional hydrology.

Paleontology

Geological units representing nearly 2 billion years of time are present in the proposed withdrawal area, although many are not exposed at the surface. Many of these units are sedimentary in nature, and some contain paleontological resources. The potential for a given geological formation to contain paleontological resources varies by formation age and deposition type. The geological units that contain paleontological resources range from 570 million years to about 10,000 years old.

The paleontological resources within the proposed withdrawal area are widespread and associated with extensive geological formations. These paleontological resources are typically small in size, common in nature, and ubiquitous. Paleontological resources of a highly unique nature are not common within the proposed withdrawal area; for this reason, while some subsurface impact to unexposed paleontological resources could occur from mining activities, it is not of a level sufficient to include in the analysis.

Mineral Deposits

Minerals of economic interest are classified as leasable, locatable, or salable. Coal, oil shale, oil and gas, phosphate, potash, sodium, geothermal resources, and all other minerals that may be acquired under the Mineral Leasing Act of 1920, as amended, are referred to as leasable minerals. Common varieties of sand, stone, gravel, pumicite, and clay that may be acquired under the Materials Act of 1947 are considered salable minerals or mineral materials. Any minerals that are not salable or leasable, such as gold, silver, copper, tungsten, and uranium, are referred to as locatable minerals. These mineral deposits include most metallic mineral deposits and certain nonmetallic and industrial minerals. Locatable minerals are subject to the Mining Law. The primary geological environments within the proposed withdrawal area with the potential for locatable minerals are breccia pipe–related deposits. Favorable environments also occur for non-metallic industrial minerals such as gypsum. Only locatable mineral resources are subject to the proposed withdrawal. Therefore, leasable and salable mineral resource occurrence and development are not discussed further, although they are considered in Chapter 4 in the context of cumulative impacts.

Locatable Minerals

The primary economic mineral resource within the proposed withdrawal area consists of locatable mineral deposits, including both stratabound deposits and breccia pipe deposits.

Gypsum deposits are found in northern Arizona associated largely with the Toroweap, Kaibab, and Moenkopi formations. No specific gypsum deposits are known to exist within the proposed withdrawal area, although several tons of alabaster were quarried for ornamental carving from one known location on the North Parcel, which has since been reclaimed. The BLM mineral report for the proposed withdrawal area indicates the potential for gypsum occurrence is Low, with a moderate level of certainty (BLM 2010a). Metallic minerals associated with stratabound deposits occur only on the South Parcel, which contains primarily copper in the Francis mining district. Secondary copper minerals, including azurite, chrysocolla, and malachite, are located within siliceous brecciated horizons of Kaibab Limestone (Scott 1992). These deposits were studied and considered small and unattractive for commercial development (Scott 1992).

All other locatable deposits of economic interest are associated entirely with geological features known as breccia pipes. Breccia pipes are vertical collapse features formed from the collapse of karst solution caverns in the Redwall Limestone. As the collapse feature migrated upward from the Redwall, a vertical pipe formed, extending several thousand feet through the overlying sedimentary formations, and within this pipe, breccia formed from broken pieces of the overlying formations. Breccia pipes are quite small, typically averaging only 300 feet in diameter. Subsequent intrusion of mineralized groundwater into the breccia pipes resulted in the precipitation of various minerals within the pipes; while thousands of pipes exist across the Colorado Plateau, it has been estimated that perhaps less than 1% contain levels of mineralization suitable for mining (Wenrich and Sutphin 1988).

A variety of metals are found within breccia pipes. Early prospectors were drawn to exposures of these minerals where breccia pipes had been eroded along the walls of incised canyons, such as the

Orphan Mine, which is located on the south rim of the Grand Canyon itself. Precious metals include copper, gold, silver, and vanadium. However, it is the presence of uranium minerals within breccia pipes that has been of the most interest over the past half century. From the 1950s through the 1980s, 12 breccia pipes were mined specifically for their uranium deposits; several other mines were constructed and placed on interim management status in the 1990s partially as a result of low commodity prices. The uranium deposits within the northern Arizona breccia pipes are of higher grade than approximately 85% of the world's known uranium deposits (International Atomic Energy Agency 2009; World Nuclear Association 2009).

While breccia pipes can have a surface exposure formed by the collapse and tilting of the overlying sedimentary beds, confirmation of the presence of a breccia pipe is typically only possible through drilling. Approximately 45 breccia pipes have been confirmed through drilling within the proposed withdrawal area (see RFD, Appendix B, Table B-1). Uranium reserves are typically expressed in relation to the naturally occurring mineral pitchblende (U_3O_8). Known reserves of uranium (U_3O_8) within these pipes amount to 4,147 tons, as shown in Table 3.3-1. Note that the term "uranium resources" used in this section is a generic term that encompasses all ore bodies, even ones not yet discovered; by contrast, the term "uranium reserves" refers to confirmed ore bodies that are both economically and technically feasible to mine.

Table 3.3-1. Estimated Known Reserves, Undiscovered Uranium Endowment, and Estimated Total Available Uranium Resources

Parcel	Confirmed Breccia Pipes*	Known Uranium Reserves (tons U_3O_8)*	Estimated Uranium Resources in Discovered Pipes not yet Quantified (tons U_3O_8)†	Undiscovered Uranium Endowment (tons U_3O_8)‡	Estimated Total Available Uranium Resources (tons U_3O_8)§
North	30	3,385	3,000	91,944	20,177
East	1	0	0	22,257	3,339
South	14	762	1,500	49,179	9,639
Totals	**45**	**4,147**	**4,500**	**163,380**	**33,155**

* Personal communication, Spiering (2010).

† Based on 15% of discovered mineralized breccia pipes containing ore bodies, each ore body averaging 1,500 tons.

‡ USGS (2010b).

§ Includes known uranium reserves (Arizona 1, Pinenut, Rim, Kanab North, EZ1, EZ2, DB, Findlay Tank NW, Findlay Tank SE, Canyon, What), estimated uranium resources in known mineralized pipes, and 15% of undiscovered uranium endowment (see RFD, Appendix B, Table B4).

While the entirety of the proposed withdrawal area has a high potential for the presence of breccia pipe deposits, approximately 82% (3,385 tons) of these known reserves occur within the North Parcel. No confirmed reserves are located within the East Parcel, and only 762 tons are confirmed within the South Parcel. Note that uranium tonnage refers to the estimated amount of uranium after processing at the mill; the amount of ore needed to be removed from the mine and transported to the mill for processing would typically be 100 to 200 times greater than the noted tonnage of processed uranium.

With respect to undiscovered uranium resources, in 1987 the USGS divided northern Arizona into areas of varying favorability for uranium resources (Finch et al. 1990). The study area for the 1987 estimate covered over 16,700 square miles, and of this area approximately 9,100 square miles were considered to be "Favorable Area A," the area with the highest potential for breccia pipes to occur (Figure 3.3-1). Almost the entire proposed withdrawal area falls within the area considered to be high potential. Similarly, the mineral report produced by the BLM for the proposed withdrawal area rates the potential for uranium occurrence as high, with a high level of certainty (BLM 2010a).

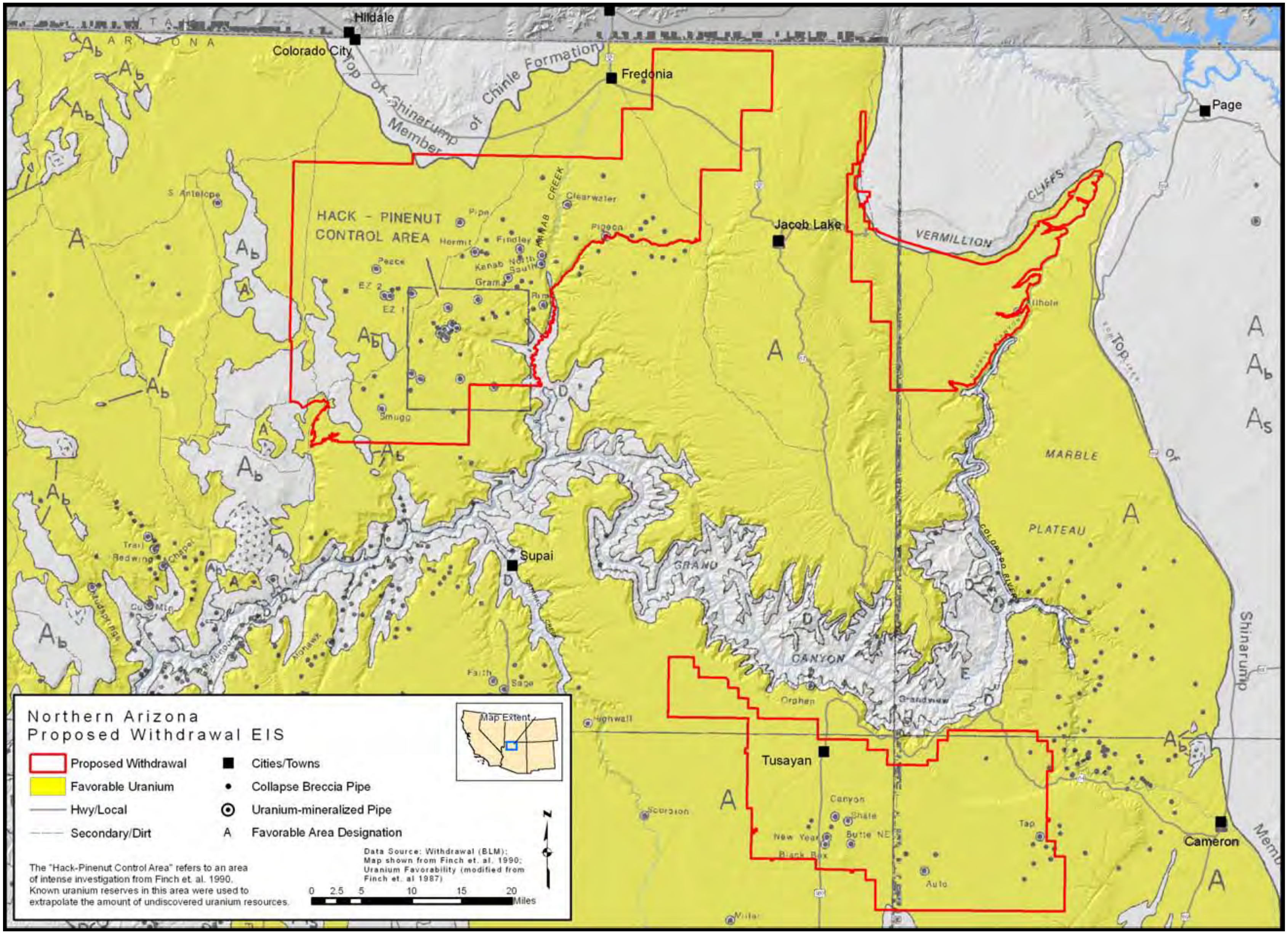


Figure 3.3-1. Areas favorable for uranium (from Finch et al. 1990).

In addition to uranium reserves confirmed through drilling, the USGS has estimated the amount of undiscovered uranium endowment within the proposed withdrawal area, as shown in Table 3.3-1. The term "endowment" refers specifically to rocks containing uranium exceeding a grade of 0.01% but does not indicate whether the uranium ore can be mined economically. Historically, the mines within the proposed withdrawal area have not contained average uranium concentrations less than 0.5% U_3O_8 (personal communication, Spiering 2010). The percentage of the uranium endowment that might be economically mined has not been determined by the USGS; for the purposes of the RFD (see Appendix B), it was assumed that 15% of the endowment might be mined. This percentage of the estimated endowment (24,507 tons U_3O_8), the amount of confirmed uranium reserves (4,147 tons U_3O_8), and the uranium estimated to be in breccia pipes already discovered (4,500 tons U_3O_8) represent the total estimated uranium resource within the proposed withdrawal area (33,155 tons U_3O_8), as shown in Table 3.3-1.

3.3.2 Resource Condition Indicators

Resource condition indicators for mineral resources include the following:

- 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, current domestic demand, and current domestic production.
- Depletion of uranium resources within proposed withdrawal area.
- Amount of uranium mined as percentage of global demand and production.
- Cumulative amount of high-potential uranium resource lands withdrawn from exploration and development.

Following is a discussion of the current value or condition with respect to each of the resource condition indicators listed above.

Availability of High Mineral Potential Lands

The approximately 1 million acres of land within the proposed withdrawal area are considered to have high mineral potential for uranium. The resource condition indicator is the availability of these high mineral potential lands. The current value is that these lands have historically been fully available for exploration and possible development of economic mineral deposits.

Number of Ore Deposits Currently under Approved Plans of Operation

The majority of exploration and development activity associated with breccia pipe uranium deposits within the proposed withdrawal area occurred during the 1980s. During this period, five breccia pipes were mined for recoverable uranium resources on the North Parcel, including the Hack 1, Hack 2, Hack 3, Hermit, and Pigeon pipes. Four additional mines within the proposed withdrawal area were partially developed but placed under interim management when uranium commodity prices collapsed. These include the Pinenut, Arizona 1, and Kanab North mines on the North Parcel and the Canyon Mine on the South Parcel. Some uranium ore was mined from both the Pinenut and Kanab North mines. The Arizona 1 mine restarted mining operations in December 2009.

The resource condition indicator is the number of ore deposits operating under approved mine plans of operation. The current value of this resource condition indicator is four: Pinenut, Arizona 1, Kanab North, and Canyon.

Potential for Subsidence and Alteration of Geology or Topography

Mining of any type alters the natural geological formations and topography. The Grand Canyon region is notable for its prominent and unique geology and striking topography, both of which could be altered by mining. This includes the potential for collapse or subsidence of reclaimed or active mine sites and alteration of the area’s topography (streams, canyon walls, mesas or knolls) and/or geology by mines.

Mining of breccia pipes is conducted through underground workings; uranium minerals in breccia pipes typically occur a thousand feet or more below ground and are accessed by a central vertical shaft, allowing for a relatively small mine footprint (typically 20 acres or less). Earlier discoveries, where minerals were exposed along the walls of incised canyons (such as Orphan Mine) also mined using horizontal shafts to reach the ore bodies. Several useful case studies of mined breccia pipes are available to estimate the potential for breccia pipe mines to subside or alter the geology of the area. These include the Orphan, Hack Canyon, Hack Canyon Complex, Pigeon, and Hermit mines; as examples, these represent mining under historic conditions (Orphan Mine and the original Hack Canyon Mine), as well as more modern mining and reclamation techniques (Hack Canyon Complex, Pigeon, and Hermit), in addition to representing three of the most productive breccia pipes mined in northern Arizona (Orphan, Hack 2, and Pigeon).

ORPHAN MINE

The Orphan pipe was discovered as a mineral exposure on a canyon wall of the Grand Canyon and was mined from the side of the canyon, as well as through a vertical shaft from the South Rim; descriptions of mine techniques are provided by Chenoweth (1986). Approximately 500,000 tons of dry ore were removed from the Orphan Mine. Mining was conducted almost entirely underground, with the exception of head structures, and included the central breccia pipe as well as the surrounding ring fractures. Mining took place to a depth of approximately 600 feet, using a series of circular tunnels, shafts, and stopes. Most of the ore bodies mined ranged from 15 to 60 feet wide. Mining ceased in 1969. Surface evidence of the mine still exists within Grand Canyon National Park in the form of open, vertical shafts. The head structure was removed from the mine in 2009. No evidence of subsidence resulting from the mining has been identified.

HACK CANYON MINES

The original Hack Canyon mine was similarly discovered as a mineral exposure at the base of the canyon wall in Hack Canyon and was mined from the floor of the canyon; descriptions of mine techniques are provided by Chenoweth (1988). Approximately 1,400 tons of dry ore were removed from the Hack Canyon mine. Mining was conducted entirely underground through several vertical shafts, horizontal tunnels, and stopes, to a depth of approximately 100 feet. Mining ceased in 1964.

In the 1970s and 1980s, three additional breccia pipes were discovered in the vicinity (Hack 1, Hack 2, and Hack 3 and known collectively as the Hack Canyon Complex). All three breccia pipes were mined from approximately 1981 through 1987 (USGS 2010b), resulting in the removal of approximately 742,000 tons of dry ore (Hack 1 – 134,000 tons, Hack 2 – 479,000 tons, Hack 3 – 111,000 tons) (personal communication, Spiering 2010). Reclamation of all three of these pipes, as well as the historic Hack Canyon workings, was completed in 1988. No evidence of subsidence resulting from the mining has been identified.

PIGEON MINE

The Pigeon Mine is located immediately north of the edge of Snake Gulch, a tributary to Kanab Creek, but unlike the Orphan and original Hack Canyon Mine, the mine was not identified through mineral exposure along the canyon wall. The Pigeon Mine is more typical of breccia pipes that would be mined under present-day conditions, as it involved a single vertical shaft to access the uranium ore body. Approximately 440,000 tons of dry ore were removed from the Pigeon Mine (USGS 2010b). Mining was conducted entirely underground, with surface access through a single vertical shaft. Surface features included a wastewater pond, head structures, and waste rock piles. Mining ceased in 1989. The site has been reclaimed, including the restoration of the natural drainage and returning the topography close to its natural state. No evidence of subsidence resulting from the mining has been identified.

HERMIT MINE

The Hermit Mine is located approximately 10 miles west of Kanab Creek, and is similar to the Pigeon Mine as being typical of breccia pipes that would be mined under present-day conditions. Approximately 36,000 tons of ore were removed from the Hermit mine (USGS 2010b). Mining was conducted entirely underground, with surface access through a single vertical shaft. Surface features included a wastewater pond, head structures, and waste rock piles. Mining ceased in 1989. The site has been reclaimed, including the restoration of the natural drainage and returning the topography close to its natural state. No evidence of subsidence resulting from the mining has been identified.

Amount of Uranium Mined as Percentage of Known Domestic Resources, Domestic Demand, and Domestic Production

Domestic uranium reserves or resources are difficult to estimate. The U.S. Energy Information Administration (EIA) last completed a domestic uranium reserve summary in 2003, based on analysis of historical data and information reported by uranium mining companies. This estimate indicates that domestic uranium reserves total 445,000 tons U_3O_8; it should be noted that the 2003 estimate is dependent on uranium price, and the number shown is based on a commodity price of $50/pound (EIA 2010a). Other available estimates include a 2007 estimate by the World Nuclear Association, which indicates U.S. domestic reserves of 403,000 tons U_3O_8 (World Nuclear Association 2009).

Total current domestic production of uranium (for 2009) was 3.75 million pounds U_3O_8, or 1,875 tons U_3O_8 (EIA 2010b), from 14 underground mines and four in-situ leaching plants located primarily in Wyoming, Nebraska, Texas, Colorado, and Utah The total current domestic uranium requirement for nuclear reactors (projected for 2010) is 23,040 tons U_3O_8 (World Nuclear Association 2010). Current production within the proposed withdrawal area occurs solely from the Arizona 1 mine, which has an estimated total uranium reserve of 478 tons U_3O_8.

The resource condition indicator consists of the percentage of known domestic uranium reserves, domestic production, and domestic demand that is accounted for by mining within the proposed withdrawal area. Currently, the actively mined reserves of the Arizona 1 mine, taken as a whole, represent approximately 0.1% of the estimated domestic uranium reserve, 25% of total 2009 domestic uranium production, and 2% of the projected domestic reactor requirement for 2010.

Depletion of Uranium Resources within Withdrawal Area

Uranium resources, once mined, are permanently depleted and unavailable for future mining. The resource condition indicator consists of the percent removal or depletion of estimated uranium resources within the withdrawal area. The estimated amount of uranium resources within the withdrawal area is

33,155 tons U_3O_8 (see Table 3.3-1). Currently, once the actively mined reserves of the Arizona 1 mine are depleted, they will represent a 1.5% reduction in the amount of uranium reserves available within the withdrawal area.

Amount of Uranium Mined as Percent of Global Demand and Production

Total current global production of uranium (for 2008) was approximately 114 million pounds U_3O_8, or 57,000 tons U_3O_8 (TradeTech 2010). The total global uranium requirement (for 2008) is approximately 168 million pounds U_3O_8, or 84,000 tons U_3O_8 (TradeTech 2010). Current production within the proposed withdrawal area occurs solely from the Arizona 1 mine, which has an estimated total uranium reserve of 478 tons.

The resource condition indicator consists of the percentage of global production and global demand that is accounted for by mining within the proposed withdrawal area. Currently, the actively mined reserves of the Arizona 1 mine, taken as a whole, represent approximately 0.8% of total 2008 global uranium production and 0.6% of the total 2008 global uranium demand.

Cumulative Withdrawal of High Mineral Potential Lands

Based on the 1987 USGS estimate, approximately 9,100 square miles were considered to be "Favorable Area A," the area with the highest potential for breccia pipes to occur.

Previous withdrawals have removed portions of the following high mineral potential lands from mineral location and entry (see Figure 2.4-1 and Table 2.4-1):

- Grand Canyon National Park, covering approximately 1,900 square miles: approximately 60% is considered high mineral potential.
- Grand Canyon–Parashant National Monument, covering approximately 1,600 square miles: approximately 25% is considered high mineral potential.
- Kanab Creek Wilderness Area, covering approximately 118 square miles: approximately 70% is considered high mineral potential.
- Saddle Mountain Wilderness Area, covering approximately 63 square miles: approximately 90% is considered high mineral potential.
- Grand Canyon Game Preserve, covering approximately 1,000 square miles (inclusive of Kanab Creek and Saddle Mountain Wilderness Areas): approximately 90% is considered high mineral potential.
- Paria Canyon–Vermilion Cliffs Wilderness Area, covering approximately 176 square miles: approximately 95% is considered high mineral potential.
- Navajo Nation. The Navajo Nation covers almost 26,000 square miles; approximately 1,600 square miles of the west side of the Navajo Nation is considered high mineral potential.
- Havasupai Tribe, covering approximately 250 square miles: approximately 80% is considered high mineral potential.
- Hualapai Tribal Nation, covering approximately 1,560 square miles: approximately 30% is considered high mineral potential.
- Kaibab Band of Paiute, covering approximately 200 square miles: approximately 50% is considered high mineral potential.

In all, approximately 5,100 square miles of high mineral potential lands have previously been withdrawn, accounting for approximately 56% of the high mineral potential lands identified by the USGS in northern Arizona and southern Utah (i.e., 56% of Favorable Area A from Finch et al. 1990).

3.4 WATER RESOURCES

The focus of this section is existing water resource conditions in the vicinity of the proposed withdrawal area and the resource condition indicators that will be the basis for evaluating potential impacts under each of the alternatives in Chapter 4. The relevant resources for this analysis include surface water, groundwater, and the interaction between these two resources. This analysis is based on review and compilation of available data for selected hydrologic parameters; information in the files of the BLM, NPS, Arizona Department of Water Resources (ADWR), Forest Service, ADEQ, ASLD, and AZGS; interviews with representatives of the mining companies that have operated mining facilities in the proposed withdrawal area; and review of information from numerous previous investigations of the Grand Canyon region, including those by the USGS, several universities, Errol L. Montgomery and Associates (Montgomery), and other environmental consultants.

3.4.1 General Description of Study Area

The study area for the water resources analysis is indicated in the inset map on Figure 3.4-1. This figure also shows the proposed withdrawal area boundaries, land ownership, uranium mine sites, and mining claims. 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. 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. Figure 3.4-2 (from Beus and Morales 2003) is a generalized map that shows the major plateaus in the area surrounding the Grand Canyon.

Different amounts and types of water resources information are available for each of the three parcels. In general, more water resources investigations have been conducted for the region south of the Grand Canyon than to the north. The studies for the South Parcel and adjacent areas south of the Grand Canyon include other large-scale EISs and a numerical groundwater flow model for the Coconino Plateau (Montgomery 1985, 1996, 1999), other numerical and conceptual groundwater flow models developed for the Coconino Plateau and adjacent areas (Bills et al. 2007; Kessler 2002; Wilson 2000), and investigations of springs that issue along the South Rim (Fitzgerald 1996; Goings 1985; Johnson and Sanderson 1968; Liebe 2003; Loughlin and Huntoon 1983; McGavock et al. 1968; Metzger 1961; Monroe et al. 2005; Rihs et al. 2004; Zukosky 1995). There are more deep groundwater wells with which to provide information on the Redwall-Muav aquifer system (henceforth referred to as the R-aquifer system or the regional aquifer system) south of Grand Canyon than to the north. However, important research has been conducted by Huntoon (1968, 1970, 1974, 1981, 1982, 1996, 2000), Woodward-Clyde Consultants (1985), Ross (2005), and Bills et al. (2010) in relation to groundwater circulation and selected large springs north of the Colorado River. Except for the Orphan Lode Mine, located at the South Rim of Grand Canyon directly north of Tusayan, and the Canyon Mine, located in the South Parcel, all of the information available for historic and current uranium mining practices in the region of the proposed withdrawal area comes from environmental assessments (EAs), mine plans, reclamation plans, personal communication with former and current mine employees, and other studies conducted for the mines in the North Parcel.

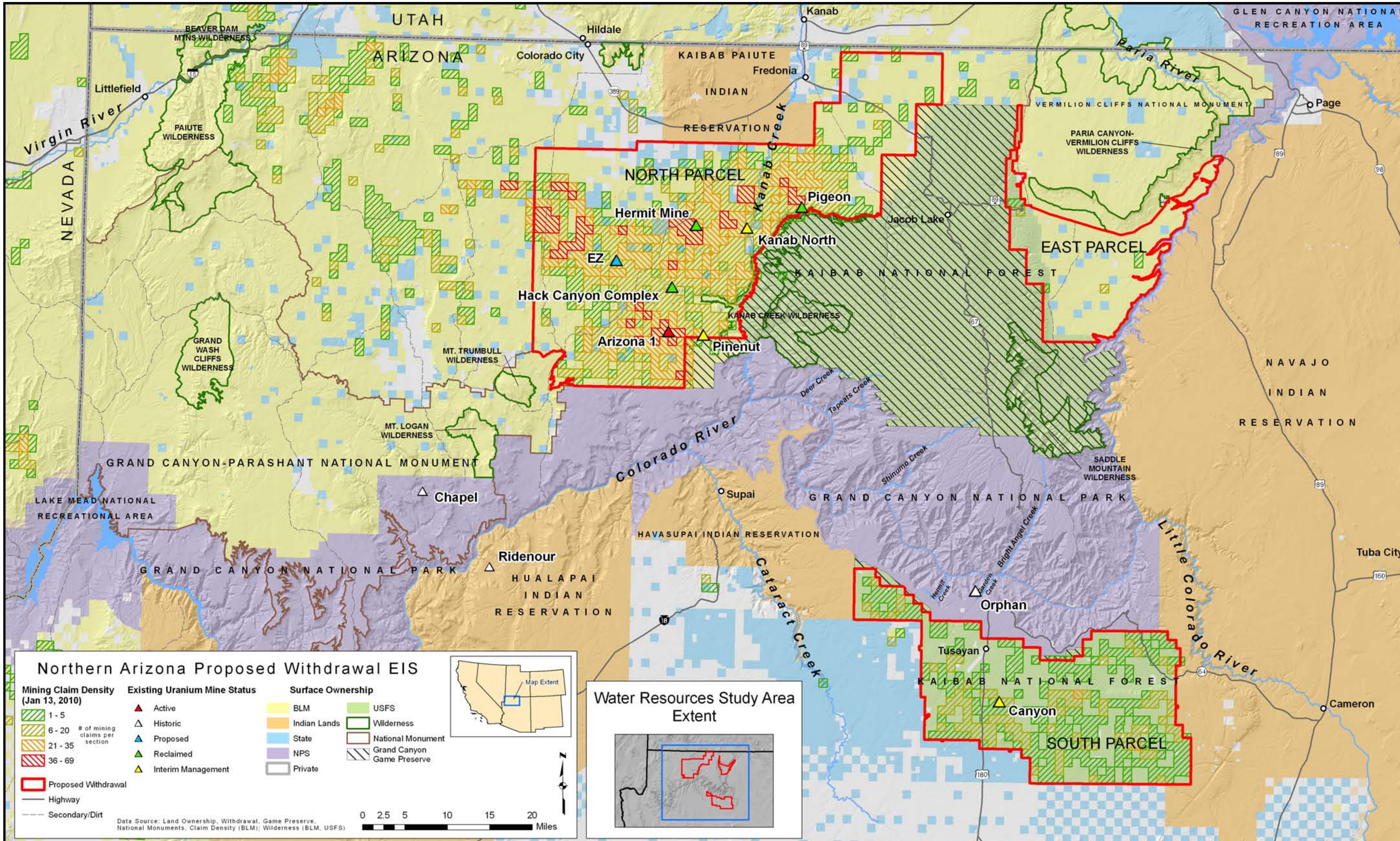


Figure 3.4-1. Regional location map.

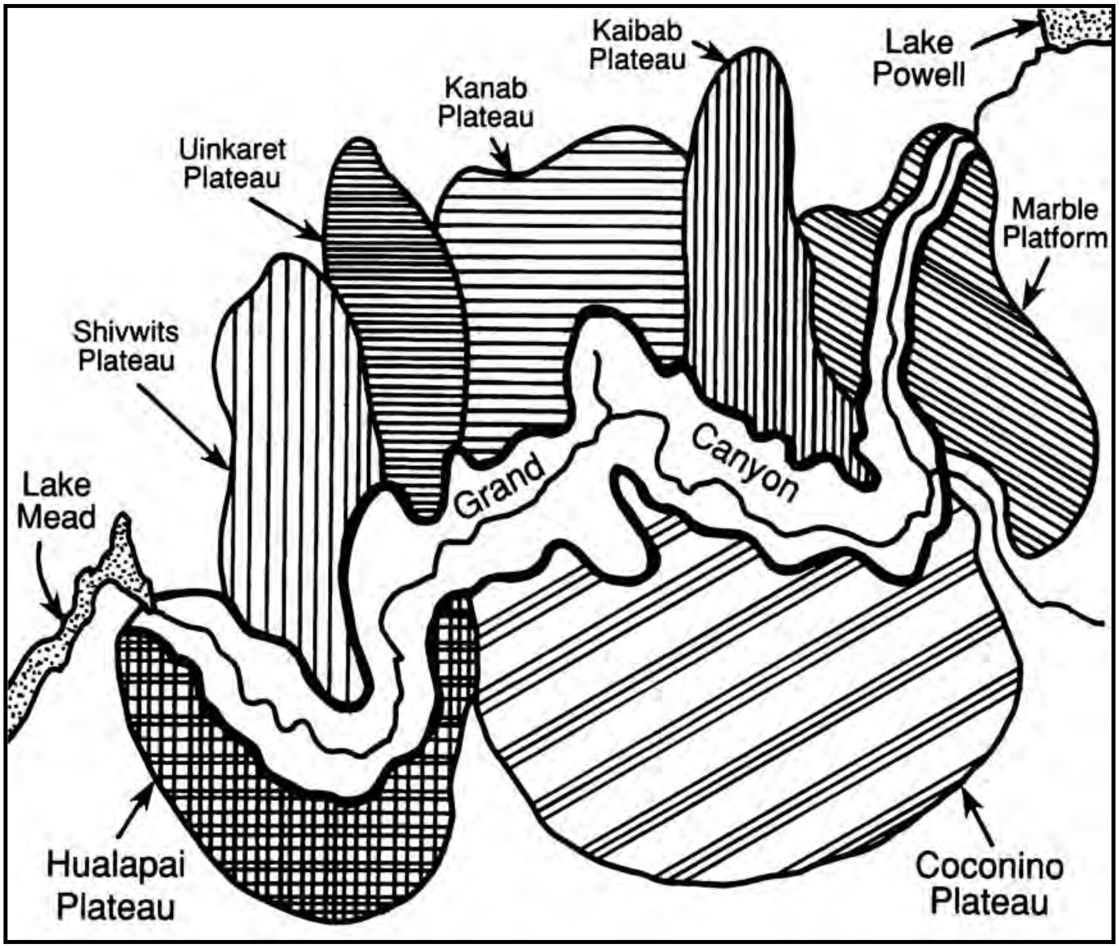


Figure 3.4-2. Generalized map showing major plateaus of the area surrounding Grand Canyon (from Beus and Morales 2003).

3.4.2 Hydrogeologic Conditions in the Study Area

This section characterizes the hydrogeologic components of the water resources system that may be affected by the proposed action or alternatives. Climatic conditions, which vary depending on land surface altitude, control the distribution of precipitation and evapotranspiration in the hydrogeologic framework. To a large extent, the hydrogeologic features of the region control the movement and fate of snowmelt, stormwater runoff, groundwater recharge, and groundwater in the underlying perched and regional aquifer systems. The lithology and structural deformation of the rock units in the study area are principal controls for movement and storage of groundwater. Human activities, such as groundwater withdrawal, diversion of discharge from springs, and development of the land surface, also affect the availability and quality of water.

The study area is located in the Plateau Uplands Hydrogeologic Province of Arizona, which is a high desert plateau region in which landforms are dominated by deeply incised canyons, high isolated mesas and buttes, and volcanic peaks (Cooley 1963; Montgomery and Harshbarger 1989). The land surface over much of the study area consists of fractured, jointed limestone with some permeable volcanic rocks, which provide for rapid infiltration of precipitation and result in meager surface water runoff (Huntoon 2000; Montgomery and Harshbarger 1989). As a result, the study area has a small number of perennial streams and rivers. The Coconino, Kaibab, and Kanab plateaus and the Marble Platform (see Figure 3.4-2) are characterized by very thick, nearly flat-lying sedimentary strata. The Colorado River is the principal drain for the groundwater systems in the plateaus, although groundwater in the north part of the North Parcel is believed to move north toward deep groundwater basins in Utah.

Extensive exposure of aquifer units along deep canyons cutting the plateaus of the study area and the ability to observe groundwater discharge from the aquifers into the canyons, together with well records, provide a degree of information on regional hydrogeologic conditions not commonly available for most regions of the country. This information has led to cogent interpretations of the groundwater systems in the Grand Canyon region, such as those by Huntoon (2000). Nevertheless, because of the size of this remote region and the depth of the groundwater systems, there remains uncertainty regarding deep geological structures, groundwater flow paths, aquifer hydraulic properties, residence times of groundwater in aquifers, and other hydrogeologic features in many parts of the study area.

The most productive aquifer, the R-aquifer, is deep (generally more than 2,000 feet below land surface [bls]) and occurs in limestone and dolomite units that are gently folded and exhibit relatively shallow regional dips. Although the plateau region is often described as a “water-short area,” deep groundwater is likely available over large areas. However, because of the great depth of the regional aquifer, costs for drilling, construction, and pump equipment are very high; the total cost can exceed $3 million for one well. Although groundwater yield from the R-aquifer is prolific where karst and other interconnected permeability features are abundant, there is a high degree of risk that wells not encountering these features may be dry or low yielding. There is also a high degree of risk that the water yielded by the well will be mineralized with high total dissolved solids (TDS) content and other constituents, especially in confined (artesian) parts of the regional aquifer (Huntoon 2000). Therefore, financial risk is high for R-aquifer well construction. These risk factors and a lack of understanding by many water developers of the groundwater systems, particularly regarding geological conditions that control locations of aquifer zones that could yield substantial volumes of groundwater to wells, have prevented more extensive development (Montgomery et al. 2000). Records indicate that no non-commercial or non-industrial entities have installed R-aquifer wells on any of the parcels, even though the R-aquifer is recognized as the most reliable source of groundwater. The only existing non-mine R-aquifer wells in the parcel areas are located at Tusayan on the South Parcel.

A summary of records for 1,333 wells in the study area is given in Appendix C. These records include data for location, well construction, water levels, and yield. It should be noted that the well inventory table was compiled from several different databases; thus, some duplication of wells may occur in Appendix C where sufficient data were not available to identify a single well from multiple similar records. The well inventory includes all well records in the ADWR and Arizona Oil and Gas Commission databases, including records for non-water production wells and records cancelled by ADWR for various reasons, such as records for wells that were abandoned or never drilled (ADWR 2005, 2009a; Arizona Oil and Gas Commission 2005). The well inventory was conducted for all wells within the three parcels and a 6-mile buffer perimeter surrounding each parcel, and for all wells 500 feet or deeper in the water resources study area. Of the 1,333 wells listed in Appendix C, those reported to be water wells that have not been cancelled by ADWR or abandoned include the following:

- **North Parcel.** Five R-aquifer wells (including the abandoned Hack Canyon Complex and Pigeon mine wells) and 103 perched aquifer wells in the North Parcel and 102 perched aquifer wells in the 6-mile buffer perimeter.
- **East Parcel.** Seven perched aquifer wells in the East Parcel and 26 perched aquifer wells in the 6-mile buffer perimeter.
- **South Parcel.** Four R-aquifer wells and 16 perched aquifer wells in the South Parcel, 19 perched aquifer wells in the 6-mile buffer perimeter, and four R-aquifer wells beyond 6 miles from the southern and western boundaries of the South Parcel.

Of particular interest in this analysis are the 13 wells constructed to yield groundwater from the R-aquifer within or in the vicinity of the parcels. Records for these regional groundwater wells are provided in Table 3.4-1.

Existing wells of record that are not reported to be abandoned or cancelled (not drilled) are shown on 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:

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.

Geological logs for the supply/monitor wells constructed for four of the uranium mine sites in the North and South parcels provide data for rock units encountered at these mine sites. These geological logs are summarized in Table 3.4-2.

Conceptual geological sections shown in Figures 3.4-3 and 3.4-4 provide a regional perspective for subsurface conditions in the study area and vicinity for the following discussion. Figure 3.4-5 is a geological map with surficial geology, major structural features, and breccia pipe locations in the water resources study area. Geological sections, with localized stratigraphic relations and major structural features for the study area, are shown in Figure 3.4-6a (from Brown and Billingsley 2010). Map locations for the geological sections in Figure 3.4-6a are shown in Figure 3.4-5.

The principal geological units that crop out and/or occur in the subsurface in the study area, in descending order, are described in the following sections and are organized by age and stratigraphic position in Figure 3.4-6b. Where present, each of these units plays an important role in the movement and/or storage of groundwater in the study area. Detailed descriptions of the individual rock formations and aquifers in the Grand Canyon region are given in McNair (1951), McKee (1974, 1982), McKee and Resser (1945), Metzger (1961), Harshbarger et al. (1957), Harshbarger and Associates (Harshbarger) and John Carollo Engineers (1972), Harshbarger (1973a, 1973b, 1974, and 1976), Montgomery and DeWitt (1975), Montgomery (1985, 1993b, 1996, and 1999), Montgomery et al. (2000), Beus and Morales (2003), Bills et al. (2000), Bills et al. (2007), and Bills et al. (2010). Descriptions of the individual rock formations in the following sections are based on these sources and the experience of Montgomery, BLM, and USGS personnel, and others, in the region.

Alluvial Deposits

The alluvial deposits are a heterogeneous mixture of unconsolidated to consolidated sediments ranging in grain size from silt and clay to boulders. The alluvial deposits are Quaternary and Tertiary in age and occur chiefly in valley floors and stream channels and along the margins of volcanic rocks. Where exposed in valley floors, the alluvial deposits commonly range in thickness from a feather edge to a few tens of feet. Thickness of older alluvial deposits may be more than 100 feet at the margins of volcanic rocks (Montgomery 1996).

Table 3.4-1. Summary of Records for Wells Completed in the Regional Aquifer within and adjacent to the Proposed Withdrawal Area

Site	Well Location	Record Source*	Database Identifier	Date Completed	Total Depth Drilled (feet bls)	Casing Diameter (inches)	Casing Depth (feet)	Casing Cemented	Casing Perforated Interval (feet)	Land Surface Altitude (feet amsl)	Groundwater Level Depth (feet)	Groundwater Level Date Measured	Groundwater Level Altitude (feet amsl)	Design Pumping Capacity (gpm)	Reported Well Yield (gpm)	Comments
Tusayan	A(30-02) 24caa	ADWR GWSI	523284 355811112074501	05/01/1989	3,108	13 8	0–35 0–2,330	Yes	none	6,575	2,420	05/16/1989	4,155	80	NR	Canyon Squire Inn; cement grout from 0–35 feet; 150 sacks of grout from 1,500–2,330 feet; South Parcel.
Tusayan	A(30-02) 24bac	ADWR	542928	05/03/1994	3,000	13 8	0–25 0–2,306	Yes	none	6,600	2,400 2,850	1994 10/25/1995	4,200	85	65	Quality Inn; South Parcel.
Tusayan	A(30-02) 24acd	ADWR†	560179	06/30/1997	3,120	8 7	0–2,440 0–3,100	Yes	2,400–3,100	6,600	2,400	1997	4,200	100	25	Behind McDonald's; South Parcel.
Valle	A(26-02) 11ddb	ADWR GWSI	543573 353843112083301	06/15/1994	3,450	13 8	0–25 0–2,602	Yes	none	6,000	2,550	1994	3,450	85	89	South of South Parcel.
Valle	A(26-02) 01cdd	ADWR	545765	12/28/1994	3,200	13 8	0–23 0–2,630	Yes	none	6,050	2,500	1994	3,550	41	41	South of South Parcel.
Hack Canyon Mine Complex‡	B(37-05) 26abb	ADWR	640855	06/17/1980	1,760	6	40	N/A	none	4,275	1,096	06/17/1980	3,179	5	5	Filled with mud from 1,475–1,760 feet; filled with concrete from 0–1,500 feet on 01/29/1988; filled with limestone from 1,330–1,760 feet; North Parcel.
Hermit Mine	B(38-04) 17cca	ADWR GWSI	518877 364123112450501	01/12/1988	3,030	10 8⅝ 5½	0–20 0–970 0–1,796	Yes	none	4,886	1,513	01/12/1988	3,373	15	15	Presently capped with no pump; unused; North Parcel.
Kanab North Mine	B(38-03) 17cca	ADWR	509198	11/05/1984	2,700	7⅝	860	Yes	none	5,043	1,470	11/05/1984	3,573	10	10	Well collapsed up to 2,460 feet; North Parcel.
Pigeon Mine‡	B(38-02) 05abb	ADWR	503711	09/03/1982	2,350	6	–	–	none	5,406	1,736	09/03/1982	3,670	10	10	Land surface altitude estimated from USGS National Elevation data (USGS 2010c); abandoned by filling with cement; North Parcel.
Pinenut Mine	B(36-04) 21cbc	ADWR	513394	09/26/1986	3,200	8⅝ 6⅝	0–900 0–2,524	Yes	none	5,338	2,494	09/26/1986	2,844	11	11	North Parcel.
Bar Four	B(32-04) 24cd	Reclamation	N/A	12/00/1996	3,115	5½	3,107	–	2,550–3,107	5,680	2,370	1996	3,310	NR	50	Havasupai Reservation; ADWR permit not required; west of South Parcel.
Quivero‡	A(25-02) 27abb	USGS ADWR GWSI	N/A 601192 353134112094901	12/01/1969	3,685	7	3,670	–	2,880–3,670	6,165	2,838	12/00/1969	>3,327	NR	28	Poor water quality; yields from formations deeper than Redwall-Muav aquifer; south of South Parcel.
Canyon Mine	A(29-03) 20bcd	Montgomery ADWR	N/A 515772	12/02/1986	3,086	8⅝ 5½	0–2,281 2,116–3,086	Yes	2,584–2,964	6,507	2,536	07/29/1993	3,971	5 40	5 40	South Parcel.

Notes:

– = Data not available; N/A = Not applicable; NR = Not reported.

* Record sources:
GWSI = ADWR Groundwater Site Inventory
Reclamation = U.S. Bureau of Reclamation

† Manera Inc. provided data for reported yield.

‡ Well is abandoned.

Table 3.4-2. Geological Units Penetrated at Wells for Selected Breccia Pipe Uranium Mine Sites

Geological Unit	Pinenut Depth Interval (feet bls)	Hermit Depth Interval (feet bls)	Kanab North Depth Interval (feet bls)	Canyon Depth Interval (feet bls)	Pinenut Thickness (feet)	Hermit Thickness (feet)	Kanab North Thickness (feet)	Canyon Thickness (feet)
Moenkopi Formation	–	0–168	0–31	0–10	–	168	31	10
Kaibab Formation	0–442	168–550	31–585	10–340	442	382	554	330
Toroweap Formation	442–775	550–899	585–801	340–550	333	349	216	210
Coconino Sandstone	775–877	899–930	801–817	550–1,125	102	31	16	575
Hermit Formation	877–1,579	930–1,678	817–1,467	1,125–1,237	702	748	650	112
Supai Group	1,579–2,547	1,678–2,850	1,467–2,460*	1,237–2,242	968	1,172	993*	1,005
Surprise Canyon Formation	–	2,850–3,010	–	–	–	160	–	–
Redwall Limestone	2,547–3,200	3,010–3,030	2,460–2,700*	2,242–2,670	> 653	> 20	> 240*	428
Temple Butte Formation	–	–	–	2,670–2,780	–	–	–	110
Muav Limestone	–	–	–	2,780–2,980	–	–	–	200
Bright Angel Shale	–	–	–	2,980–3,086	–	–	–	> 106
Total Depth Drilled	**3,200**	**3,030**	**2,700**	**3,086**	**3,200**	**3,030**	**2,700**	**3,086**

* = estimated.

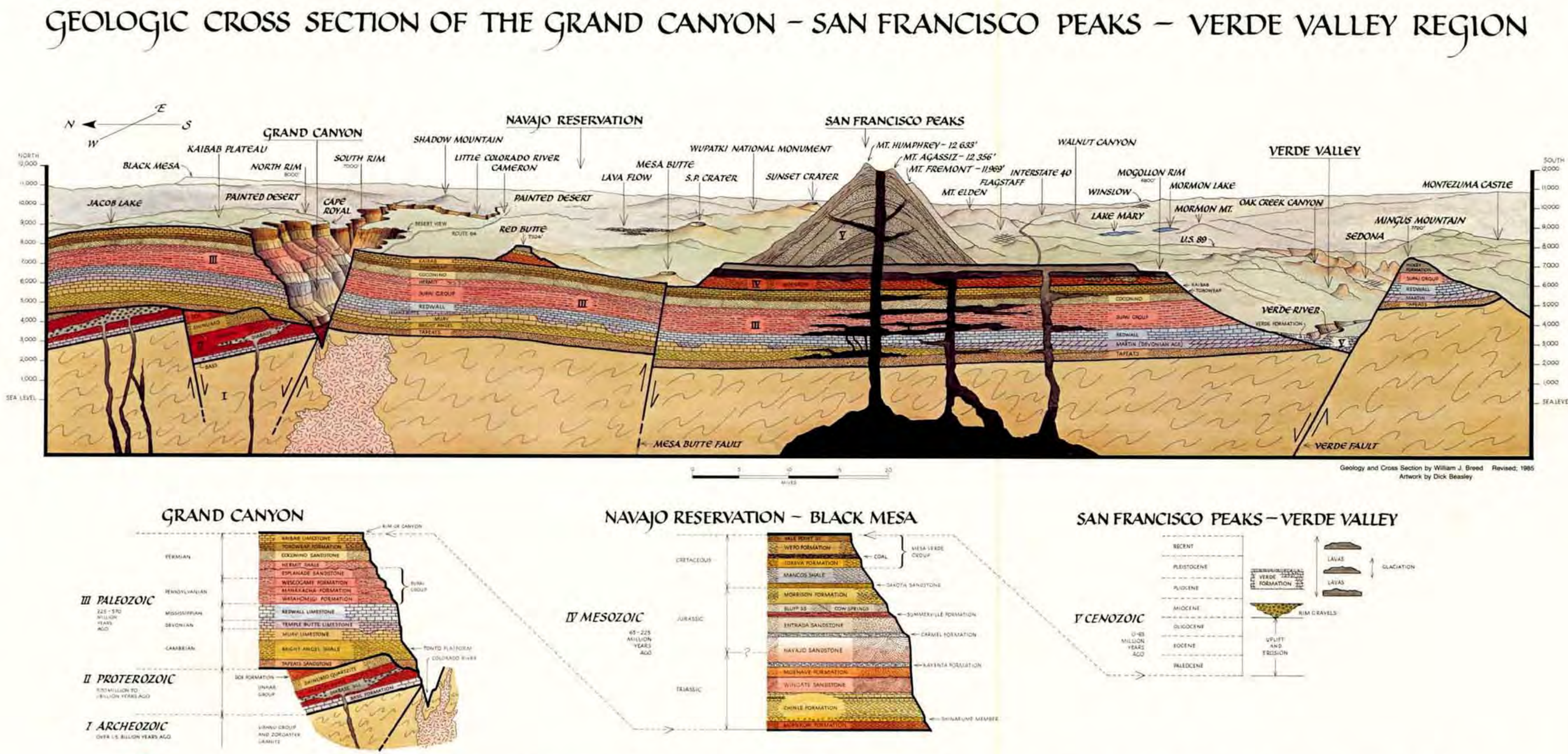
– = data not available because not reported.

> = greater than; base of unit not penetrated.

Alluvial deposits that occur in the valley floors are permeable and transmit precipitation and stormwater runoff from the land surface to underlying formations. Where alluvial deposits overlie less permeable rocks, temporary perched groundwater zones may occur in the lower part of the alluvial deposits. Such perched groundwater zones are thin and discontinuous and are generally ephemeral; the stored water is gradually lost via evapotranspiration and slow downward seepage, especially during periods of precipitation deficit.

Volcanic Rocks

The volcanic rock sequence in the study area comprises lava-flow rocks, dikes, plugs, and pyroclastics, including volcanic ash and cinders that are Quaternary and Tertiary in age. Precambrian volcanic rocks occur at depth in the Grand Canyon but are not important for this investigation. The thickness of the volcanic rocks ranges from about 20 feet at the edge of some lava flows to more than 1,000 feet near the centers of past volcanic eruptions (Montgomery and Harshbarger 1989). Where present at land surface, cinders provide an excellent infiltration medium. As water infiltrates, the subsurface sequence of consolidated volcanic rocks commonly has small vertical permeability and retards the downward movement of water, except where extensively fractured. Thin, discontinuous, perched groundwater zones occur locally in the volcanic rocks and typically discharge at seeps and springs along the margins of volcanic outcrops. These perched groundwater zones have been penetrated by wells and yield small, often poorly reliable, quantities of water for domestic and stock use (Montgomery and Harshbarger 1989).



In the region between the Grand Canyon and the Verde Valley, the history of the Earth is revealed on a gigantic scale. As exposed in the bottom of Grand Canyon, two episodes of mountain building and erosion occurred during the Archeozoic and Proterozoic Eras, from two billion to five hundred and seventy million years ago. From the beginnings of the Paleozoic Era to the end of the Mesozoic Era – five hundred and seventy million to sixty-five million years ago – this area was essentially a low-lying plain, sometimes submerged under the sea, at other times a flood plain crossed by sluggish rivers and on occasion a desert with blowing sand dunes. During this time period over 10,000 feet of sediment accumulated – rocks present today at Grand Canyon and in the Zion Canyon region to the north and Black Mesa and the Navajo Reservation to the east. In Cenozoic times from sixty-five million years ago to the present this region was uplifted, the Mesozoic rocks were removed by erosion and eventually canyons such as Grand Canyon and Oak Creek Canyon were formed. During the latter part of the Cenozoic, outpourings of lava built the volcanic field near Flagstaff including the San Francisco Peaks. These peaks were later modified by glaciation. This area of the Colorado Plateau is only slightly disturbed by faulting and folding and is mainly underlain by horizontal beds – in great contrast to the Basin and Range province south of the Mogollon Rim.

Figure 3.4-3. Conceptual geological section of the Grand Canyon–San Francisco Peaks–Verde Valley region (from Zion Natural History Association 1975).

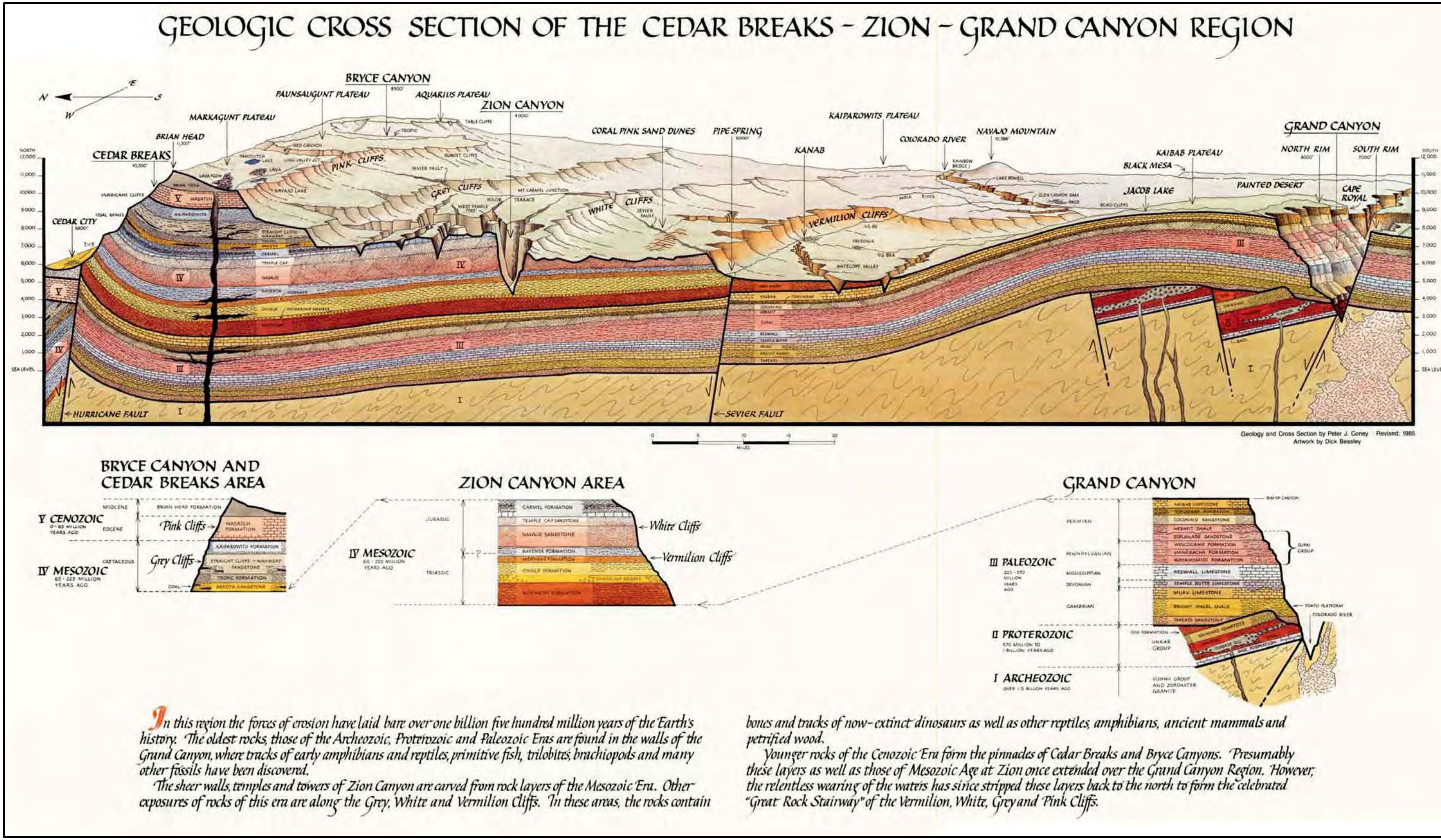


Figure 3.4-4. Conceptual geological section of the Cedar Breaks–Zion–Grand Canyon region (from Zion Natural History Association 1975).

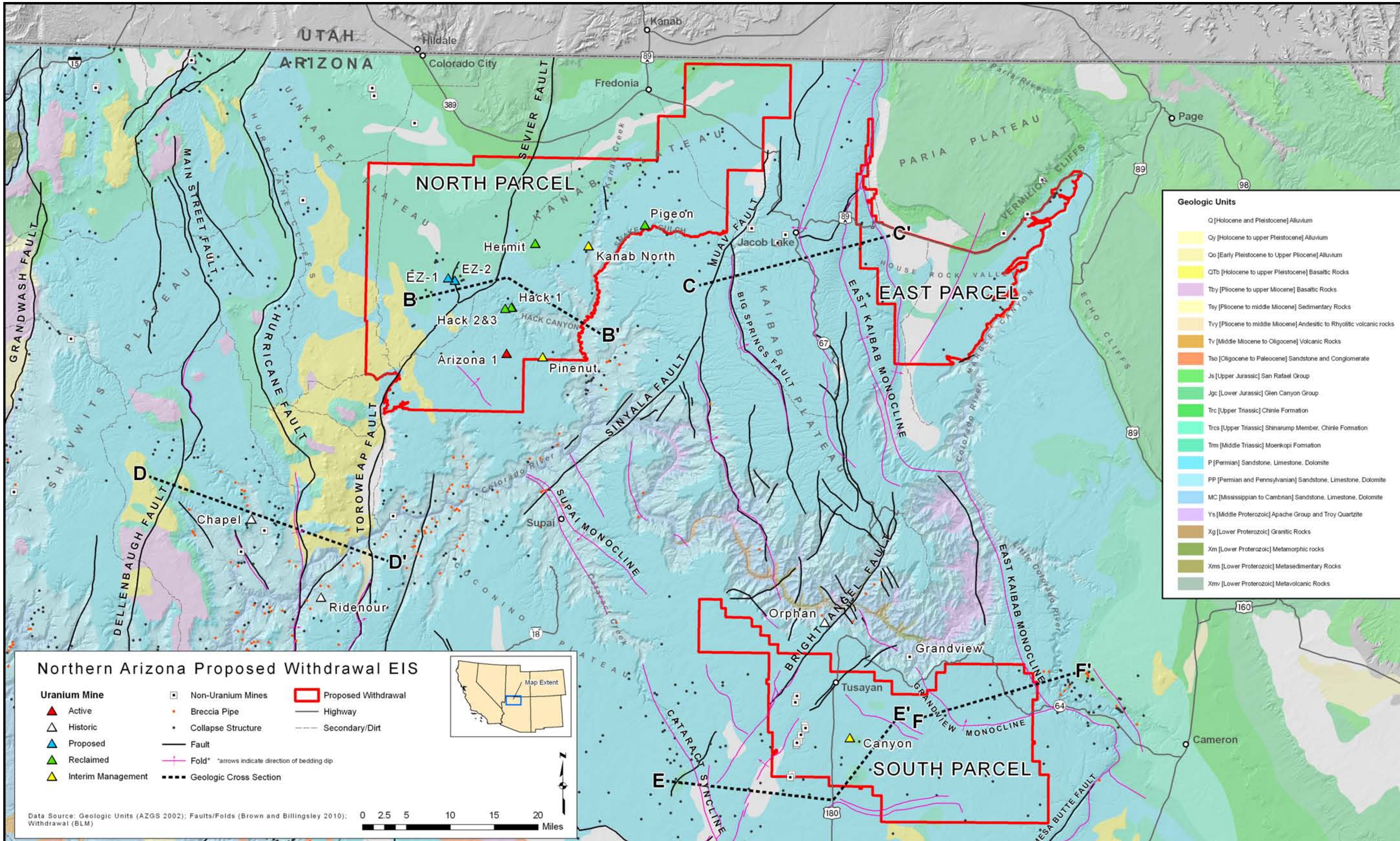


Figure 3.4-5. Geological map for water resources study area.

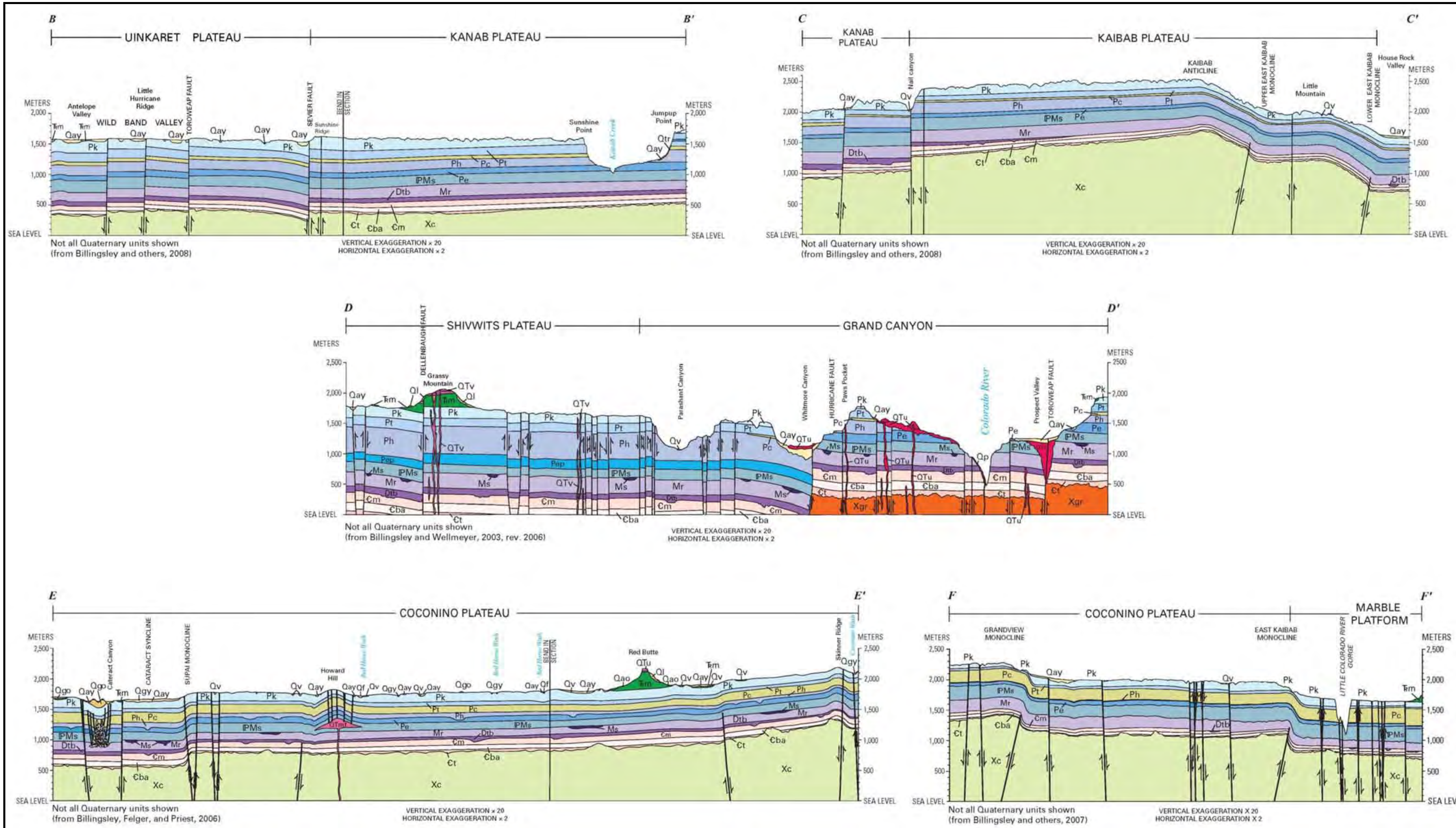


Figure 3.4-6a. Geological sections in water resources study area (modified from Brown and Billingsley 2010).

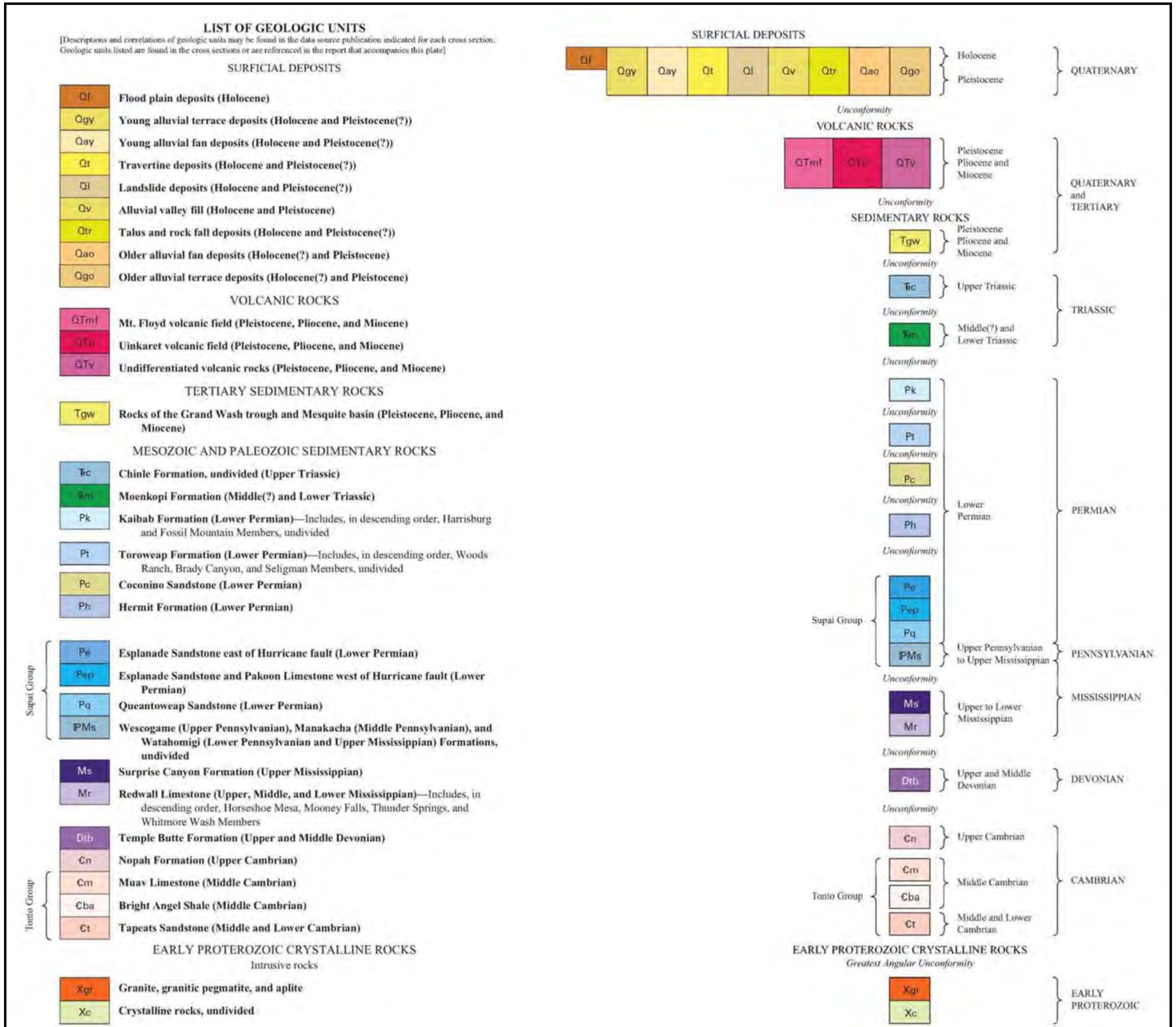


Figure 3.4-6b. Geological sections in water resources study area (modified from Brown and Billingsley 2010).

Glen Canyon Group

The Glen Canyon Group is Jurassic in age and, in the study area, consists of the following formations in descending order: Navajo Sandstone, Kayenta Formation, and Moenave Formation. This group forms the steep face of the Vermilion Cliffs, which occur a short distance north of the North and East parcels (see Figures 3.4-1, 3.4-4, and 3.4-5). The thickness of the Glen Canyon Group in the study area ranges from about 2,200 feet in the House Rock Valley area to about 2,500 feet in the Kanab Plateau area (Blakey 1989). Navajo Sandstone is a cross-bedded eolian sandstone (Blakey 1989), which, throughout most of the region, has a very consistent lithology composed of medium- to fine-grained, subrounded quartz grains weakly bonded by calcareous cement (Harshbarger et al. 1957). The Navajo Sandstone is partly saturated to completely saturated and is a significant source of groundwater supply north of the study area at Fredonia and the Kaibab Paiute Indian Reservation and is a major source of groundwater to the north in Utah (Cordova 1981) and to the east on the Navajo and Hopi Indian reservations. The lower portion of the Glen Canyon Group in the study area consists of the Kayenta and Moenave formations, which comprise several hundred feet of interbedded and inter-tonguing sandstones and siltstones (Blakey 1989); the fine-grained beds may function as confining layers that retard the downward movement of groundwater.

Chinle Formation

The Chinle Formation is Triassic in age and consists of lacustrine rocks and sediments containing clay, heterogeneous clastic rocks, and minor carbonate rocks (Blakey 1989). The Chinle Formation and its basal conglomerate, the Shinarump Member, were eroded from most of the study area but crop out at the base of the Vermilion Cliffs north of the North and East parcels, and near the top of Red Butte in the South Parcel (see Figures 3.4-1, 3.4-4, and 3.4-5). Thickness of the Chinle Formation in the study area ranges from about 500 feet in the Kanab Plateau area to about 1,000 feet in the House Rock Valley area (Blakey 1989). This predominantly very fine-grained unit is an excellent confining layer that retards the downward movement of groundwater where present in the study area (Harshbarger et al. 1957; Repenning et al. 1969). The Shinarump Member, where present in the North Parcel area, is a discontinuous, perched water-bearing zone that is locally a source of groundwater for springs and wells (Levings and Farrar 1979; Truini et al. 2004).

Moenkopi Formation

The Moenkopi Formation consists chiefly of thin-bedded, fine-grained, red sandstone, siltstone, mudstone, and gypsum and is Triassic in age (Blakey 1989). Although the Moenkopi Formation was completely eroded from large parts of the study area, scattered and discontinuous outcrops of the formation occur on the Shivwits, Uinkaret, Hualapai, and Coconino plateaus (see Figures 3.4-3, 3.4-4, 3.4-5, and 3.4-6a [sections B-B', D-D', and E-E']). These outcrops are generally less than 100 feet thick and typically occur where the formation is capped by erosion-resistant volcanic rocks or where remnant Moenkopi strata fill structural depressions, such as at breccia pipes. Larger, thicker outcrops of the Moenkopi Formation are exposed along the northern part of the study area, in the upper part of the Kanab Creek drainage area of the North Parcel, and in the East Parcel area (see Figure 3.4-3, 3.4-4, and 3.4-5). The thickness of the unit ranges from a few hundred feet in House Rock Valley to more than 1,000 feet near Fredonia, Arizona (Blakey 1989).

The fine grain size and poor sorting of the Moenkopi Formation strata cause the unit to function as a basal confining layer that retards the downward movement of percolating groundwater from overlying formations, except where the unit is extensively fractured (Cosner 1962). Sandstones in the Moenkopi Formation can be water bearing locally in the northern part of the North Parcel, where they yield groundwater to a few springs and low-capacity wells.

Kaibab Formation

The Kaibab Formation consists chiefly of thick- to thin-bedded, jointed, cherty, and sandy dolomitic limestone (McKee 1974), but it also contains dolostone, sandstone, evaporites, and redbeds (Hopkins 1990). The formation is Permian in age, crops out over large parts of the North, East, and South parcels, and forms the rim rock of the Grand Canyon at most locations (see Figures 3.4-3, 3.4-4, 3.4-5, and 3.4-6). Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Kaibab Formation ranges in thickness from about 300 to 450 feet. Thickness of the formation is reported to be more than 500 feet west of Kanab Creek and northwest of the Colorado River (Hopkins 1990) (see Table 3.4-2 for thickness of the Kaibab Formation reported in deep mine wells).

The Kaibab Formation is brittle and extensively fractured in areas where geological structural deformation has occurred. The erosion resistant dolomites that cap most of the plateaus in the eastern Grand Canyon region are permeable as a result of open vertical joints and epikarst localized on joints and partings along bedding planes (Huntoon 2000). Water circulation through these joints and fractures has enlarged the openings by dissolution and has created extensive systems of caves and caverns (Montgomery and Harshbarger 1989; Huntoon 2000). Cave passages in the Kaibab Formation have been observed at many locations in northern Arizona, including Wupatki National Monument (Cosner 1962) north of Flagstaff, Babbitt Ranch (Harshbarger 1973a) southwest of Tusayan, and the Grand Canyon. Where the Kaibab Formation is exposed at land surface, precipitation and runoff infiltrate readily downward via the fractures and solution openings, making the unit an important recharge medium. Many flash floods sink directly into “swallow holes” along fault zones in the Kaibab Formation (Huntoon 2000). However, because of high evapotranspiration, recharge is a small fraction of precipitation. In most of the study area, the Kaibab Formation is above the regional groundwater table; however, well data for the upper part of the Kanab Creek drainage area suggest that, although it may be perched, a viable water-producing aquifer occurs in the Kaibab Formation in that area. The unit is reported to yield small quantities of perched groundwater to a few wells in the Coconino Plateau and regional groundwater to wells near Cameron, Arizona (McGavock et al. 1968), located about 40 miles east of Tusayan (see Figure 3.4-5). Similarly, three water wells near Fredonia, Arizona, have reported pump capacities of between 50 and 400 gpm and are likely completed in the Kaibab and/or Toroweap formations where these units represent a viable aquifer.

Toroweap Formation

The Toroweap Formation is Permian in age and, in the study area, consists of an upper evaporite and red sandstone and shale member (Woods Ranch Member), a middle massive limestone member (Brady Canyon Member), and a lower fine-grained sandstone and evaporite member (Seligman Member) (McKee 1974). Because of the variability in composition, the topographic expression of the Toroweap ranges from a weak slope-former to a cliff-former. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Toroweap Formation ranges in thickness from about 100 to 300 feet. The cementation of the sandstone in the upper and lower members of the Toroweap Formation, which were deposited in a marine environment, is weaker than cementation in the eolian Coconino Sandstone, described in the following section.

Fine-grained strata in the upper and lower members of the formation function as basal confining layers for the local accumulation of thin, discontinuous, perched groundwater zones in overlying sandstone strata. The middle massive limestone member of the Toroweap Formation is brittle and extensively fractured. Fractures in the limestone member have commonly been enlarged by solution activity and solution openings are abundant in this member. Gypsum karst is developed at some locations where solution features are prevalent and the Toroweap Formation is the dominant geological unit exposed at land surface (Huntoon 2000). Groundwater percolates downward readily via fractures and solution openings in the limestone member. The Toroweap Formation is considered to be a minor aquifer in parts of the

Coconino and Kanab plateaus and yields small quantities of groundwater to wells from thin, discontinuous perched groundwater zones in the upper and lower members. The Toroweap Formation is reported by McGavock et al. (1968) to yield less than 5 gallons per minute (gpm) from a few wells in the Grand Canyon Village area. Well data for the upper part of the Kanab Creek drainage area suggest that although it may be perched, the Toroweap Formation is a viable water-producing aquifer in that area. For example, the Pah Tempe Spring system, located near Hurricane, Utah, discharges more than 4,100 gpm from the Toroweap Formation (Dutson, 2005).

Coconino Sandstone

The Coconino Sandstone is Permian in age and is a very fine- to fine-grained, cross-bedded eolian sandstone composed chiefly of subangular to well-rounded, frosted quartz grains (Metzger 1961). The Coconino Sandstone is commonly a cliff-former in outcrop, is a well-lithified and brittle rock unit, and is extensively fractured near faults and folds. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Coconino Sandstone ranges in thickness from about 500 to 600 feet. Billingsley and Ellis (1984) report that the Coconino Sandstone does not crop out between the Toroweap and Hermit formations along the Kanab Creek Wilderness Area of Snake Gulch, about 18 miles north from the Grand Canyon (see Figure 3.4-1). Inspection of Table 3.4-2 indicates that thicknesses of only 16 and 31 feet of the Coconino Sandstone were penetrated by the supply/monitor wells at the Hermit and Kanab North mine sites, respectively.

The Coconino Sandstone, together with the Toroweap and Kaibab formations, is part of the principal aquifer (also known as the C-aquifer) for water wells in the San Francisco Plateau of northern Arizona (east and southeast of the Coconino Plateau), where the regional groundwater table occurs above the base of the formation. Municipal water supply wells for the city of Flagstaff obtain groundwater from the Coconino Sandstone, and hydraulic parameters have been computed from results of pumping tests (Montgomery and DeWitt 1975). At the Woody Mountain well field near Flagstaff, the permeability of the formation is great as a result of the occurrence of abundant fractures, and pumping rates from individual wells are as great as 1,000 gpm. Where the Coconino Sandstone is not abundantly fractured near Flagstaff, permeability is small, and pumping rates from individual wells are commonly less than 100 gpm.

In the study area, west of the extensive Mesa Butte Fault Zone on the Coconino Plateau, the regional groundwater table (for an unconfined aquifer) or potentiometric surface (level to which the groundwater would rise if not trapped in a confined aquifer) occurs below the base of the Coconino Sandstone and the formation does not contain groundwater at most locations (Bills et al. 2007) (see Figure 3.4-5 for location of Mesa Butte Fault). This condition is observed in the proposed withdrawal area and along the north and south walls of the Grand Canyon. Where favorable structural conditions occur and where mudstone strata in the underlying Hermit Formation provide a basal confining layer that retards the downward movement of groundwater, thin, discontinuous perched groundwater zones may occur in the lower part of the Coconino Sandstone and may supply small quantities of groundwater to springs and wells for domestic and stock use. At mineralized breccia pipes, a sulfide zone or “pyrite cap” often occurs in the base of the Coconino Sandstone or Toroweap Formation at the top of the ore deposit and causes any perched groundwater in the base of the unit to be highly mineralized and of poor quality (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Based on interpretation of regional water quality data, Bills et al. (2010) concluded that elevated concentrations of arsenic, iron, lead, manganese, sulfate, radium, and uranium may be the result of recharge that contains dissolved gypsum derived from overlying formations (such as the Moenkopi and/or Chinle formations) or from natural contact with sulfide-rich mineralization.

Hermit Formation

The Hermit Formation is Permian in age and consists chiefly of interbedded red silty sandstone and sandy mudstone (Blakey 2003). Where the Hermit Formation crops out, it forms a slope between the overlying cliff-forming Coconino Sandstone and the underlying ledge- and slope-forming Supai Group. The Hermit Formation ranges in thickness from about 100 feet in the eastern part of the Grand Canyon to more than 900 feet at the Toroweap Valley and Shivwits Plateau areas (McNair 1951). The formation thickens to the west (Blakey and Knapp 1989). At Snake Gulch, thickness of the Hermit Formation is about 575 feet (Billingsley and Ellis 1984). Because of its fine-grained lithology, the Hermit Formation generally retards the downward movement of groundwater and is considered to be an important basal confining layer for overlying thin, discontinuous perched groundwater zones in the study area.

Supai Group

The Supai Group in the study area is Permian and Pennsylvanian in age and is composed of the following four formations, in descending order: Esplanade Sandstone, Wescogame Formation, Manakacha Formation, and Watahomigi Formation (McKee 1982). The Supai Group consists of alternating siltstone and fine-grained sandstone units, with some limestone beds (Metzger 1961). Where the Supai Group crops out in the Grand Canyon, it is a ledge- and slope-forming unit. Where exposed at land surface and where penetrated by wells in the Coconino Plateau, the Supai Group ranges in thickness from about 900 to 1,000 feet. The siltstone units are red and occur in flat, lenticular beds. The sandstone units are commonly light brown but in many places are stained red by the overlying siltstone. Because the Supai Group is composed chiefly of siltstone and fine-grained sandstone, groundwater does not move readily through the fine-grained, unfractured rock matrix, although some downward movement of groundwater does occur (Metzger 1961). The upper part of the Supai contains sandstone units that yield small quantities of water from local thin, discontinuous, perched groundwater zones to seeps in the Grand Canyon. The Supai Group is reported to yield small quantities of groundwater to wells in the study area. Fracture permeability along widely spaced fault zones allows water to move downward (Huntoon 2000). However, the Supai functions chiefly as a confining layer, retarding downward groundwater movement to the more permeable underlying formations.

Surprise Canyon Formation

The Surprise Canyon Formation is composed of isolated, lenticular deposits of clastic and carbonate rocks that fill erosional valleys, caves, and other local karst features in the top of the Redwall Limestone (Beus 1990a). The Surprise Canyon Formation is Mississippian in age and can be divided into three units: 1) an upper unit that consists chiefly of marine siltstone and silty, sandy, or algal limestone; 2) a middle unit that consists of marine skeletal limestone; and 3) a basal unit that consists of terrestrial conglomerate and sandstone. The Surprise Canyon Formation is probably the least visible rock unit in the Grand Canyon as a result of the discontinuous nature and extreme remoteness of outcrops; the formation was not identified formally until 1985 (Billingsley and Beus 1985).

Redwall Limestone, Temple Butte Formation, and Muav Limestone

The Redwall Limestone, Temple Butte Formation, and Muav Limestone form a sequence of carbonate rocks comprise the Redwall-Muav aquifer system (henceforth referred to as the R-aquifer system or the regional aquifer system). The Redwall Limestone is Mississippian in age and consists of thick-bedded, cliff-forming, microcrystalline, light to dark gray limestone and dolomite (Metzger 1961; Huntoon 2000). The most abundant rock-forming minerals in the R-aquifer are calcium and magnesium carbonates. The Redwall forms massive vertical cliffs that are 500 to 800 feet thick in the Grand Canyon; thickness increases to the west and to the east from the Grand Canyon Village area (Beus 1989). Where exposed, the Redwall Limestone is commonly stained red by iron oxide material washed down from red beds in the overlying Supai Group (Beus 1990a).

The Temple Butte Formation underlies the Redwall and consists chiefly of microcrystalline dolomite or sandy dolomite with minor beds of sandstone and limestone (Beus 1990b; Huntoon 2000). The Temple Butte is Devonian in age, crops out as thin ledges, and occurs in channels cut into the underlying Muav Limestone. Thickness of the formation ranges from about 100 feet in scattered channel-fill lenses to more than 450 feet west of the Grand Canyon; westward from Hermit Creek, the Temple Butte forms a continuous band of dolomite above local basal channel-fill deposits (Beus 1990b).

The Muav Limestone is Cambrian in age and consists chiefly of thin- to thick-bedded dolomitic and calcareous mudstone and packstone, with intraformational conglomerate (Middleton and Elliott 1990). The Muav forms resistant cliffs above the underlying Bright Angel Shale in the Grand Canyon.
The contact with the underlying Bright Angel Shale is gradational and is characterized by complex inter-tonguing of the two formations. Bedding and formation thicknesses increase to the west. McKee and Resser (1945) reported that thickness of the Muav in the study area ranges from 136 feet at the confluence of the Little Colorado and Colorado rivers to 439 feet at Toroweap Valley in the central part of the Grand Canyon.

A sequence of undifferentiated Cambrian-age dolomites, with thicknesses as great as 426 feet in the western part of the Grand Canyon (Middleton and Elliot 2003), overlies the Muav Limestone and is part of the R-aquifer system.

In the study area, the Redwall-Temple Butte-Muav sequence of carbonate rocks (R-aquifer) lies below or partly below the regional groundwater table and constitutes the regional aquifer system. Huntoon (2000) reports that combined thickness of these rocks is 1,300 feet in eastern Grand Canyon, thickening to 2,500 feet in western Grand Canyon. In the Coconino Plateau, total thickness of the formations that constitute the R-aquifer at wells and at the South Rim of the Grand Canyon ranges from about 500 to 1,000 feet; the average thickness is about 750 feet. Results of pumping tests for well (A-29-3)20bcd, located at the Canyon Mine southeast of Tusayan, indicate that transmissivity of the R-aquifer in this relatively unfractured area is about 1,000 gallons per day per foot width of aquifer (gpd/foot) at a 1:1 hydraulic gradient (Montgomery 1993b). Although the permeability of unfractured rock in the R-aquifer is typically very small, in areas where the rocks are extensively fractured by large extensional faults and flexures, solution openings have developed that provide for the transmission of large quantities of groundwater. Extensive interconnected maze cave and cavern systems occur in the R-aquifer, particularly along large fault zones (Huntoon 1968, 1970, 1974, 1981, 1982, 2000; Montgomery and Harshbarger 1989). The term maze cave, used by Huntoon (2000), refers to intersecting, closely spaced dissolution cavities and caves. Progressive upward collapse from caves and caverns in the Redwall Limestone is thought to be the origin of the pipes that eventually were filled with breccia and mineralized with the ore that is the target of breccia pipe prospecting in northwestern Arizona (Huntoon 1996).

Bright Angel Shale and Tapeats Sandstone

Together with the overlying Muav Limestone, the Bright Angel Shale and Tapeats Sandstone form the Tonto Group, which is Cambrian in age. The Bright Angel Shale consists chiefly of mudstone and shale, with minor thicknesses of sandstone and limestone (Metzger 1961). As a result of inter-tonguing with the overlying Muav Limestone, the thickness of the Bright Angel Shale is variable. McKee and Resser (1945) reported that the thickness of the Bright Angel Shale is more than 450 feet in the western part of the Grand Canyon, 270 feet at Toroweap Valley in the central part of the Grand Canyon, and 325 feet along Bright Angel Creek. The Bright Angel Shale functions as an effective basal confining layer for the overlying R-aquifer, even where faulted, as a result of its ductility (Huntoon 2000). The Tapeats Sandstone consists of cross-bedded, poorly sorted, coarse sandstone and conglomerate. Metzger (1961) reports that thickness of the Tapeats Sandstone ranges from a feather edge to 300 feet; thickness typically ranges from 100 to 325 feet (Middleton and Elliot 1990). Only small quantities of groundwater issue from seeps in the Tapeats Sandstone because it is overlain by the fine-grained Bright Angel Shale. The Bright Angel Shale and the Tapeats Sandstone are not known to yield groundwater to wells in the vicinity of the proposed withdrawal area, except at exploration water well (A-25-2)27aba, which was constructed for Black Mesa Pipeline, Inc., about 18 miles north of Williams, Arizona. Water quality and yield from this well are considered poor; therefore, the well is not presently used. The discharge from springs in the Bright Angel Shale and Tapeats Sandstone is commonly saline and limited in quantity.

Precambrian Rocks

The occurrence of sedimentary, metamorphic, and igneous rocks of Precambrian age below the Tapeats Sandstone in the study area is indicated from outcrops in the Grand Canyon and from analysis of deep oil test boreholes in the Flagstaff region. The permeability and porosity of the Precambrian rocks underlying the Grand Canyon region are generally very small, except where open fractures may occur along fault zones, and these rocks are expected to function as the basal confining layer to the overlying rock sequence.

3.4.3 Structural Features

The principal structural features in the study area are a series of north- to northeasterly trending fault zones as well as northerly trending folds and associated faults (see Figure 3.4-5). Many more faults and folds occur in the study area than can be shown with the low resolution of Figure 3.4-5. The major north- to northeasterly trending fault zones are the Bright Angel, Redlands, Red Horse, Vishnu, Hurricane, Sevier, Toroweap, Fence, Eminence, and Mesa Butte faults and the West Kaibab (including the Muav and Sinyala faults) and Cataract fault zones (some not shown in Figure 3.4-5). The major northerly trending folds and associated faults include the Supai, East Kaibab, and Echo Cliffs monoclines (not all shown in Figure 3.4-5). Where these geological structural systems are vertically continuous, enhanced by solution processes, and intersect the Grand Canyon, large springs discharge into the Canyon and its tributaries. When groundwater moves along fractures in carbonate rocks, such as in the R-aquifer, the fractures are often widened by dissolution of soluble carbonate minerals. These preferential pathways are referred to herein as solution-enhanced permeability features or solution features; they range in size from small, interconnected fractures to large, interconnected cavern systems. Solution features preferentially develop along extensional fractures, faults, and folds that are generally aligned with the groundwater hydraulic gradient between points of groundwater recharge and points of discharge.

Permeability of the Kaibab Formation has been greatly increased in some areas by the presence of solution-enhanced fracture openings and joints. Because the Kaibab Formation comprises plateau surfaces over much of the area, karst topography is prevalent. For example, the Markham Dam fracture zone is an area of intense structural deformation along Cataract Creek, where oblique sets of extensional faults in the Kaibab Formation are readily visible at land surface and can be identified by the surface water drainage patterns, which are caused by preferential erosion along the fractured rocks of the fault traces (Montgomery 1996). Similarly, the Kaibab Plateau is broken by intersecting sets of well-developed fault zones and master joints in the Kaibab Formation that provide high capacity for infiltration of surface water flow (Huntoon 1974 and 2000). The presence of karst in the parcels results in subterranean drainage, which together with low precipitation and high evapotranspiration contributes to the near absence of perennial flowing surface streams, except in the upper reach of Kanab Creek at Clearwater Spring, short reaches of Kanab Creek below Hack Canyon, and at a number of short, spring-fed perennial reaches of Kanab Creek tributary canyons.

The rocks underlying the Coconino Plateau (South Parcel) are folded into a gentle northwest-plunging syncline, referred to as the Cataract Syncline. The regional dip for the northern limb of the Cataract Syncline south from the Grand Canyon ranges from ½ to 1½ degrees to the southwest (Huntoon et al. 1986). This bedding dip controls the direction of groundwater movement away from the Grand Canyon in areas where faults are few or hydraulically isolated (see Figure 3.4-3). In areas where faults and cave systems occur, groundwater may be collected and conveyed toward or away from the Canyon, depending on the direction of hydraulic gradient.

The Kaibab Plateau is located on a north-south trending, doubly plunging anticlinal fold (Huntoon 2000). The rock units underlying the Kaibab Plateau (between the North and East parcels) are higher than correlative rock units underlying the Kanab Plateau and Marble Platform as a result of movement and deformation along the West Kaibab Fault Zone (including the Muav and Sinyala faults) and the East Kaibab Monocline (see Figures 3.4-2, 3.4-5, and 3.4-6a [section C-C']). The Kaibab Plateau also lies at a higher altitude than the Coconino Plateau to the south (see Figures 3.4-3 and 3.4-5) and receives a greater amount of precipitation and snowmelt than the other areas.

Near the South Rim of the Grand Canyon, the Eremita Monocline (west of Hermit Creek), the Grandview Monocline, and other monoclines cause beds to dip locally northward toward the Grand Canyon (Huntoon et al. 1986). The north-dipping beds and bedding offsets associated with the monoclines and faults near the South Rim result in local areas where recharge collects along fracture systems, moves northward along bedding planes, and discharges at small springs and seeps where faults and fracture systems intersect canyon walls. Recharge in these local drainage catchment basins along the Canyon rim is very important to the occurrence and sustainability of local water-bearing zones that support the discharge at many small springs and seeps (average generally less than about 50 gpm) and at a few moderate-sized springs (average about 50 gpm to several hundred gallons per minute) within the Grand Canyon or its tributary canyons. Because of the northward dip and small discharge, these springs and seeps are considered to be poorly connected or in some cases not connected hydraulically to the regional solution-enhanced circulation systems of the R-aquifer (Montgomery 1996, 1999). However, the results of isotope studies reported by Monroe et al. (2005) and Bills et al. (2007) suggest that the apparent residence time in the aquifer of the water discharged at the small R-aquifer springs along the South Rim ranges from "modern" to 3,400 years. These results suggest that a fraction of the water from several of the springs may have slowly percolated downward from land surface and/or flowed from more distant parts of the aquifer, possibly south of the R-aquifer divide of Bills et al. (2007). Modern residence times are defined as being less than 50 years by Monroe et al. (2005) and as being less than 250 years by Bills et al. (2007). For comparison, the largest residence time reported was 22,600 years for an R-aquifer well in the city of Williams, Arizona, located about 52 miles south of the South Rim (Bills et al. 2007). Residence time reported for the Canyon Mine well, about 9 miles south of the South Rim, was 10,600 years (Bills et al. 2007).

Fracture systems associated with major structural features provide preferential pathways for recharge, transmission, and discharge of groundwater in the R-aquifer (Huntoon 1974, 1982, 2000; Montgomery 1985, 1996). Recharge from precipitation and ephemeral stream flow infiltrates downward through fracture systems associated with major structural features. Most groundwater discharged from the R-aquifer issues from several large springs located near major structural features in the Grand Canyon and its tributary canyons, such as Havasu Springs, Blue Springs, Fence Fault Spring complex, and Tapeats/Thunder River Spring complex (Huntoon 1982, 2000; Montgomery 1985, 1996; Montgomery et al. 2000). Therefore, these large springs are considered to be well connected hydraulically to the regional circulation systems of the R-aquifer. Thunder River is tributary to Tapeats Creek.

3.4.4 Breccia Pipes and Uranium Mining Legacy

Bills et al. (2010) and Otton et al. (2010) provide a comprehensive study of 1980s legacy mining issues related to uranium mining in the Grand Canyon region. Breccia pipes have been defined in other sections of this EIS, and a comprehensive overview of the history of breccia pipe uranium mines and genesis of the pipes and ore bodies is given in Wenrich and Titley (2008). The presence of naturally occurring dissolved uranium is nearly ubiquitous in groundwater and spring-fed surface water in the study area. Other trace metals associated with ore deposits are also common in groundwater. An important source for these dissolved constituents appears to be the mineralized rock that occurs in breccia pipes. The highest-grade uranium deposits in the United States occur in solution-collapse breccia pipes in northwestern Arizona (Wenrich and Titley 2008).

Figure 3.4-5 shows the locations provided by the USGS (Brown and Billingsley 2010) for 207 breccia pipes exposed by erosion (shown as solid red circles) and for 759 collapse features (shown as solid black circles), which also may include breccia pipes, located some distance from the canyon rims. Figure 3.4-7 shows the stratigraphic relation of perched groundwater zones and the regional R-aquifer to mineralized breccia pipe deposits. Figure 3.4-8 is a conceptual diagram showing various types of solution-collapse features in northwestern Arizona. All of the breccia pipes are surrounded by zones of ring fractures that may or may not be interconnected and that, where open, can create secondary permeability in the rocks and expose ore bodies in contact with the fractures to groundwater from perched water-bearing zones. Where exposed to erosion or oxidation from groundwater or surface water contact, ore minerals in breccia pipes tends to dissolve away, leaving little economic mineral value. These conditions have been observed where breccia pipes are exposed in the walls of the Grand Canyon (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010a, 2010b). Conditions that prevent such exposure are required to preserve economically viable breccia pipe uranium deposits.

Based on a review of ADEQ (1985, 1988–1988c, 1995, 1999, 2009a–2009c), Energy Fuels Nuclear (1984, 1986, 1987, 1988a, 1990a–1990c, 1995a, 1995b, n.d.), BLM (2010b, 2010c), Dames and Moore (1985, 1987a, 1987b), JBR Environmental (2010), Montgomery (1993b), and Canonie Environmental (1988, 1991), the modern (post-1980) breccia pipe uranium mine sites in the study area are generally characterized by well-cemented, very low permeability breccias and adjacent formation rocks, which do not permit the flow of groundwater through the tightly locked mineral deposits. This condition inhibits dissolution of mineral deposits associated with these economically viable breccia pipes into groundwater. Some ring fracture zones and the cemented breccia itself at these sites have locally contained some connate water (water trapped during formation of the geological feature), which drained away quickly when intercepted by mine openings; at many places, the ring fracture zones had been completely healed by carbonate or other mineralization and did not yield water (personal communication, Karen Wenrich, geologist and breccia pipe uranium deposit expert 2010a, 2010b).

In each case, these ore deposits are on the order of 1,000 feet or more above the R-aquifer system and are underlain by the poorly permeable breccias and siltstones/mudstones of the Hermit Formation and Supai Group. Therefore, conditions are not favorable for downward migration of leached minerals and constituents (such as uranium and arsenic) from the ore deposits to the R-aquifer (Dames and Moore 1987b).

Most of these sites have or had supply/monitor wells completed in the R-aquifer. Exploration drilling was also conducted at the sites. AAC R12-15-817 for exploration wells and AAC R12-15-816 for water wells require proper abandonment to prevent cross-contamination of different aquifers. ADWR records indicate that all but one of the water supply wells were constructed with cement seals and blank steel casing to prevent downward drainage of perched groundwater via the annular space between the blank casing and the borehole wall. Although not sealed during operation, the well for the Hack Canyon 1, 2, and 3 mines was abandoned by being filled with cement during reclamation. The Pigeon Mine well was also abandoned by being filled with cement (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). The wells are generally designed to yield groundwater from a significant thickness of the R-aquifer; therefore, groundwater samples obtained from the wells typically represent composite samples from the aquifer rather than the uppermost part of the saturated interval, which is required for many environmental monitor wells. Nevertheless, none of the studies conducted for water quality at these wells, one of which included periodic sampling data for up to 9 years after completion of mining activities (Hermit 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 relations between the occurrence of dissolved uranium and 13 other trace elements and mining activities were few and inconclusive.

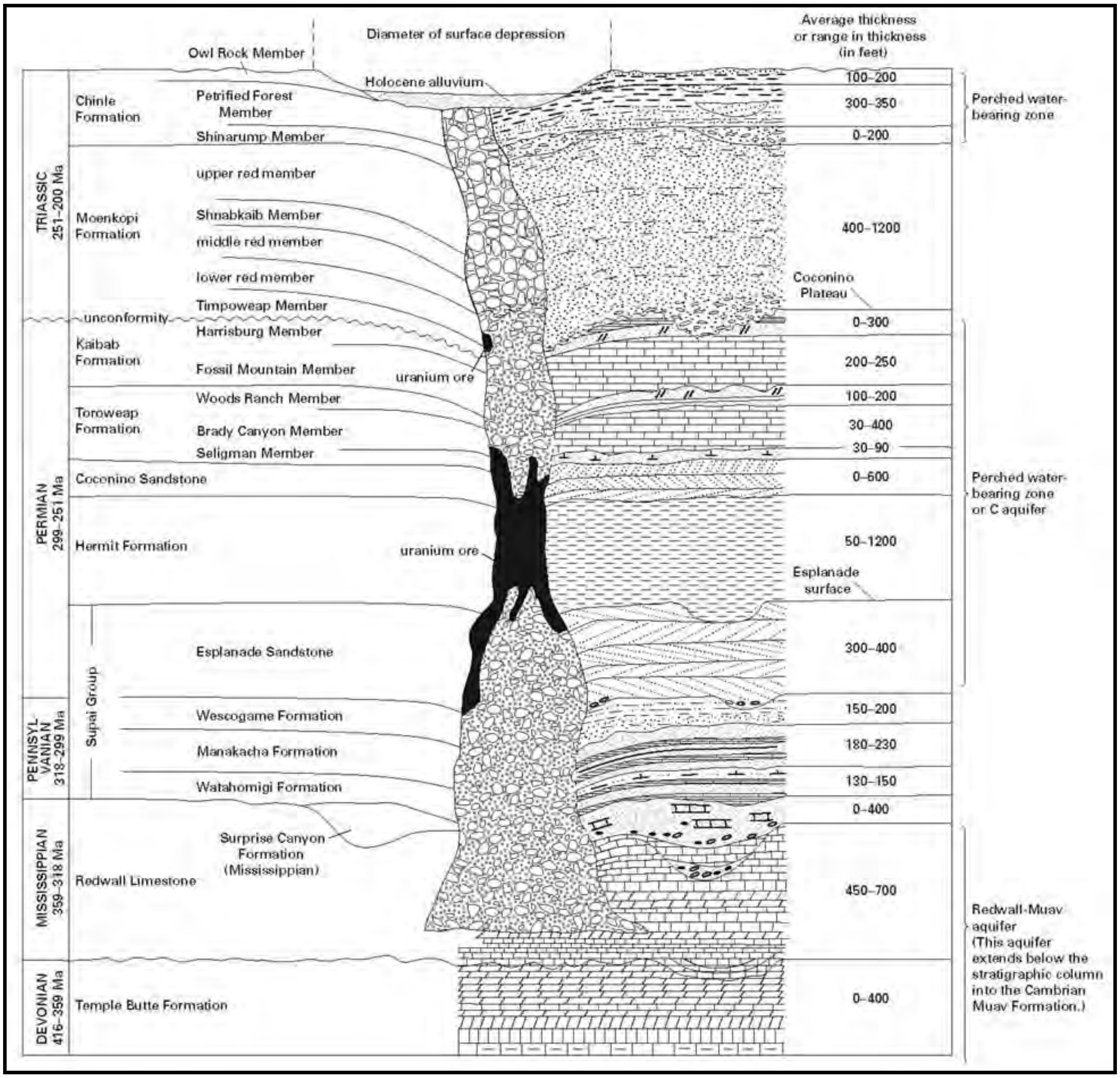
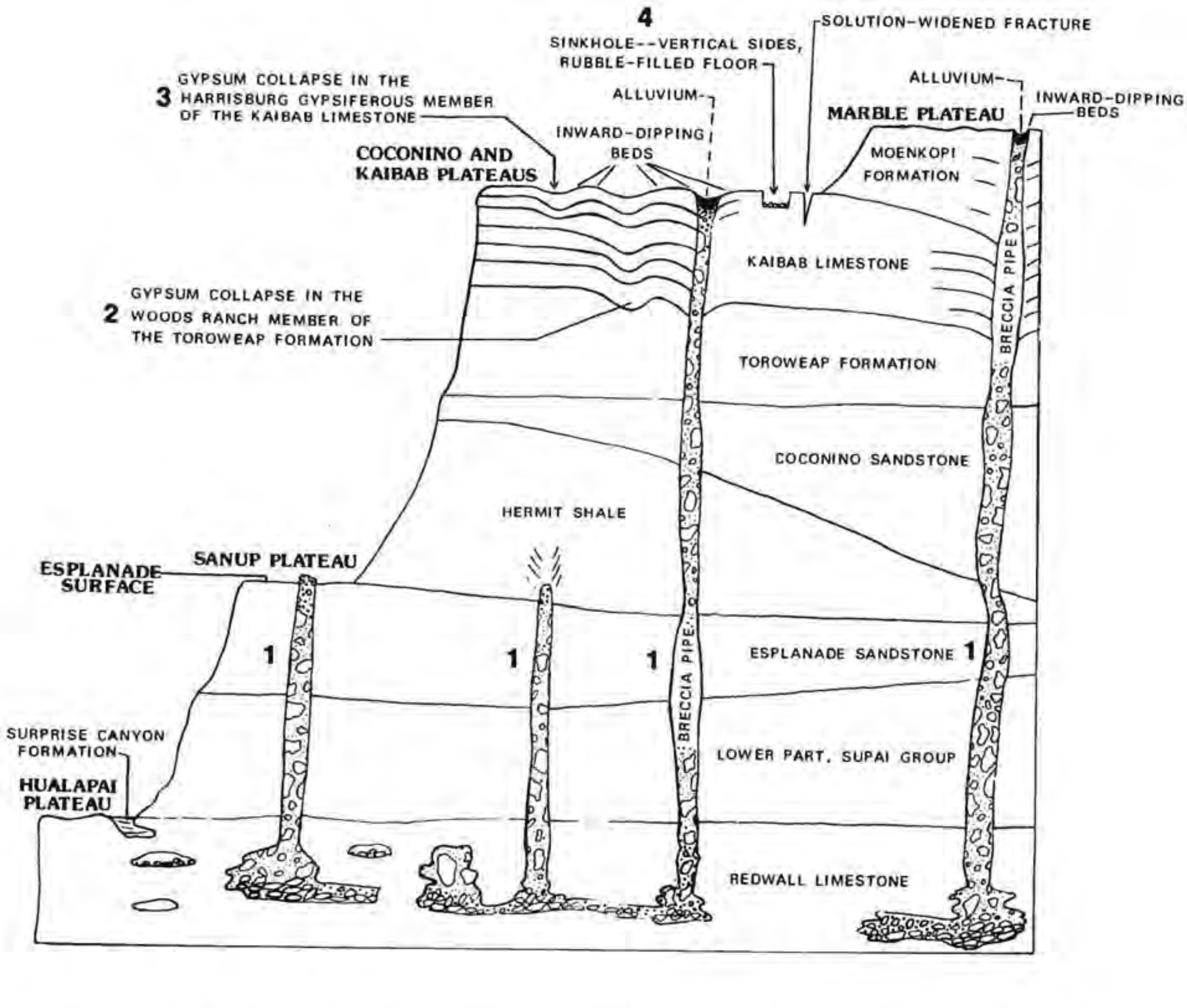


Figure 3.4-7. Stratigraphic relation of perched groundwater zones and regional aquifer to mineralized breccia pipe deposits in northern Arizona (from Bills et al. 2010 and modified from Van Gosen and Wenrich 1989).



(1) Breccia pipes that bottom in the Redwall Limestone, (2) Collapse due to dissolution of gypsum beds in the Woods Ranch Member of the Toroweap Formation, (3) Collapse due to dissolution of gypsum beds in the Harrisburg Gypsiferous Member of the Kaibab Limestone, and (4) Collapse (with vertical sides, as opposed to the gently-sloping sides of the other 3 collapse types) due to recent sinkholes in the limestone beds of the Kaibab Limestone.

Figure 3.4-8. Conceptual diagram showing various types of solution-collapse features found in northwestern Arizona (from Wenrich 1992).

At the breccia pipe uranium mines in the study area, perched water-bearing zones, if present (typically above the Hermit Formation basal confining unit), are small, thin, and discontinuous. Water yield to mine openings from these perched zones typically decreases over the first few months to 2 years of mining, from several gallons per minute to no measurable flow (Canonie Environmental 1988). Because of the dipping of adjacent formation layers down toward the solution-collapse breccia pipe, any perched groundwater that is present is expected to drain inward to the mine openings, which function as local hydrologic sinks. This water collects in the sump at the bottom of the mine and is used for mine operations; the water remaining after the demands of mine operations are met is pumped to lined evaporation and containment impoundments at land surface (Energy Fuels Nuclear 1984, 1986, 1987, 1988a; JBR Environmental 2010; personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Therefore, movement of perched water away from the mine openings is not anticipated to occur during mine operations. JBR Environmental (2010) reported that estimated maximum average flow of perched groundwater into the mine openings for previous breccia pipe uranium mines in the North Parcel was about 0.9 gpm (0.119 acre-feet per month).

In accordance with applicable state and federal permits, the entrances to reclaimed mines have typically been sealed to prevent surface water from entering the mine openings (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). Requirements for reclamation of the mines changed over time during the 1980s so that earlier mines, such as the Hack Canyon 1, 2, and 3 and Pigeon mines, were not specifically required to seal the perched groundwater zones. Perched groundwater drainage at these mines had either ceased or was very small (personal communication, Roger Smith, formerly with Energy Fuels Nuclear, Inc. 2010). For example, inflow of perched groundwater to the Pigeon Mine ranged from a maximum rate of 7.1 gpm in May 1985 to a minimum rate of 0.08 gpm in June 1987 (Canonie Environmental 1988). However, reclamation for the Hermit Mine (the last mine closed) included sealing of the perched groundwater zones using bentonite and cement (personal communication, John Stubblefield, Denison 2010). Existing regulations allow for the requirement of sealing perched groundwater zones from new mines. To the extent that reclamation does achieve re-establishment of the perching layer, the perched water-bearing zones may be slowly replenished over time (possibly several years) until natural lateral movement in the perched system resumes. If the reclamation does not re-establish the perching layer, the area of the perched aquifer that is affected may continue to drain into the mine openings in response to seasonal recharge events. At existing mines operating under interim management (some for decades), no efforts have typically been made to prevent continued drainage to the mine openings. In these circumstances, re-establishment of any affected perched water-bearing zones does not occur during the interim management period, and there is the potential for drainage and accumulation of perched groundwater, if present, in these mines as natural recharge occurs. More frequent and comprehensive monitoring, data collection, and reporting are necessary for pre-mining, mining, and post-mining periods to fully document subsurface conditions in mines and conditions at perched aquifer springs near mines.

It should be noted that environmental issues surrounding the Orphan Lode Mine (which is outside the proposed withdrawal area) are the result of the lack of mine reclamation, which has allowed surface water and/or perched groundwater to collect within one or more of the mine adits (Hom 1986) and drain through the mine openings to the R-aquifer. The location of this mine at the South Rim of Grand Canyon increases the risk of mine drainage via enhanced secondary permeability of faults or flexure fractures from “relaxation” due to lithostatic unloading near the South Rim. Drainage from the mine appears to have affected water quality in Horn Creek, which issues directly from the R-aquifer (Liebe 2003). No pre-mining water quality data exist for Horn Creek to compare with post-mining data. Although the Orphan Lode Mine is a singularly poor example of post-mining practices, it does provide data with which to compare other mine sites. These comparisons are made in subsequent sections.

3.4.5 Surface Water Resources of the Study Area

Except for the main stem of the Colorado River, virtually all of the perennial surface water base flow in the study area, including the base flow for the Little Colorado River, is supported solely by flow from springs and seeps. Hydrologic features, including the location of selected wells, springs, and streams, for the study area are shown on Figure 3.4-9. Stream base flow is augmented by seasonal surface water runoff from precipitation and snowmelt. The source of water for the springs and seeps is groundwater in the R-aquifer and in small, discontinuous perched groundwater zones located above the regional aquifer. Groundwater recharge in the region occurs chiefly via infiltration of precipitation in areas of higher altitude, such as in the northeastern part of the Coconino Plateau (South Parcel area) and the Kaibab Plateau (between the North and East parcels). Recharge also occurs on the Hualapai Plateau (west of

Cataract Creek), and at the Bill Williams Mountain and San Francisco Mountain complexes (south and southeast of the South Parcel, respectively), and via infiltration of surface water runoff in ephemeral stream channels located along major fault zones.

Figure 3.4-10 shows mean annual precipitation from 1971 through 2000 in the study area. Most of the annual precipitation in Arizona occurs in late summer and mid-winter. Precipitation is provided by winter storms of the Pacific Ocean system and annual summer monsoon storm systems originating in the southern Pacific Ocean and the Gulf of Mexico (Jones 1993). Although the late summer monsoons provide intense rainstorms, these storms are of relatively short duration and are believed to provide limited groundwater recharge as a result of high rates of evapotranspiration during the summer. It is the longer duration of winter rain and snow and subsequent snowmelt that provide most of the groundwater recharge to the aquifers in the study area. Losses of rain and snow to evapotranspiration and sublimation are high in the region.

Figures 3.4-11, 3.4-12, and 3.4-13 show hydrologic features for the North, East, and South parcels, respectively. These figures include the same content as Figure 3.4-9 but are enlarged and centered on each respective parcel for clarity.

North Parcel

Kanab Creek is the only perennial surface water drainage in the North Parcel; all other drainages are ephemeral. Kanab Creek is perennial in its lower reach near the Colorado River, in a 2- to 3-mile-long reach associated with Clearwater Spring in the northern part of the North Parcel (see Figure 3.4-11), and in short reaches below a few small springs in its tributary canyons. Kanab Creek and its numerous ephemeral tributaries drain southward to the Colorado River. A north-south-trending surface water divide along Little Hurricane Ridge in the western part of the parcel separates the Kanab Creek surface water drainage basin from the Virgin River surface water drainage basin to the west (see Figure 3.4-11). Surface water on the North Parcel west of this divide flows northwestward into Clayhole Wash, which flows northwest toward the Virgin River in Utah. Several small springs and seeps issuing from perched water-bearing zones in the Moenkopi Formation, together with an extensive system of surface water retention dams constructed to reduce the salinity of runoff downstream (personal communication, Lorraine Christian, BLM Arizona Strip Field Office 2010), occur in the upper reach of Clayhole Wash in the western part of the North Parcel. A small area in the southwest corner of the North Parcel appears to overlap the surface water drainage areas for Tuckup Canyon and Toroweap Valley. Tuckup Canyon is tributary to the Colorado River, and Toroweap Valley is tributary to Toroweap Lake, which overflows to the Colorado River during periods of substantial surface water runoff.

East Parcel

The surface water drainage system of House Rock Valley is composed of several ephemeral washes that drain into North Rim canyons, including, from south to north, Bedrock (tributary to South Canyon), North, Rider, Soap Creek, and Badger canyons. These canyons are tributary to the Colorado River, which flows southward through Marble Canyon along the entire eastern boundary of the East Parcel (see Figure 3.4-12). There are no perennial surface water drainages in the East Parcel; however, some perched water-bearing zones discharge at a few small seeps and springs in these North Rim canyons, and several small to large R-aquifer springs discharge to the Colorado River along the west wall of Marble Canyon and into the bottom of the river channel downstream of its confluence with North Canyon.

South Parcel

No perennial surface water drainages occur in this parcel; however, numerous ephemeral washes occur across the area. Most of the parcel lies in the surface water drainage basin of Havasu and Cataract creeks, and the remainder is tributary to the Little Colorado River (see Figure 3.4-13). The perennial reach of Cataract Creek is called Havasu Creek, which begins at Havasu Springs. West of the surface water divide, ephemeral surface water on the South Parcel flows downgradient to the south, southwest, and west. During intense rainstorms, runoff from this part of the South Parcel may ultimately reach Havasu Creek, which is tributary to the Colorado River. However, permeable surficial deposits and sinkholes in the Kaibab Formation in ephemeral stream channels along major fracture zones, such as the Markham Dam fracture zone of Cataract Creek, have a high capacity to intercept surface water and convey it underground.

East of the surface water divide, ephemeral surface water on the South Parcel flows downgradient to the south and east (see Figure 3.4-13). During intense storms, runoff from this part of the South Parcel may ultimately reach the Little Colorado River, which is tributary to the Colorado River.

3.4.6 Groundwater Resources of the Study Area

Groundwater moves from areas of recharge to areas of discharge. In the study area, groundwater recharge occurs from infiltration of precipitation and ephemeral stream flow. The Grand Canyon and its larger tributary canyons function as groundwater drains. The principal aquifer in the study area is the regional R-aquifer system, which transmits and stores large quantities of groundwater. The R-aquifer includes the carbonate rocks of the Redwall Limestone, Muav Limestone, and Temple Butte Formation. Groundwater movement in this aquifer occurs chiefly via fracture zones and interconnected cave passages, which are most abundant where faults are associated with tensional tectonic stresses (regional geological movements within the earth that cause extensional stress [pulling apart] in rocks versus compressional stress [pushing together]). These features together comprise a complex groundwater system that supports springs having diverse water quality and discharge characteristics. Uncertainty regarding specific flow paths and hydrologic connections in these types of groundwater systems is greater than for other types of systems, such as alluvial basins.

The C-aquifer includes the Coconino Sandstone and overlying or underlying water-bearing strata, including, at places, the Toroweap Formation, Kaibab Formation, and upper part (Esplanade Sandstone) of the Supai Group (see Figure 3.4-7). Outside the study area, east of the Mesa Butte Fault Zone, the C-aquifer is the principal groundwater source for the city of Flagstaff water supply; however, it is a thin, discontinuous perched water-bearing unit in the proposed withdrawal area (west of the fault). Bills et al. (2007) and Bills et al. (2010) indicate that the saturated thickness in this aquifer decreases to the west between Flagstaff and the Mesa Butte Fault Zone and north of the Little Colorado River as a result of downward drainage of groundwater to deeper units. South from the Little Colorado River, Bills et al. (2007) indicate the Mesa Butte Fault Zone functions as a barrier to groundwater movement in the C-aquifer. The rock units that form the C-aquifer west of the Mesa Butte Fault Zone, together with other perched water-bearing systems in the proposed withdrawal area store and transmit small amounts of groundwater, and their discontinuous nature allows only local flow of perched groundwater.

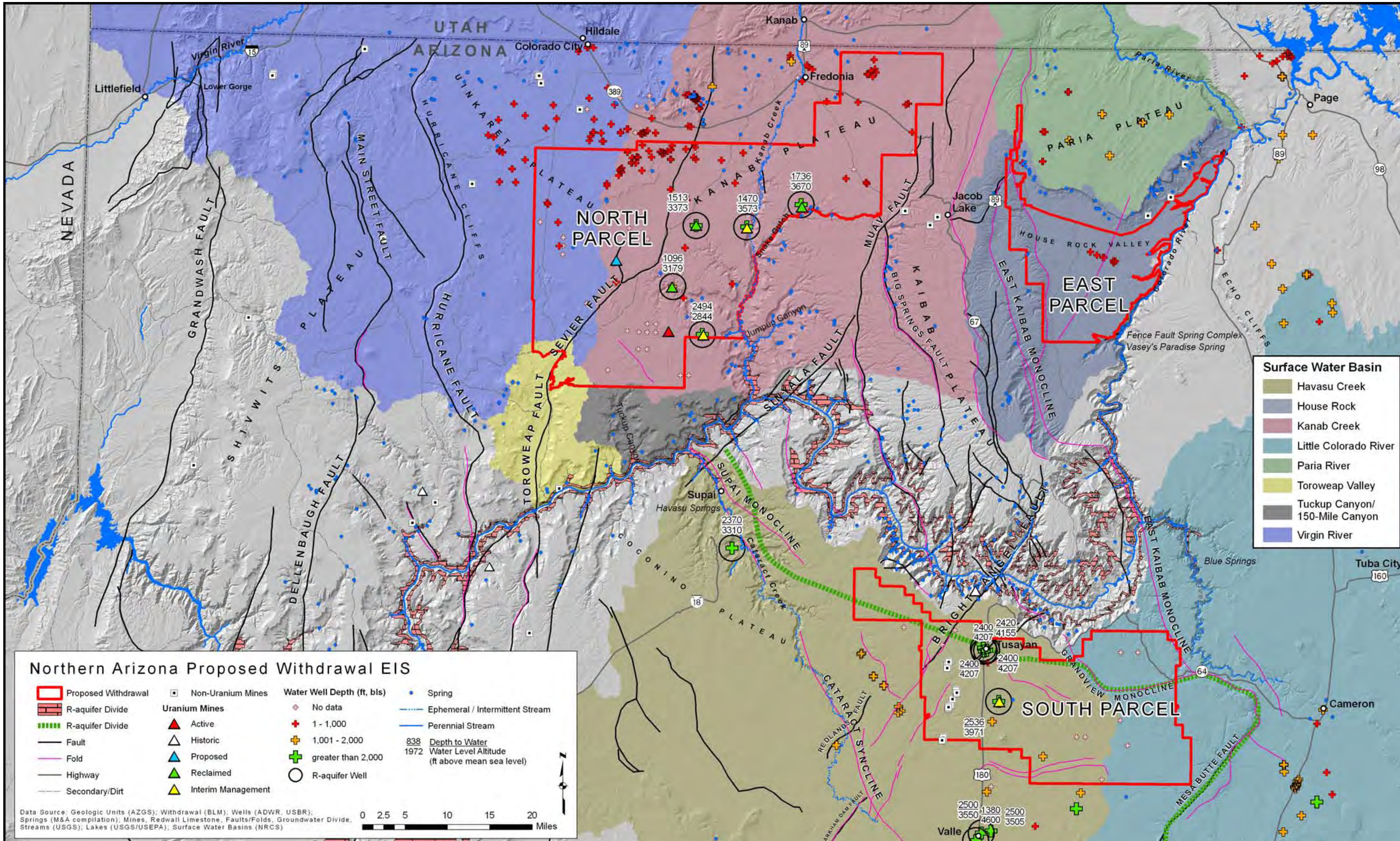


Figure 3.4-9. Hydrologic features for water resources study area.

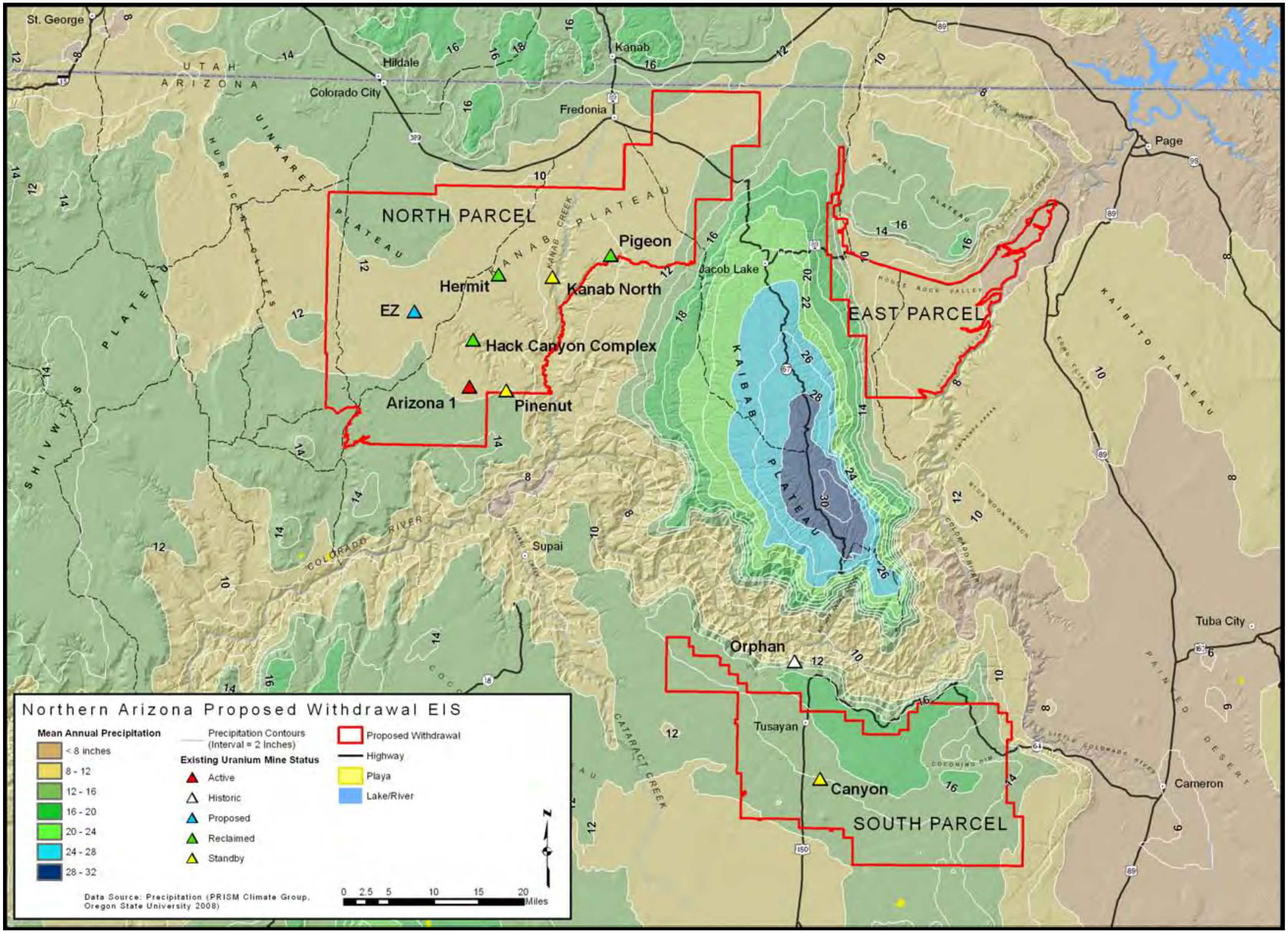


Figure 3.4-10. Mean annual precipitation, 1971 through 2000.

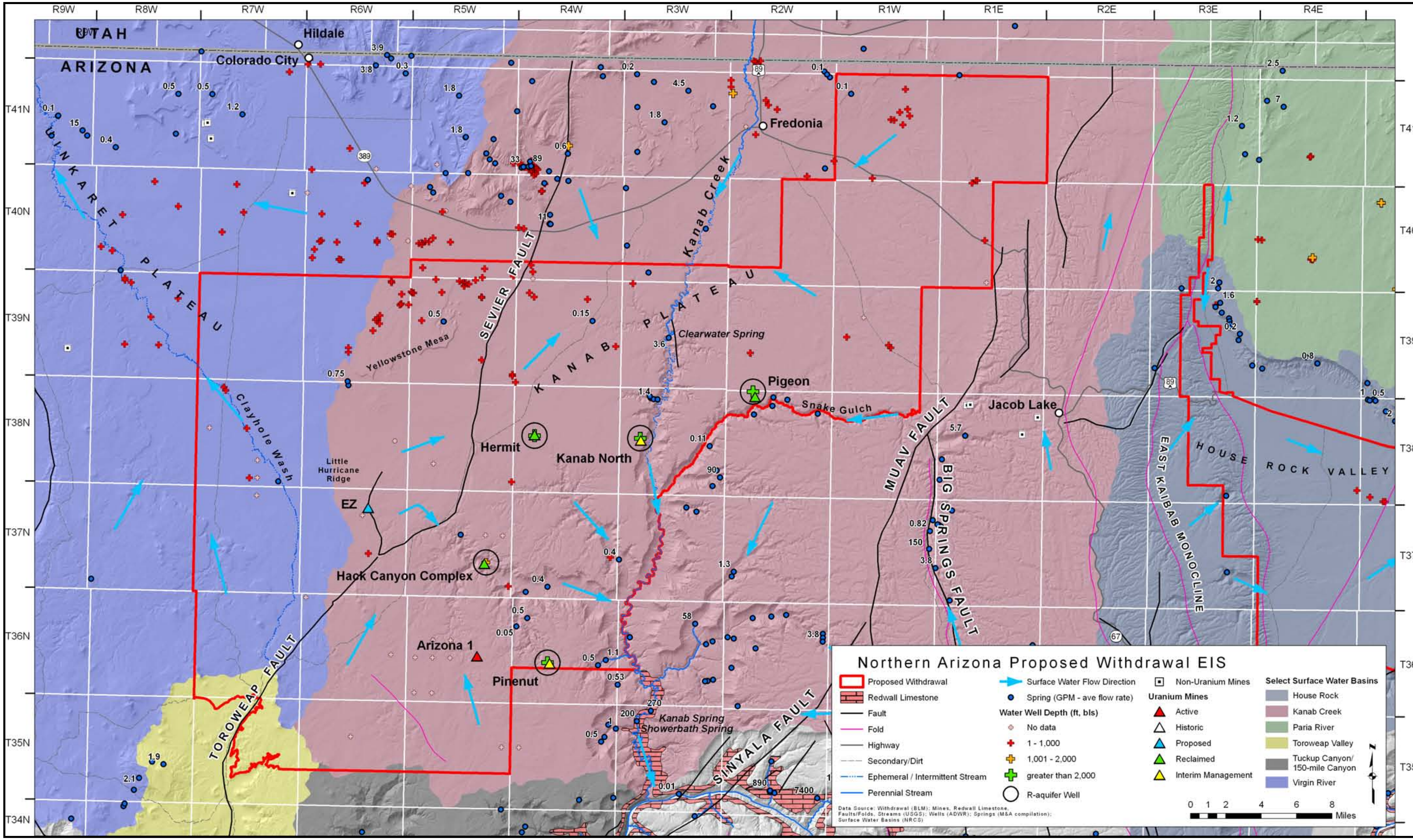


Figure 3.4-11. Hydrologic features for North Parcel.

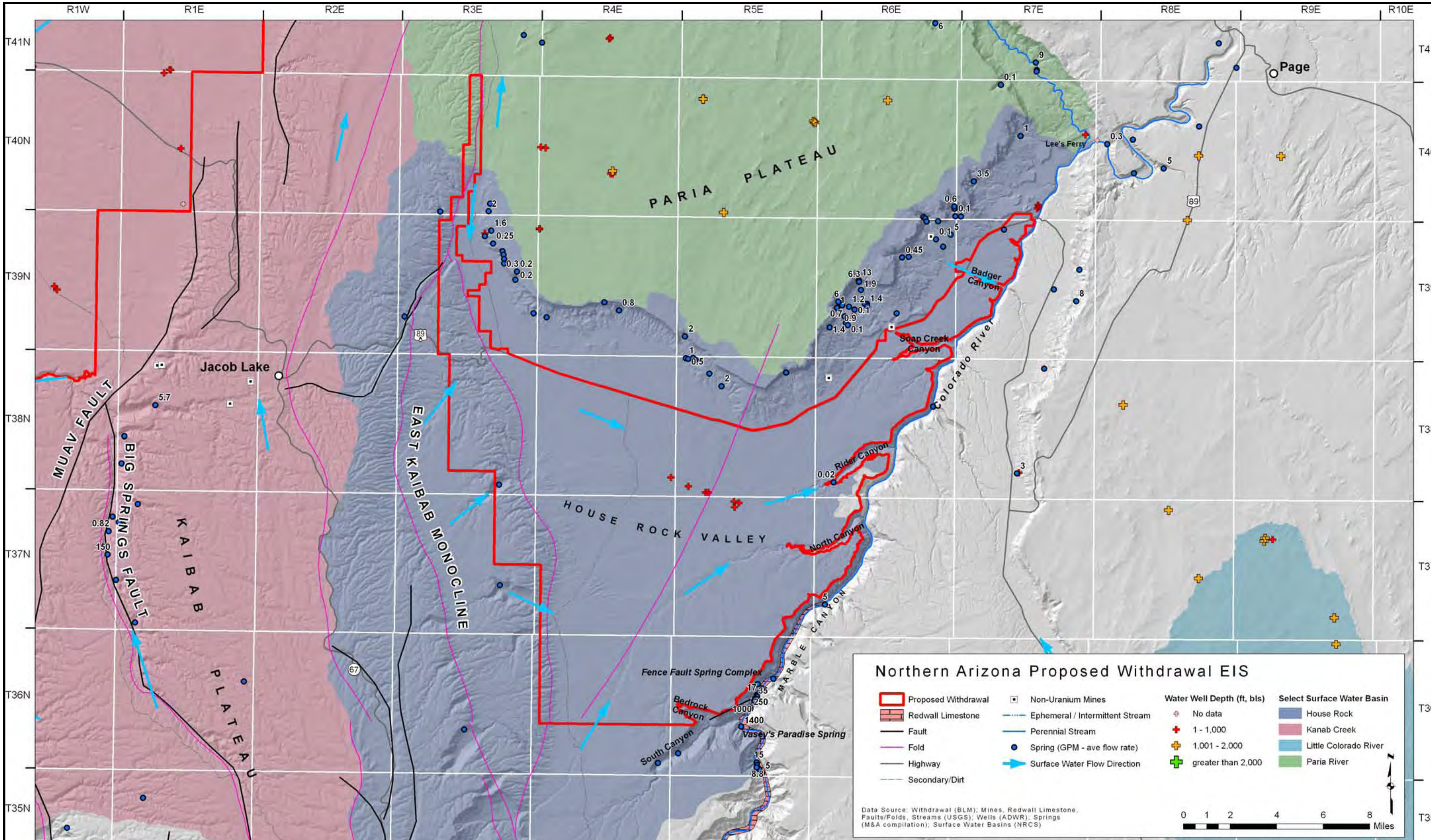


Figure 3.4-12. Hydrologic features for East Parcel.

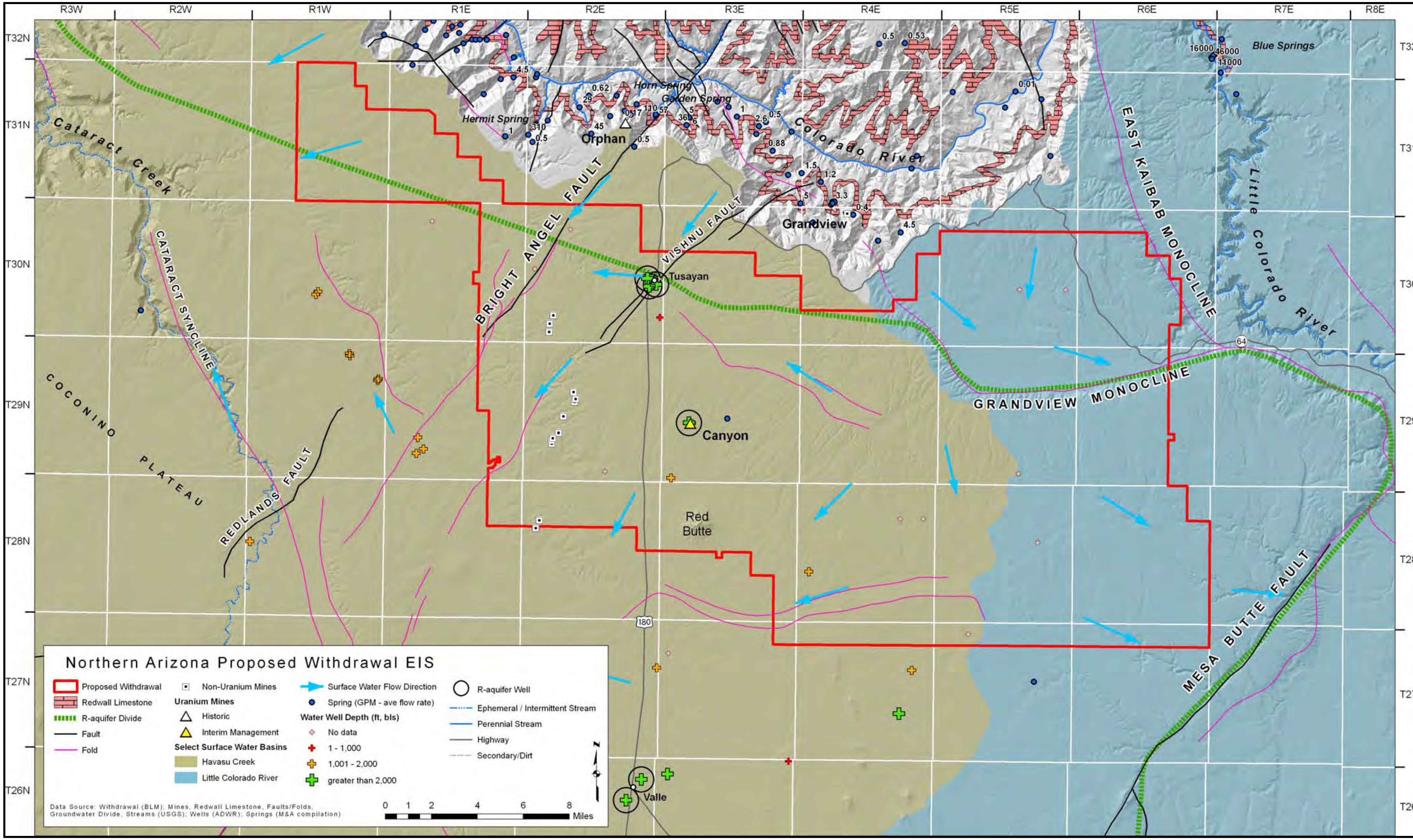


Figure 3.4-13. Hydrologic features for South Parcel.

Groundwater moves in sedimentary rocks by flowing through pore spaces between the particles that form the rock matrix, as well as through fracture openings in the rock. The property of rocks that relates to their ability to transmit water through intergranular porosity is known as primary permeability. Where particles are relatively large, as in the case of sandstone, intergranular pore spaces may also be relatively large, and groundwater may flow with moderate ease unless cementation is substantial. Primary permeability for sandstones is commonly fairly large unless the pore spaces have been filled with carbonate or silica cement; sandstones may constitute aquifers that are conducive for water supply. Where particles are exceedingly small, as for mudstone or shale strata, intergranular spaces are also exceedingly small, and resistance to groundwater flow is substantial. Therefore, mudstone and shale strata, such as the Hermit Formation and parts of the Supai Group and Moenkopi Formation, generally function as barriers to groundwater movement (Montgomery et al. 2000). Intergranular spaces in carbonate rocks, such as many limestones and dolomites, are also usually exceedingly small. Unless larger openings occur, such as those associated with fractures and cave passages, carbonate rocks such as the Redwall Limestone may also constitute barriers to groundwater movement (Montgomery et al. 2000).

Both the C- and R-aquifer systems consist of brittle rock strata (Montgomery et al. 2000). When tectonic activity occurs, such as movement on faults, both units accommodate the associated stress and strain by fracturing. Where fractures are abundant in brittle rocks, the fractures enhance permeability and provide preferential pathways for groundwater movement. This “secondary permeability” of sandstones in the C-aquifer and carbonate rocks in the R-aquifer is substantially improved where fractures are abundant and interconnected. Because shale and mudstone strata tend to be ductile rather than brittle, these strata often flex rather than fracture when subjected to tectonic stresses (Montgomery et al. 2000). Open fractures that do occur in these strata tend to become filled or “healed,” blocking off pathways for groundwater movement. Because of the ductile nature of shale and mudstone strata, such as in the Bright Angel Shale and Hermit Formation, it is likely that these strata will continue to act as barriers to retard groundwater movement, even where tectonic activity has occurred.

Where groundwater movement occurs chiefly via the preferential pathways provided by interconnected fractures and solution-enlarged features such as caves, there is little opportunity for the removal of some groundwater contaminants via slow filtering through the intergranular pore spaces of the rock units. Therefore, where the hydraulic gradient of the groundwater system is sufficiently large, rapid movement of contaminated groundwater over large distances can occur via the fracture and cave passage network. These conditions can occur in the R-aquifer but primarily occur in the Kaibab Plateau (Huntoon 2000). However, it should be emphasized that the long residence times estimated for groundwater in the R-aquifer (Bills et al. 2010; Monroe et al. 2005), outside the immediate vicinity of springs along canyon walls where hydraulic gradients tend to be steeper, indicate that the typical condition in the aquifer of the Havasu Springs groundwater sub-basin supports slow groundwater movement conducive to gradual mixing and dilution as fracture and cave systems interconnect along the pathway to points of discharge.

Recharge

Groundwater beneath the study area originates as recharge from infiltration of rainfall and snowmelt. Average precipitation measured at Grand Canyon Village, in the northern part of the Havasu Springs groundwater sub-basin, during the period from 1941 through 1970, was about 14.5 inches per year (Sellers and Hill 1974). Normal annual precipitation for 1961 through 1990 measured at Williams, in the southern part of the Coconino Plateau, was 21.17 inches (Owenby and Ezell 1992). Metzger (1961) estimated average annual recharge to the R-aquifer to be about 0.3 inch per year, 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 annual precipitation for the Coconino and San Francisco plateaus based on total groundwater discharge from the principal aquifers. Bills et al. (2007) estimated an average recharge rate of about 3.5% of the average annual precipitation for the Coconino Plateau and adjacent areas.

Rainstorm events are often sporadic and localized, resulting in amounts of short-term, local groundwater recharge that can vary substantially from long-term, regional average recharge estimates. The frequency and magnitude of these events for a specific area can range widely from year to year. Therefore, although long-term average recharge for an area may be small, amounts of local, rainstorm-based recharge may be relatively large. Groundwater travel time from land surface to the deep aquifers varies temporally and spatially owing to variations in precipitation, air temperature, properties and thickness of the root and soil zone, presence of faults and fractures, and hydrologic properties of the geological strata in the unsaturated zone (Flint et al. 2004).

Most of the precipitation is lost via evaporation, transpiration, and surface water runoff. The remaining fraction infiltrates chiefly through permeable surficial deposits, volcanic rocks, and fractures and solution openings in the Kaibab Formation. Many flash floods sink directly into "swallow holes" along fault zones in the Kaibab (Huntoon 2000). Where open, extensive vertical fractures and solution openings do not convey the water directly to the deep aquifer system, this infiltrated water moves downward until it encounters a confining rock layer with sufficiently small permeability to impede vertical movement of the water. Where downward migration of the water is impeded, a thin, saturated zone, referred to as a perched groundwater zone, may form above the confining layer, and lateral groundwater movement may occur. Because confining layers are not completely impermeable, part of the perched groundwater eventually seeps downward through the confining layer matrix. The remaining perched groundwater moves laterally until it 1) encounters the edge of the confining unit and moves downward; 2) encounters fractures or other openings that permit downward movement through the confining layer; 3) discharges along canyon walls as seeps, springs, or evapotranspiration; or 4) is withdrawn from the perched aquifer via active wells. Groundwater travel time from land surface to the deep aquifers varies temporally and spatially owing to variations in precipitation, air temperature, root zone and soil properties and thickness, faults and fractures, hydrologic properties of the geological strata in the unsaturated zone (Flint et al. 2004).

Groundwater Occurrence in Perched Aquifers

In areas where confining layers are laterally continuous, groundwater may be perched. In the proposed withdrawal area, these conditions occur most commonly in the Toroweap Formation, where groundwater is perched in sandstone units that overlie fine-grained confining strata, and at the base of the Coconino Sandstone (or base of the Toroweap Formation in the north area, where the Coconino is absent), where groundwater may be perched on fine-grained strata of the Hermit Formation. The Moenkopi and Kaibab formations can also contain perched water-bearing zones, especially in the northern part of the North Parcel. At these locations, the perched aquifers may yield small quantities of groundwater to wells for domestic and stock use and to springs. These perched reservoirs are commonly small, thin, and discontinuous, and generally depend on annual recharge to sustain yield to wells and springs (Bills et al. 2010; Montgomery et al. 2000). The perched aquifers overlie and have no direct hydraulic connection to the deep R-aquifer; therefore, any downward movement of perched groundwater is by gravity drainage.

Discharge from Perched Aquifer Springs

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. Available data for the North Parcel and the South Rim of Grand Canyon indicate that groundwater discharge from individual seeps and springs is small, and the chemical quality of groundwater discharged from perched aquifer systems ranges widely from location to location (see Appendix F, Figures 3.4-11 and 3.4-13) (Bills et al. 2007; Bills et al. 2010; Monroe et al. 2005; Montgomery 1996, 1999). Available data for the East Parcel indicate that discharge from individual seeps and springs is small (see Appendices C and D, Figure 3.4-12); no water quality data are available. Records indicate that only one seep (Miller

Seep) occurs on the South Parcel and there are no data for discharge quantity or quality; however, a recent visit to the seep by Forest Service personnel indicated the spring was dry (personal communication, Liz Schuppert, Forest Service 2010).

Groundwater Occurrence and Movement in the R-Aquifer

The R-aquifer is the only aquifer of regional extent that is capable of consistently yielding large quantities of groundwater to wells and springs in the proposed withdrawal area. On the Colorado River, from about river mile (RM) 50, 11 miles upstream from the mouth of the Little Colorado River in east Grand Canyon, to about RM 142, about 1.5 miles upstream from the mouth of Kanab Creek, the base of the R-aquifer is exposed in outcrop above river level (Figures 3.4-13 and 3.4-14). Saturated thickness in the aquifer decreases toward the Grand Canyon (Metzger 1961).

Groundwater enters the R-aquifer in the proposed withdrawal area chiefly by downward migration of precipitation and stormwater runoff via vertical fractures and solution-enhanced features in overlying strata. Groundwater also enters as underflow from those portions of the R-aquifer that are hydraulically upgradient from the proposed withdrawal area. After groundwater enters the saturated zone in the R-aquifer, it becomes part of groundwater in storage in the regional system. Lateral groundwater movement is believed to occur chiefly via fracture and solution openings that are concentrated along principal structural features (Huntoon 1982, 2000). Arterial groundwater migration pathways, with large storage capacity and transmissivity, are believed to have developed in response to dissolution in the direction of the hydraulic gradient toward the principal drains for the aquifer system, such as the Little Colorado River, Havasu Springs, Tapeats Creek, Thunder River, Bright Angel Creek, and the Fence Fault complex reach of Marble Canyon (including Vasey’s Paradise), and downgradient areas to the north in Utah. The majority of the discharge from the R-aquifer in the vicinity of Kanab Creek occurs at Tapeats Creek and Thunder River, which are associated with the West Kaibab Fault Zone (including the Muav and Sinyala faults).

Direction of groundwater movement developed by Bills et al. (2007) and Bills et al. (2010) for the R-aquifer in the study area is shown in Figure 3.4-14. Direction of groundwater movement developed by Huntoon (1974) for the Kaibab Plateau region is shown in Figure 3.4-15 and is shown to be focused along principal fault zones.

Basin-type karsts, such as those associated with the fully saturated artesian conditions in the R-aquifer of the Havasu Springs groundwater sub-basin, are characterized by well-developed two-dimensional, or even three-dimensional, maze cave systems that provide maximum groundwater storage, high permeability, interstitial spaces approaching on a macro scale the conditions of porous media, and gentle groundwater hydraulic gradients (Huntoon 2000). The pulse-through hydraulics of this type of system cause fluctuations in spring discharge to be highly moderated and, in large basins, remarkably steady (Huntoon 2000). Groundwater in these systems tends to have elevated TDS content and temperature because most of the water has relatively long residence time in the aquifer due to large storage (Huntoon 2000).

Uplift-type karsts, such as those associated with partially saturated, unconfined conditions in the R-aquifer of the Kaibab Plateau, are characterized by simple vadose zone stream tubes along widely spaced extensional fault zones that provide minimal groundwater storage, localized large fracture permeability, and relatively steep hydraulic gradients (Huntoon 2000). The flow-through hydraulics of this type of partially saturated system cause spring discharge to be highly variable from season to season (Huntoon 2000). Groundwater in these systems tends to have relatively small TDS content and low temperature because most of the water is derived directly from seasonal recharge events and has relatively short residence time in the aquifer (Huntoon 2000).

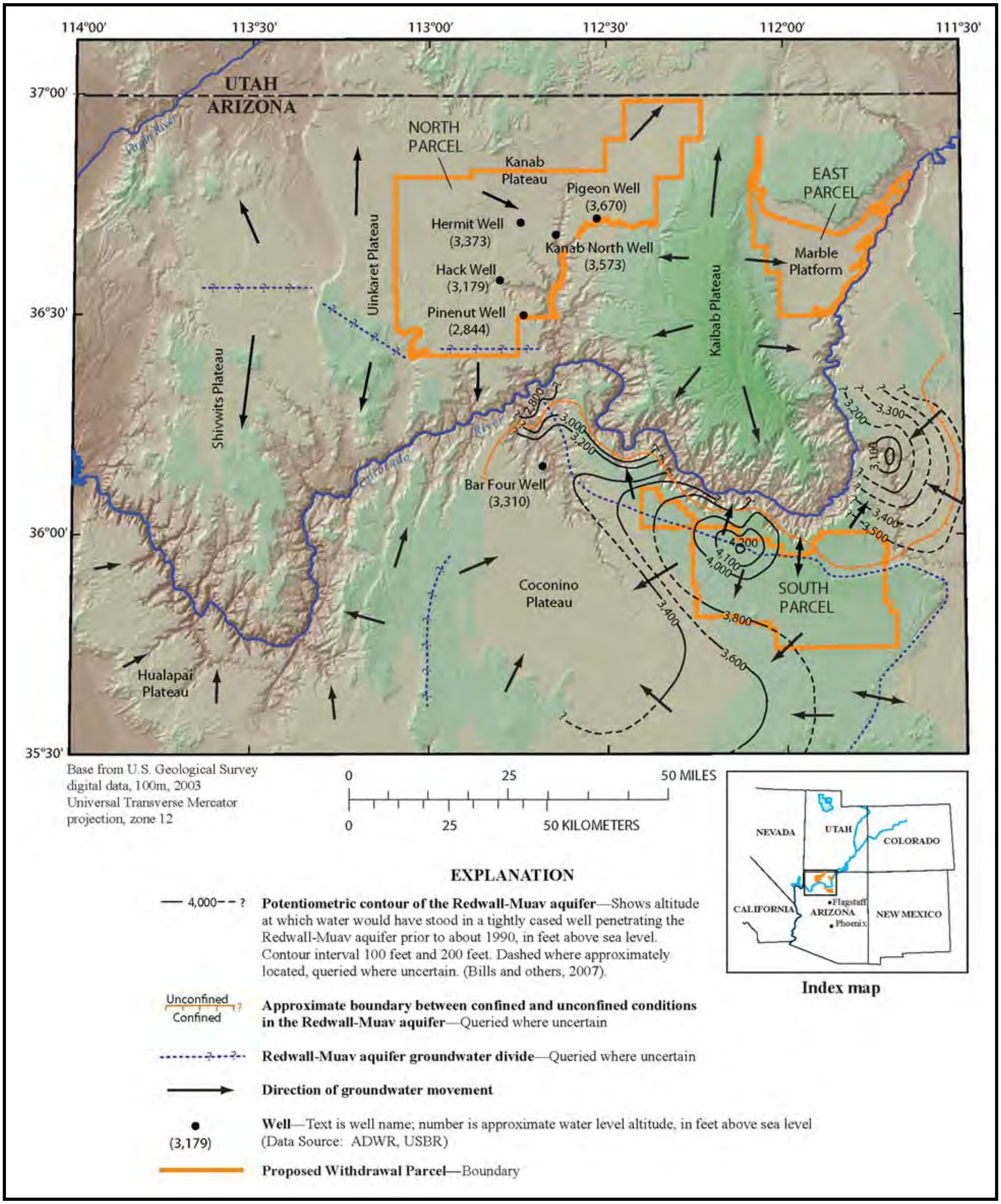


Figure 3.4-14. General direction of groundwater movement in the regional aquifer in the water resources study area (modified from Bills et al. 2010).

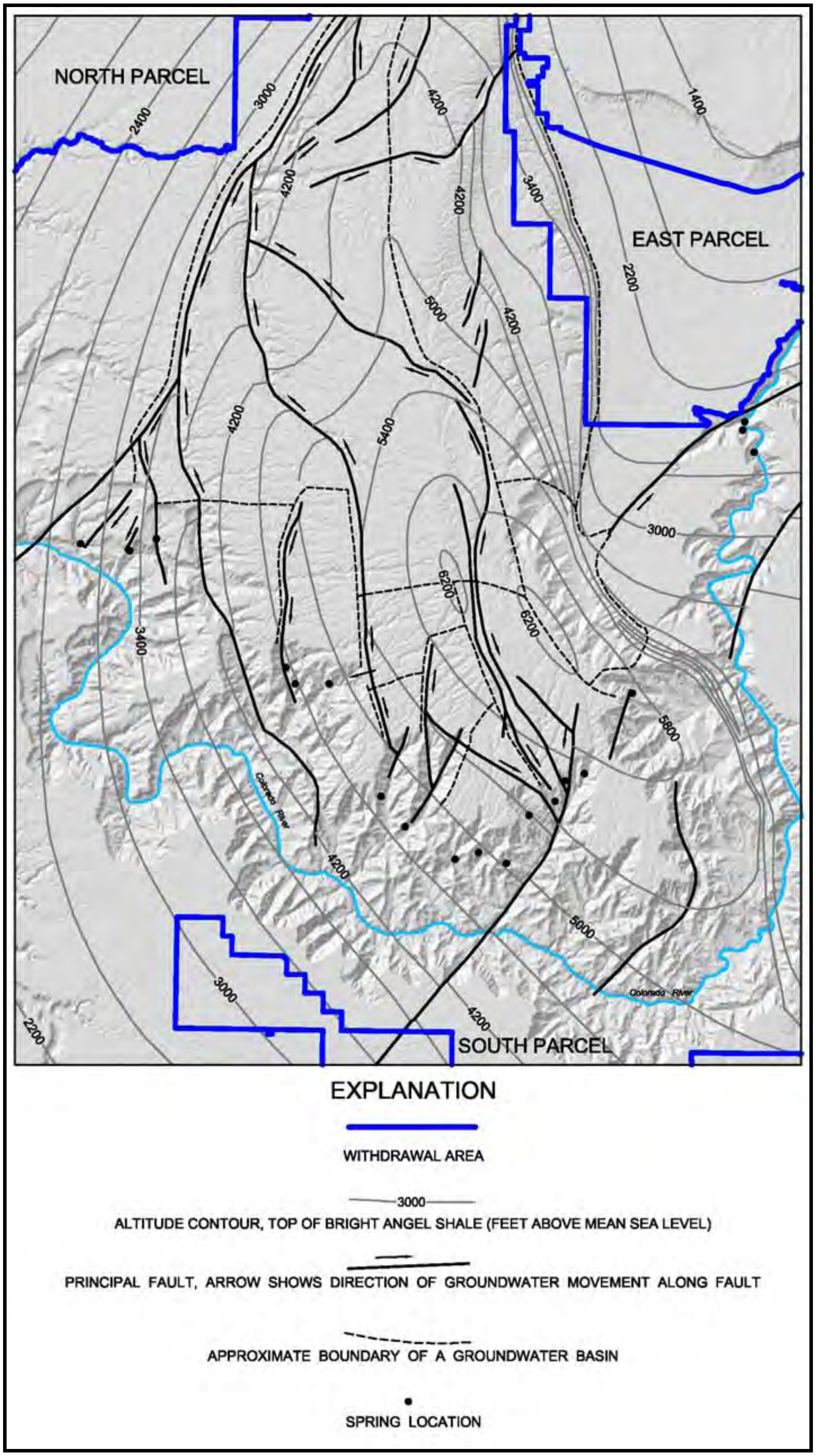


Figure 3.4-15. Direction of groundwater movement in the Kaibab Plateau region (modified from Huntoon 1974).

Huntoon (2000:159) describes the difference between pulse-through (basin karst) and flow-through (uplift karst) systems by comparing porous media and surface water systems as follows:

> In porous media, recharge water moves into the aquifer and enters storage in the rock matrix causing hydraulic heads in the recharged zone to increase. The increased heads propagate toward the discharge points causing a steepening of the hydraulic gradient, thereby increasing flow rates through the aquifer. When the steepened gradient arrives at a spring, flow rates increase as the water in storage closest to the spring is pushed from the aquifer by piston flow. Notice, the water that flows from the spring does not contain much if any of the water which entered the aquifer during the recharge event. Rather it is older water in the most downstream part of the aquifer that is displaced out. The increased spring discharge is therefore called a Pulse-through event because it represents the arrival of the energy at the spring but not the recharge water itself. The recharged water is left behind in storage in the upstream part of the aquifer. As the energy from the recharge pulse passes through the aquifer, it is dissipated so that the spring response will be attenuated and drawn out over time.
>
> Surface water systems respond differently. A precipitation event in the upstream part of a basin produces a flash flood that moves down the channel as a hydraulic pulse in the form of a flood wave. When the pulse arrives at the downstream end of the basin, the water that caused the pulse is carried in it. The increased discharge represents a flow-through event. Comparable flow-through hydraulics operate in many unconfined karst aquifers because storage is minimal and the flood waters are actually coursing through relatively simple, well interconnected, open conduits analogous to surface streams. Actual flow rates approach surface water velocities. As a result, spring discharges from unconfined systems tend to be flashy.

It is likely that a range of conditions, with basin karst (pulse-through) and uplift karst (flow-through) at the endpoints, occurs in the Grand Canyon region (Huntoon 2000).

The potentiometric surface (level to which the groundwater would rise if not trapped in a confined aquifer) of the R-aquifer on the Coconino Plateau and directions of groundwater movement in the study area are shown in Figure 3.4-14 (modified from Bills et al. 2010). These contours were developed by extrapolation of observed data to show general directions of groundwater movement, but do not account for groundwater flow in specific fault and fracture zones. These contours generally illustrate the same general directions of flow as the groundwater flow model developed by Montgomery (1999) for the Coconino Plateau, which did simulate flow along major faults and fracture zones. Figure 3.4-14 also depicts a groundwater divide (shown as a blue dotted line) along the South Rim that is further from the Grand Canyon than was simulated by Montgomery (1999). North of the Grand Canyon, insufficient data are available to construct potentiometric level contours for the R-aquifer groundwater system; however, general directions of groundwater movement and general locations for groundwater divides are shown in Figure 3.4-14. Groundwater movement in the R-aquifer at each of the parcels is described in the following sections.

North Parcel

Groundwater data for the R-aquifer are sparse for the area north of Grand Canyon and the flow system is not as constrained by points of discharge at springs in the Grand Canyon watershed. However, a conceptual model for groundwater movement in the R-aquifer north of Grand Canyon has been developed based on groundwater levels in five R-aquifer wells on the North Parcel, the regional dip of geological formations (see Figures 3.4-4 and 3.4-6a [sections B-B’ and C-C’]), the location of major springs and fault zones (see Figures 3.4-5 and 3.4-11), and conceptual directions of R-aquifer groundwater movement developed by Bills et al. (2010), personal communication Don Bills, USGS (2010a), and Huntoon (1974, 1982, 2000). Indirect evidence suggests that R-aquifer groundwater in the North Parcel collects into solution-enhanced permeability features along fault zones and interconnected cave systems and thence generally moves along the pathways described below.

- Groundwater in the area of Kanab Creek and its tributaries likely moves chiefly southward toward springs in the lower reach of Kanab Creek. The area of the Hermit, Kanab North, Pigeon, Hack Canyon Complex, and Pinenut mines occurs within this flow regime (see Figure 3.4-14).
- Groundwater in the southernmost part of the North Parcel may move south toward small springs along the north wall of the Grand Canyon and potential discharge areas in the channel of the Colorado River, where it cuts into the R-aquifer (downstream from Kanab Creek) (see Figure 3.4-14). Spring discharge along the north wall of Grand Canyon in this reach is meager; therefore, it is believed that this flow regime is minor for the North Parcel.

  The large springs at Deer Creek and Thunder River shown east from the Sinyala Fault in Figure 3.4-11 are not part of the groundwater discharge from the North Parcel. These springs are southward points of discharge for groundwater collected by the West Kaibab Fault Zone (including the Muav and Sinyala faults) from the Kaibab Plateau. This relation is also illustrated in Figure 3.4-15.
- Groundwater in the westernmost and northwesternmost areas of the North Parcel may move northward into southern and central Utah along ancient (more than 200-million-year-old) preferential pathways that are believed to have existed during the formation of the breccia pipes in northern Arizona (see Figure 3.4-14). These pathways likely include deep, interconnected maze cave systems and major fault zones, such as the Sevier and Hurricane faults (see Figure 3.4-9). 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. The large spring system (total flow of more than 4,100 gpm) that discharges into the Virgin River, where it intersects the Hurricane Fault near Hurricane, Utah issues from the Toroweap Formation.
- Similarly, groundwater in the northeasternmost part of the North Parcel may also move northward into Utah by collecting into major structural preferential pathways, such as the West Kaibab Fault Zone (including the Muav Fault) (see Figures 3.4-9 and 3.4-14).

Groundwater divides occur between these directions of groundwater movement in the North Parcel. Although available data are not sufficient to determine the exact locations for the divides, the conceptual locations are sufficient for the purposes of describing relative groundwater movement.

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). 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. 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 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.

Figure 3.4-15 shows the conceptual groundwater flow regime developed by Huntoon (1974) for the R-aquifer beneath the Kaibab Plateau, which is a source of recharge for the aquifer east of Kanab Creek. Huntoon (1974, 1982, 2000) indicated the occurrence of several R-aquifer groundwater divides in the Kaibab Plateau caused by collection of groundwater into solution-enhanced permeability features along principal fault and fracture zones, many of which eventually circulate to springs in the Grand Canyon and its tributaries. Huntoon (2000) indicates that the West Kaibab Fault Zone intercepts substantial R-aquifer recharge and groundwater flow moving west in the Kaibab Plateau and conveys the water along the fault zone to the Tapeats Creek and Thunder River spring system, thereby capturing groundwater that might have provided substantial spring flow into the Kanab Creek system. This interpretation explains the lack of large springs west from the fault zone and the relatively limited discharge of R-aquifer springs near the mouth of Kanab Creek. Therefore, exploration and development activities in the North Parcel can not affect the springs that are supported by recharge and groundwater movement in the Kaibab Plateau.

East Parcel

As described previously in this chapter, the surface water drainage of House Rock Valley is composed of several ephemeral washes that drain into North Rim canyons, including, from south to north, Bedrock (tributary to South Canyon), North, Rider, Soap Creek, and Badger canyons. 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 near Lees Ferry. There are no perennial surface water drainages in the East Parcel; however, some perched water-bearing zones feed some small seeps and springs in these North Rim canyons. There are no data available to define the groundwater flow regime in the R-aquifer beneath the East Parcel. However, the presence of a major source of recharge to the west on the Kaibab Plateau and the location of a major R-aquifer discharge area along the Fence Fault complex reach of Marble Canyon, including Vasey's Paradise, suggest that groundwater generally moves along preferential pathways from west to east or southeast beneath the East Parcel (see Figure 3.4-14). The flow pathway may be somewhat convoluted as a result of the north and northwest orientation of the faults and folds in the East Parcel area. Large quantities of groundwater discharge from the R-aquifer along the Fence Fault and at Vasey's Paradise (see Figure 3.4-12). Underflow in the R-aquifer may occur beneath the river channel in Marble Canyon, and unknown quantities of groundwater may discharge directly into the bottom of the Colorado River, where the aquifer crops out in the river channel downstream of North Canyon (Huntoon 1981). R-aquifer groundwater in the small area at the northernmost extent of the East Parcel may move northward into Utah, but like groundwater in the North Parcel, it is unlikely to discharge to any of the large springs along the Virgin River.

South Parcel

Most of the South Parcel lies in the R-aquifer groundwater sub-basin of Havasu Springs (see Figures 3.4-13 and 3.4-14). R-aquifer groundwater south and west of the groundwater divide flows downgradient to the south, southwest, and west, eventually discharging to the large Havasu Springs complex (see Figures 3.4-13 and 3.4-14).

R-aquifer groundwater north of the groundwater divide and the Grandview Monocline flows downgradient to the east and northeast, discharging to the Little Colorado River and the large Blue Springs complex (see Figures 3.4-13 and 3.4-14). Based on groundwater contours shown on Figure 3.4-14, there may be some R-aquifer groundwater north of the Grandview Monocline that flows northward to discharge at small springs and seeps along the south wall of Grand Canyon. Fault and fracture zones along the northern extent of the monocline likely provide pathways for R-aquifer groundwater to discharge at small springs and seeps along the south wall of Grand Canyon, such as Miner's and O'Neill springs. The Grandview Mine breccia pipe is located within the monocline between these two springs (Alter et al. 2009). It should be noted that the outcrop pattern of the Redwall Limestone shown on maps in this section of the EIS is offset in some areas with respect to the locations for R-aquifer springs shown on the maps because of map scale and map corrections that are not yet available from the USGS; some R-aquifer springs erroneously appear to be above the Redwall Limestone.

In the northern part of the South Parcel, which lies in the Havasu Creek surface water drainage basin, R-aquifer groundwater north of the groundwater divide, which is near and approximately parallel to the South Rim of Grand Canyon, flows north toward the Colorado River and springs and R-aquifer seeps along the south wall of Grand Canyon (see Figures 3.4-13 and 3.4-14). These springs include the Hermit Springs and Garden Spring complexes, each of which has an aggregate discharge of about 300 gpm. It should be noted that each of the groundwater drainage areas that support the Hermit Springs and Garden Springs complexes likely extend southwestward along the associated southwest-trending fault zones that intersect the Grand Canyon at these locations. These groundwater drainage areas may extend farther southwest than indicated by the R-aquifer groundwater divide estimated by Bills et al. (2007) and shown in Figure 3.4-14.

Discharge from R-Aquifer Springs

Groundwater in the R-aquifer south of the Colorado River discharges chiefly at the Blue and Havasu spring complexes. North of the Colorado River, the R-aquifer discharges chiefly at Tapeats Creek, Thunder River, Kanab Creek, Bright Angel Creek, Deer Creek, Shinumo Creek, the Fence Fault complex, and Vasey's Paradise. There is also significant, but undefined, groundwater discharge, as well as underflow, from the R-aquifer in Marble Canyon. Assuming steady-state conditions, the amount of recharge to and groundwater movement through the R-aquifer can be estimated by summing discharge from large springs that occur on the margins of the plateaus. Appendix D provides a summary of reported locations and discharge rates for springs and seeps.

Recharge from infiltration of precipitation in local drainage catchment basins along both rims of the Grand Canyon is very important to the occurrence and sustainability of local water-bearing zones that support the discharge at many small springs and seeps and at a few moderate-sized springs within the Grand Canyon or its tributary canyons. The drainage area necessary to support the small but environmentally important discharge from these springs and seeps is limited and can be contained within the near-rim areas of more weathered and fractured rock. As described previously, the small springs and seeps are considered to be poorly connected or in some cases not connected hydraulically to the regional circulation systems of the R-aquifer (Montgomery 1996, 1999). The results of isotope studies reported by Monroe et al. (2005) and Bills et al. (2007) suggest that a fraction of the water from several of the springs may have slowly percolated downward from land surface and/or flowed from more distant parts of the aquifer, and that the small, local drainage basins at the Canyon rim may not be the only source of water for these springs.

Rihs et al. (2004) studied several springs discharging from the R-aquifer along the South Rim of Grand Canyon. They concluded that there was a significant decreasing trend in discharge from some springs but not others. The cause of the decrease was not identified and could be the result of a complex set of circumstances, including decreasing precipitation trends and pumping from the aquifer at Tusayan since 1989. This decrease is not attributed to uranium mining operations because there have been no uranium mining or groundwater withdrawals from the R-aquifer for mining in the South Parcel or adjacent areas during the period of the Rihs et al. (2004) study, and only minor use of the Canyon Mine well since it was drilled.

Yield from Wells

Records indicate that only 13 wells are completed in the R-aquifer in the study area (see Table 3.4-1, Figure 3.4-9). Many more wells are completed in the perched aquifers and yield small quantities of water with varying reliability and chemical quality. Records for pumping rates at wells are given in Appendix C. It should be emphasized that the reported pumping capacity of a well is often limited to the size of the pump and the diameter of the well casing, rather than the capacity the aquifer.

Reported pump capacity for all wells in the study area ranges from 0.1 to 1,200 gpm. The highest pump capacities reported (600 to 1,200 gpm) are for several water wells located far to the northeast of the East Parcel in the vicinity of Lake Powell. Reported pump capacities for water wells completed in Mesozoic-age geological units in North and East parcels range from 0.5 to 600 gpm. Three water wells near Fredonia, Arizona have reported pump capacities of between 50 and 400 gpm and are likely completed in the Kaibab and/or Toroweap formations where these units represent a viable aquifer. Other water wells completed in perched aquifers in the three parcels and their immediate vicinity have recorded pump capacities of 15 gpm or less; pump capacities of these wells average about 4 gpm. Reported pumping rates for R-aquifer water wells range from 5 to 89 gpm; average rate is about 29 gpm (Table 3.4-1).

In most parts of the study area, long-term pumping of significant volumes of groundwater from R-aquifer wells within the drainage basins of R-aquifer springs would intercept groundwater that, in the absence of pumping, would have discharged at these springs. It should be emphasized that because of complex subsurface relationships, some springs would be affected more than others, and some would not be affected at all. If pumping were to continue for a sufficiently long period at a rate less than the total groundwater recharge rate for the system, a new condition of dynamic equilibrium would be established where the average rate of groundwater discharge at the springs would be equal to the average rate of recharge minus the average rate of groundwater pumping at the wells. Groundwater levels would slowly stabilize in the aquifer at a level that is less than the pre-pumping level. However, if the rate of long-term pumping exceeds the rate of recharge, groundwater would continue to be removed from storage, and groundwater levels and spring flow reductions would continue until groundwater levels eventually decline to the bottom of the pumps in the wells. In either case, the amount and duration of impact to springs would depend on site-specific conditions. In some cases, springs could dry up. If pumping stopped at any point, recharge would eventually replenish the aquifer over time and re-establish pre-pumping water levels and discharge rates at the affected springs.

3.4.7 Water Quality

Natural processes and human activities (including improperly abandoned mines and improperly disposed mine waste or waste rock) can cause concentrations of dissolved trace elements and radionuclides to be elevated in groundwater and surface water. Water chemistry data for wells, springs, seeps, and mine sumps within the study area have been obtained, compiled, and reported by numerous academic, government, and industry sources. The most relevant of these data have been reviewed and compiled for the EIS. Uranium and uranium decay products are the principal mine-related constituents of concern for water quality in the proposed withdrawal area. 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, except for arsenic, not all of these constituents are known to necessarily correlate with dissolved uranium in water because of a lack of data. Thus, only impacts to water resources related to uranium and arsenic are analyzed in Chapter 4.

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 sparse data exist for these radionuclides other than uranium in the study area, so uranium data must be used as a proxy for assessing potential levels of decay-chain products. Hinck et al. (2010) report that species in the region may be susceptible to adverse effects at uranium concentrations ranging from 0.57 to 46,000 micrograms per liter (μg/L). Water quality thresholds for wildlife are discussed in detail in Section 3.7.

Bills et al. (2010) conducted a recent, comprehensive survey of water chemistry data and compilation of historical uranium data for the study area. Historical water-chemistry data from selected data sources were compiled and reviewed by USGS for streams, wells, and both perched aquifer and R-aquifer springs. In addition, in 2009, new water-chemistry data were obtained by USGS and NPS at 24 sites to augment historical data for the three parcels. USGS reviewed more than 1,000 water samples obtained from more than 400 sites in the Grand Canyon and surrounding regions. The results of this USGS study form an important part of the database used for analysis of water quality for this chapter of the EIS; additional analyses were compiled and reviewed for the EIS.

Numerous mineralized breccia pipes are exposed in the walls of the Grand Canyon and adjoining canyons. Many others, located some distance from canyon walls, remain undisturbed (see Figure 3.4-5). Uranium and associated minerals may occur naturally in groundwater in northern Arizona and southern Utah. Bills et al. (2010) reported that concentrations of dissolved uranium were less than 5 μg/L for about 66% of all historic samples in their data set and were less than 20 μg/L for about 95% of all historic samples in their data set. Their historic data set consisted of 1,014 samples from 428 documented sites that have analyses for dissolved uranium, including 480 samples from 63 stream locations, 385 samples from 288 springs, 138 samples from 74 wells, and 11 samples from three mines.

The EPA has established National Primary Drinking Water Regulations that set mandatory water quality standards for drinking water contaminants. These are enforceable standards called maximum contaminant levels (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. In addition, EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for 15 contaminants. EPA does not enforce these secondary MCLs. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the secondary MCL.

Bills et al. (2010) reported that the results of chemical analyses indicated that, at about 16% of the sites, concentrations exceeded either the primary or secondary MCL for a few major ions and trace elements such as arsenic, iron, lead, manganese, sulfate, radium, and uranium. Arsenic and lead are commonly associated with uranium deposits. The average concentration of arsenic was found to exceed the primary MCL at 70 sites, and lead concentrations were determined to exceed the primary MCL at only three sites in the data collected and compiled by the USGS.

Water type varies throughout the study area. Water quality results reported by Bills et al. (2010) were generally categorized as shown in Table 3.4-3, based on the principal anions and cations.

Table 3.4-3. Summary of Water Types*

Aquifer or River	Location	Water Type
Perched Aquifer	North of Colorado River	$CaMg\text{-}SO_4$
Regional (R-aquifer)	North of Colorado River	$Ca\text{-}HCO_3$
Perched Aquifer	South of Colorado River	$CaMg\text{-}HCO_3$
Regional (R-aquifer)	South of Colorado River	$CaMg\text{-}HCO_3$
Regional (R-aquifer)	West part of Grand Canyon	$CaMg\text{-}SO_4$
Regional (R-aquifer)	Little Colorado River (at Blue Springs)	Na-Cl
Regional (R-aquifer)	Marble Canyon	$Ca\text{-}HCO_3$
Regional (R-aquifer)	Southwest of Kaibab Plateau	$Ca\text{-}HCO_3$
Regional (R-aquifer)	Kanab Plateau	$Ca\text{-}HCO_3$
Little Colorado River	Cameron	$Na\text{-}SO_4$

Notes: Ca = Calcium Mg = Magnesium
Cl = Chloride Na = Sodium
HCO_3 = Bicarbonate SO_4 = Sulfate
* From Bills et al. (2010).

A principal conclusion of the 2010 USGS report was that "observation of groundwater-chemistry relations between concentration and mining condition (no exploration or development activity, active mines on interim management, or reclaimed mine areas) were limited and inconclusive" (Bills et al. 2010:194).

The ambient water quality of perched groundwater near mines is generally of poor quality as a result of mineralization from the ore bodies. Groundwater that is contained within the breccia pipes (connate water) is also generally of very poor quality as a result of mineralization (personal communication, Roger Smith, formerly with Energy Nuclear Fuels, Inc. 2010).

Water sample data compiled for the EIS include results for TDS content, flow rate at springs, dissolved arsenic, dissolved uranium, and a small number of dissolved lead analyses. Analytical results for uranium, arsenic, and lead were generally composed of filtered samples that were analyzed for dissolved constituents. Sources for TDS, flow rate, arsenic, and uranium data that were compiled include USGS (2010d); Bills et al. (2010); Grand Canyon National Park (2010a); ADWR (2009b); Grand Canyon Wildlands Council, Inc. (2002); Fitzgerald (1996); Montgomery (1993a, 1993b); and Office of Nuclear Waste Isolation (1985). In addition, historical data on selected sites, including mine wells and sumps, reported in Bills et al. (2010) for arsenic and uranium were included in the compilation. Sample results for dissolved lead were obtained from USGS (2010d). Additional information from the EPA's STORET database, primarily composed of site information, was used to supplement data compiled from the above sources (EPA 2010l).

Locations and estimates of discharge rate for all sample locations for springs and seeps, as well as for selected sample locations for streams compiled for the EIS, are summarized in Appendix D. Information compiled for locations of all water quality sampling and flow rate estimates is summarized in Appendix

E. Sample statistics are summarized in Appendix F for the study area and proposed withdrawal area; statistics include the total number of sites in each aquifer or sample source category, the number of sites constituting each summarized constituent, and the minimum, maximum, and average parameter values for each constituent (averages consist of the numeric mean of all parameter averages calculated for each site). Results for water quality analyses were compiled from the sources noted above for a total of 687 sampling locations in the water resources study area and for 6-mile buffers around each of the parcels. Of the total number of sites for the regional study area with sample results, 265 were classified as discharging from aquifers composed of Mesozoic rock, 154 sites were classified as discharging from the perched aquifer, 148 sites were classified as discharging from the R-aquifer, 32 were classified as discharging from a source below the R-aquifer, five sites were associated with mine seepage, and the remaining 83 sites were from a zone that is not classified under a specific aquifer; samples were obtained from wells, springs, and streams.

Results reported for TDS are from laboratory analyses, where available. Where laboratory results were not available, TDS was estimated by multiplying measured electrical conductivity of the water sample by a conversion factor of 0.65 (Hem 1985). Table 3.4-4 summarizes relevant information provided in Appendix F regarding parameter values reported for the combined data set, including all sample sources (wells, springs, and streams) classified as being associated with the perched and regional aquifer systems.

For all samples in the water resources study area, samples for the perched aquifer system showed that concentrations of the principal constituents ranged from 17 to 7,500 milligrams per liter (mg/L) for TDS, 0.4 to 241.6 µg/L for arsenic, and 0.02 to 44 µg/L for uranium. For all samples in the R-aquifer system, concentrations of the principal constituents ranged from 70 to 25,000 mg/L for TDS, 0.11 to 220 µg/L for arsenic, and 0.15 to 400 µg/L for uranium. Higher concentrations of TDS in groundwater and springs generally indicate that the rock unit in which the groundwater resides has more soluble minerals and/or that the groundwater has resided in the aquifer for longer periods.

Estimated background concentrations of parameters stored in the database for the entire water resources study area are provided by calculating summary statistics for all sample sites, regardless of aquifer or source (Table 3.4-5). However, in order to obtain statistics representative of natural conditions, samples that are known to be affected by mining operations (such as samples of mine seepage obtained from mine sumps and shafts) and samples obtained from water that may be impacted by mining (such as samples obtained from Horn Creek [see Appendix G]) were not included in the calculations.

North Parcel

Results for water quality analyses were compiled for a total of 118 sampling locations in the North Parcel and for a 6-mile buffer region outside the area. Of these locations, 64 were classified as discharging from aquifers composed of Mesozoic rock, 34 sites were classified as discharging from the perched aquifer, nine sites were classified as discharging from the R-aquifer, no sites were classified as being below the R-aquifer, seven sites were classified as stream sample sites, and the remaining four sites were classified as mine seepage.

For the North Parcel, discharge rate and TDS results are shown in Figure 3.4-16a, arsenic results are shown in Figure 3.4-16b, and uranium results are shown in Figure 3.4-16c. For the perched aquifer system, concentrations of the principal constituents ranged from 293 to 3,380 mg/L for TDS, 0.4 to 28 µg/L for arsenic, and 0.5 to 44 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 455 to 3,970 mg/L for TDS, 0.5 to 34 µg/L for arsenic, and 0.15 to 24 µg/L for uranium.

Table 3.4-4. Summary of Statistics for Water Quality Samples*

Sample Source	Total Number of Sites	TDS (mg/L) Min	TDS (mg/L) Max	TDS (mg/L) Avg	Number of Sites with TDS Results	Arsenic (µg/L) Min	Arsenic (µg/L) Max	Arsenic (µg/L) Avg	Number of Sites with Arsenic results	Uranium (µg/L) Min	Uranium (µg/L) Max	Uranium (µg/L) Avg	Number of Sites with Uranium Results	Flow Rate (gpm) Min	Flow Rate (gpm) Max†	Flow Rate (gpm) Avg†	Number of Sites with Flow Rate Results
All Data within Water Resources Study Area																	
Mesozoic	265	79	12,600	1,097	153	0.41	105.6	15.6	21	0.00	249.6	11.6	70	0	673	13	114
Perched	154	19	7,750	908	98	0.4	241.6	22.0	32	0.02	44	5.3	59	0	673	10	89
R-aquifer	148	70	25,000	1,066	110	0.11	220	22.5	61	0.15	400	10.9	92	0	48,000	1,460	106
Below Regional	32	109	8,320	1,212	24	6	350	86.2	12	1.5	29	10.8	21	0	5,270	209	18
Mine seepage	5	1,920	1,920	1,920	1	5	1,090	152.6	5	20.7	36,600	7,693.6	5	–	–	–	0
N/A (Stream)	66	87	3,560	656	47	0.5	310	40.9	13	0.14	29.21	5.8	29	0	2,200,000	11,100	45
N/D (Well)	17	117	3,150	1,401	8	0.5	248.1	116.4	7	1.21	13.47	3.7	9	–	–	–	0
North Parcel																	
Mesozoic	64	79	6,810	1,253	37	0.5	4	2.4	8	0.11	249.6	24.0	24	0	170	25	19
Perched	34	293	3,380	1,486	23	0.4	28	4.6	13	0.50	44	10.3	19	0	90	9	24
R-aquifer	9	455	3,970	1,418	8	0.5	34	6.9	8	0.15	24	4.7	8	1	274	65	8
Mine seepage	4	1,920	1,920	1,920	1	5	1,090	168.2	4	20.7	36,600	9,462.1	4	–	–	–	0
N/A (Stream)	7	820	3,560	2,007	6	0.5	10	1.5	6	0.5	18.9	6.5	7	189	31,900	8,530	5
East Parcel																	
Mesozoic	56	109	4,200	607	30	–	–	–	0	0.6	5.05	1.9	5	0	18	2	44
Perched	3	897	897	897	1	1.44	5	3.2	2	0.77	4.64	2.1	3	0	0	0	1
R-aquifer	14	163	1,600	777	14	1.3	21	9.6	13	0.5	2.5	1.6	13	1	4,480	391	14
N/D (Well)	1	2,353	2,353	2,353	1	–	–	–	0	–	–	–	0	–	–	–	0
South Parcel																	
Perched	8	145	1,120	525	6	0.5	0.5	0.5	1	0.6	7.2	3.4	3	1	1	1	3
R-aquifer	30	70	1,829	372	27	0.26	20	8.8	8	1.06	400	29.3	23	0	359	45	22
Below regional	11	275	1,235	581	10	54	54	54	1	1.75	18	7.3	9	0	54	6	8
Mine seepage	1	–	–	–	0	90	90	90	1	620	620	620	1	–	–	–	0
N/A (Stream)	16	166	853	424	9	–	–	–	0	1.4	29.21	7.6	9	0	1,020	128	9
N/D (Well)	1	–	–	–	0	237.3	237.3	237.3	1	3.12	3.12	3.1	1	–	–	–	0

Notes:

Avg = average value.

Min = minimum value.

Max = maximum value.

N/A = not applicable.

N/D = not determined.

– = Data not available.

* Samples reported for the proposed withdrawal area include all results within 6 miles of the parcel boundaries.

† Three significant figures assumed for all flow rate results.

Table 3.4-5. Summary Statistics for All Non-mine-Related Samples

Parameter	Number of Sites	Minimum	Maximum	Average
TDS (mg/L)	438	19	25,000	1,015
Arsenic (µg/L)	146	0.11	350	32.8
Uranium (µg/L)	275	0.001	249.6	7.16
Lead (µg/L)	70	0.03	210	8.7

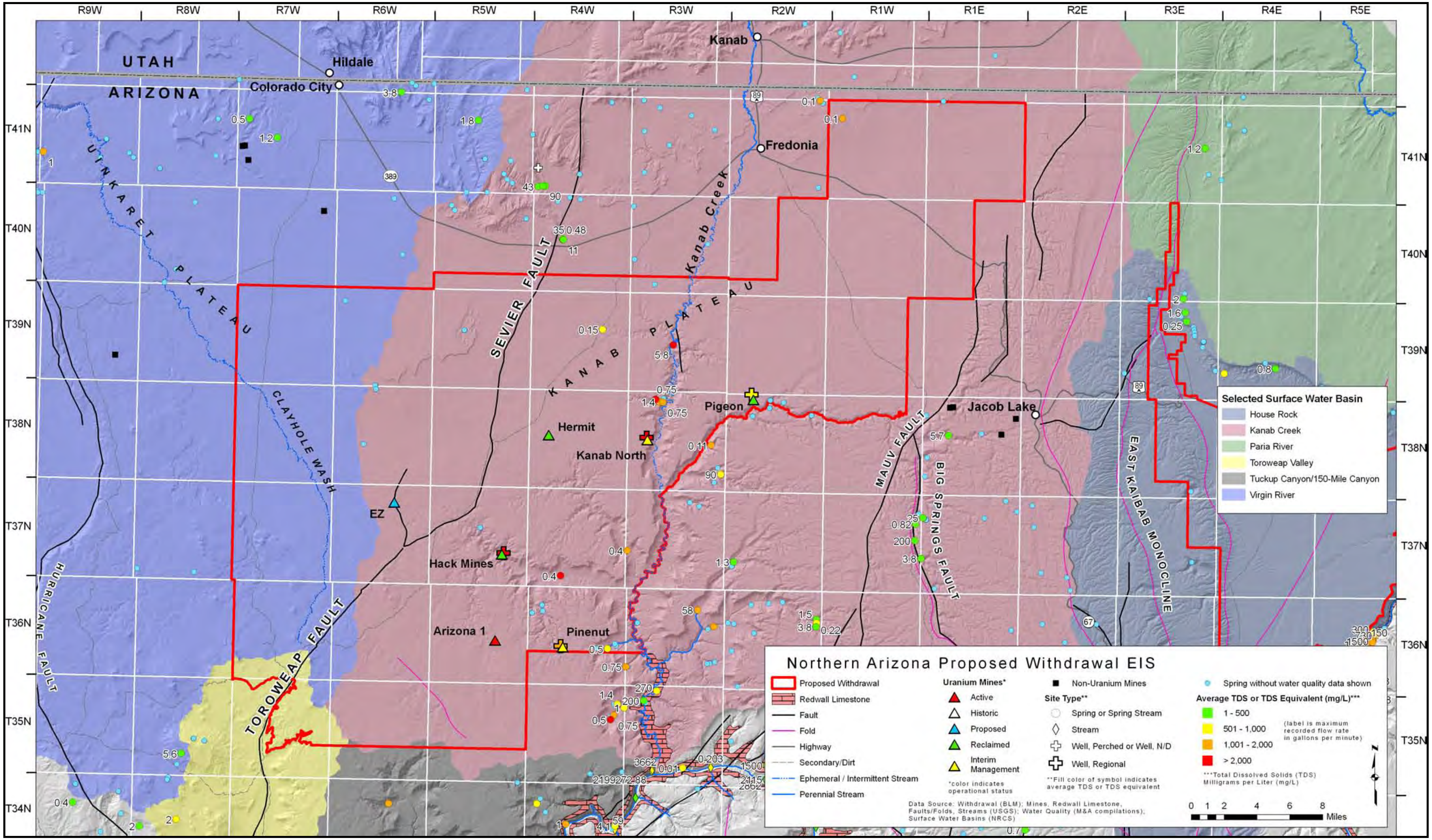


Figure 3.4-16a. Total dissolved solids concentration and discharge of springs, streams, and wells for the North Parcel and vicinity.

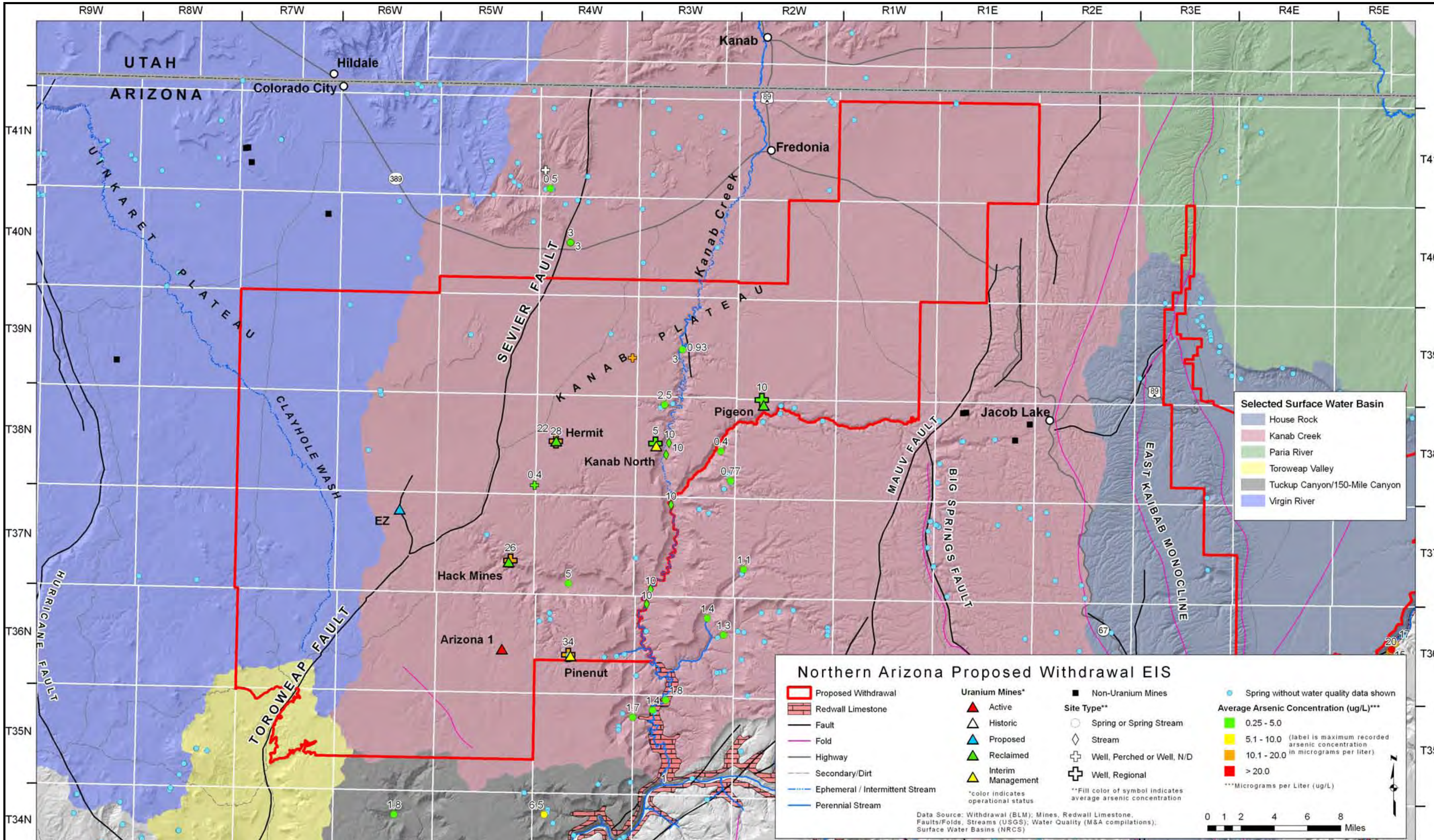


Figure 3.4-16b. Arsenic concentration of springs, streams, and wells for the North Parcel and vicinity.

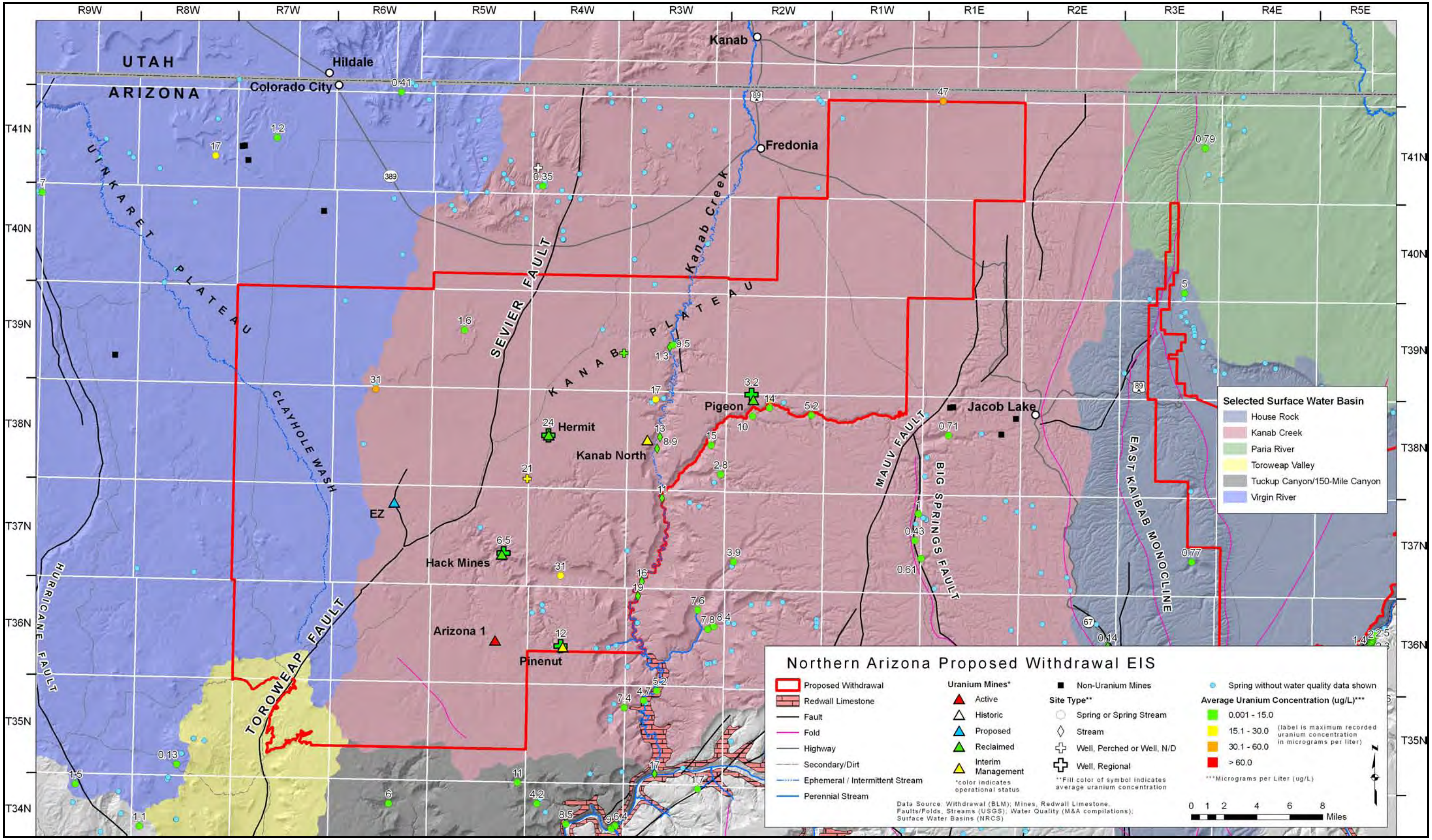


Figure 3.4-16c. Uranium concentration of springs, streams, and wells for the North Parcel and vicinity.

East Parcel

Results for water quality analyses were compiled for a total of 74 sampling locations in the East Parcel and for a 6-mile buffer region outside the area. Of these locations, 56 were classified as discharging from aquifers composed of Mesozoic rock, three sites were classified as discharging from the perched aquifer, 14 sites were classified as discharging from the R-aquifer, no sites were classified as being below the R-aquifer, and one site was from zones not classified as being associated with a specific aquifer.

For the East Parcel, discharge rate and TDS results are shown in Figure 3.4-17a, arsenic results are shown in Figure 3.4-17b, and uranium results are shown in Figure 3.4-17c. For the perched aquifer system, concentrations of the principal constituents were 897 mg/L for TDS, ranged from 1.44 to 5 µg/L for arsenic, and ranged from 0.77 to 4.64 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 163 to 1,600 mg/L for TDS, from 1.3 to 21 µg/L for arsenic, and from 0.5 to 2.5 µg/L for uranium.

South Parcel

Results for water quality analyses were compiled for a total of 67 sampling locations in the South Parcel and for a 6-mile buffer region outside the area. Of these locations, none were classified as discharging from aquifers composed of Mesozoic rock, eight sites were classified as discharging from the perched aquifer, 30 sites were classified as discharging from the R-aquifer, 11 sites were classified as being below the R-aquifer, 16 sites were classified as stream sample sites, one site was classified as mine seepage, and the remaining site was from zones not classified as being associated with a specific aquifer.

For the South Parcel, discharge rate and TDS results are shown in Figure 3.4-18a, arsenic results are shown in Figure 3.4-18b, and uranium results are shown in Figure 3.4-18c. For the perched aquifer system, concentrations of the principal constituents ranged from 145 to 1,120 mg/L for TDS, 0.5 µg/L for arsenic (only one sample available), and from 0.6 to 7.2 µg/L for uranium. For the R-aquifer system, concentrations of the principal constituents ranged from 70 to 1,829 mg/L for TDS, from 0.26 to 20 µg/L for arsenic, and from 1.06 to 400 µg/L for uranium.

Legacy Impacts to Water from Uranium Mining

Dissolved uranium concentrations exceeding the regional average of about 7 µg/L detected in groundwater or springs near existing and/or former mines do not necessarily indicate that the water is impacted from exploration and development activities. In hydrologic systems poorly connected to the regional groundwater circulation system in the R-aquifer, it is unlikely that discharge to springs is substantially mixed with groundwater from distant sources. The isotopic composition of uranium in water from such systems may be used to evaluate whether high uranium concentrations result from the natural dissolution of uranium-bearing rocks or from anthropogenic activities at uranium mines (Appendix G). Samples exhibiting high ^{234}U activity relative to ^{238}U activity are indicative of ambient groundwater because of the preferential mobility of ^{234}U in natural waters. Conversely, samples having ^{234}U activity approximately equal to ^{238}U activity represent conditions of aggressive water-to-rock interaction symptomatic of water impacted by mine leachate. Isotopic and dissolved uranium data compiled for the study area and Colorado River indicate that only samples collected from Horn Creek springs, which originate from the R-aquifer about ½ mile or less north of the Orphan Lode Mine, have high concentrations of dissolved uranium (>30 µg/L) and an $^{234}U/^{238}U$ activity ratio near one. Apparently, surface water and/or perched groundwater seepage into the abandoned, unreclaimed mine workings of the Orphan Lode Mine have interacted with mine waste and/or disturbed ore deposits to generate elevated concentrations of uranium in water that has moved vertically downward from the mine openings into the R-aquifer. Additional monitoring data are necessary to rule out the possibility that groundwater in locations other than Horn Creek springs may also be impacted from uranium mining because potential mixing of impacted water with native groundwater may mask the isotopic signature.

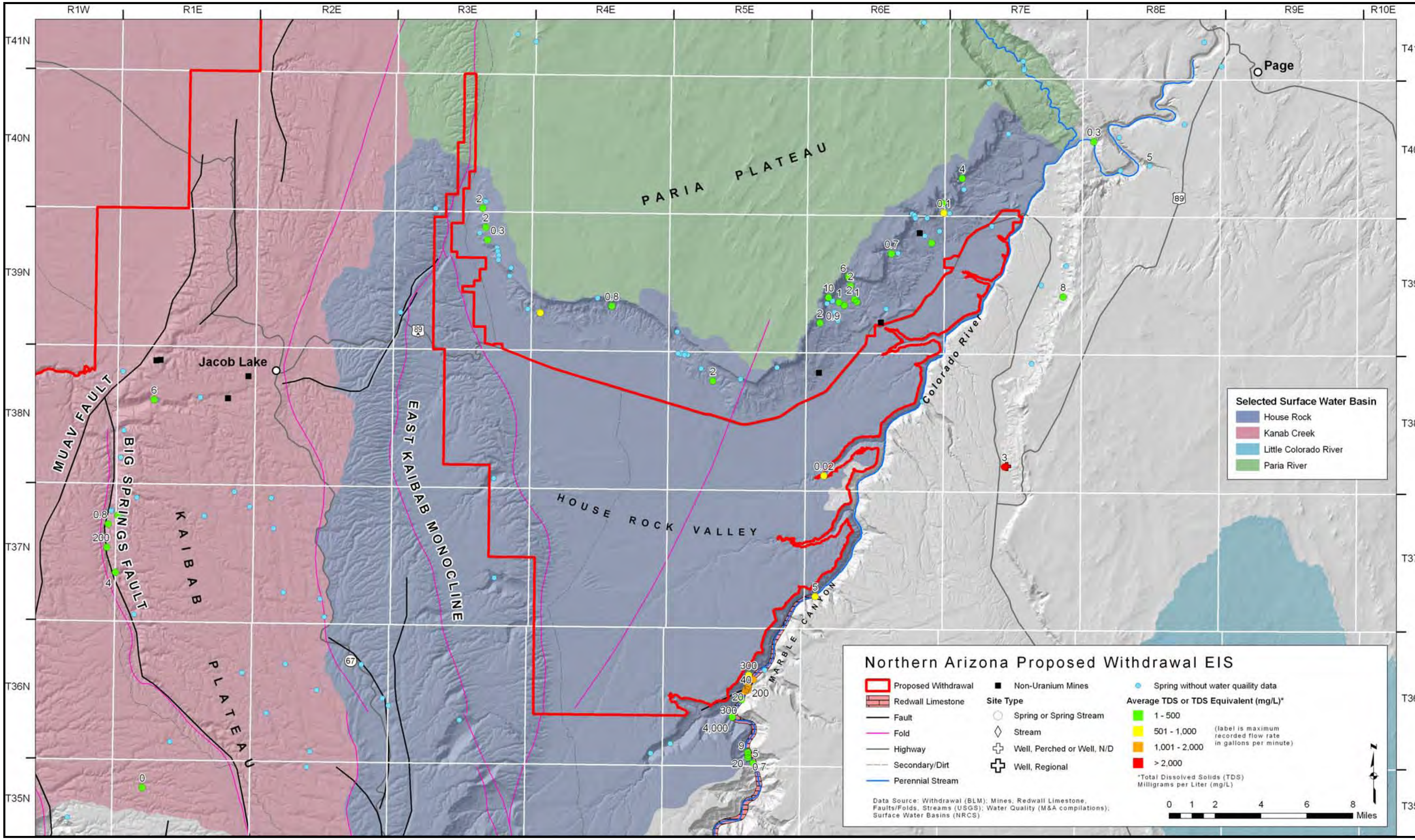


Figure 3.4-17a. Total dissolved solids concentration and discharge of springs, streams, and wells for the East Parcel and vicinity.

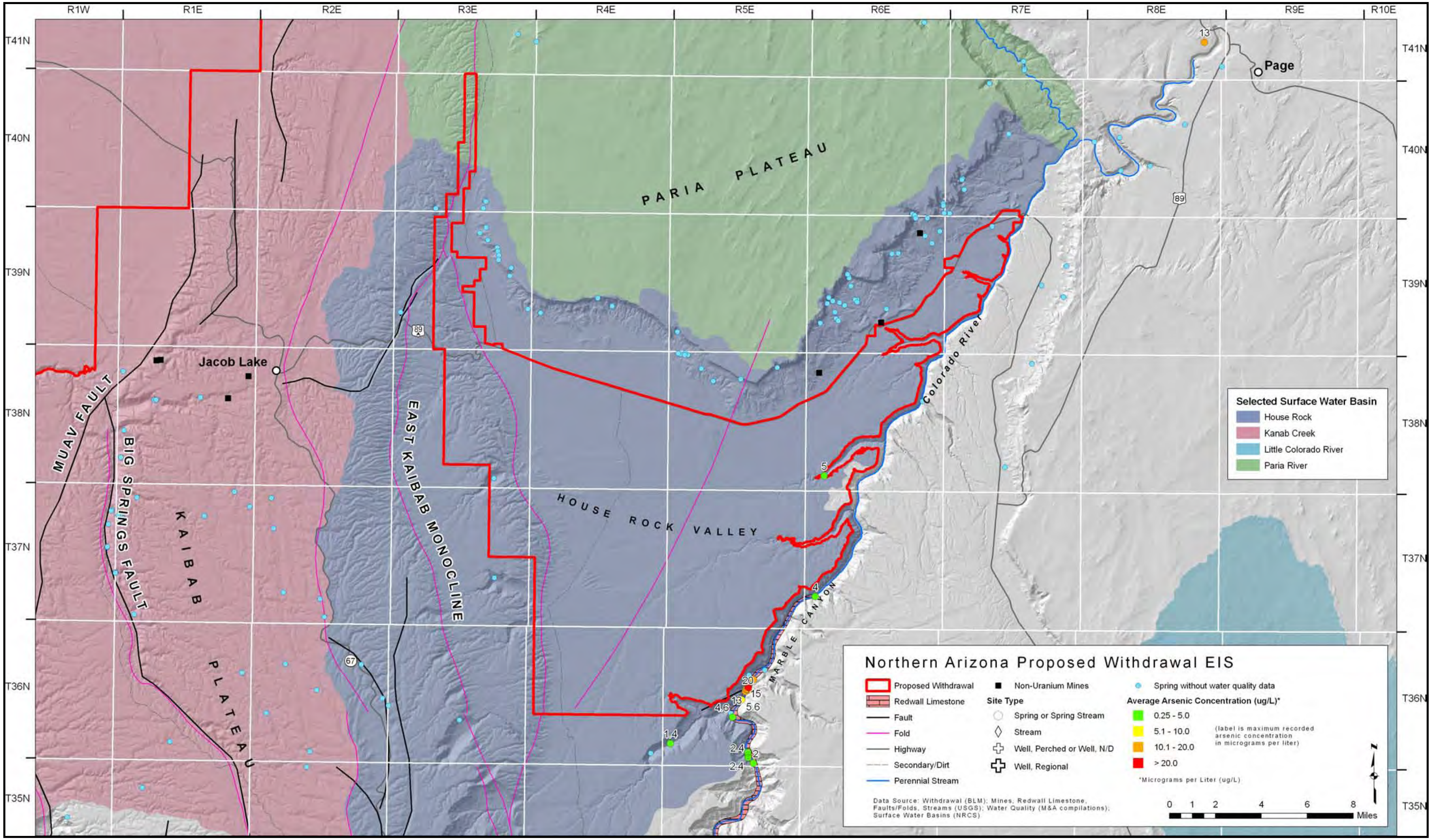


Figure 3.4-17b. Arsenic concentration of springs, streams, and wells for the East Parcel and vicinity.

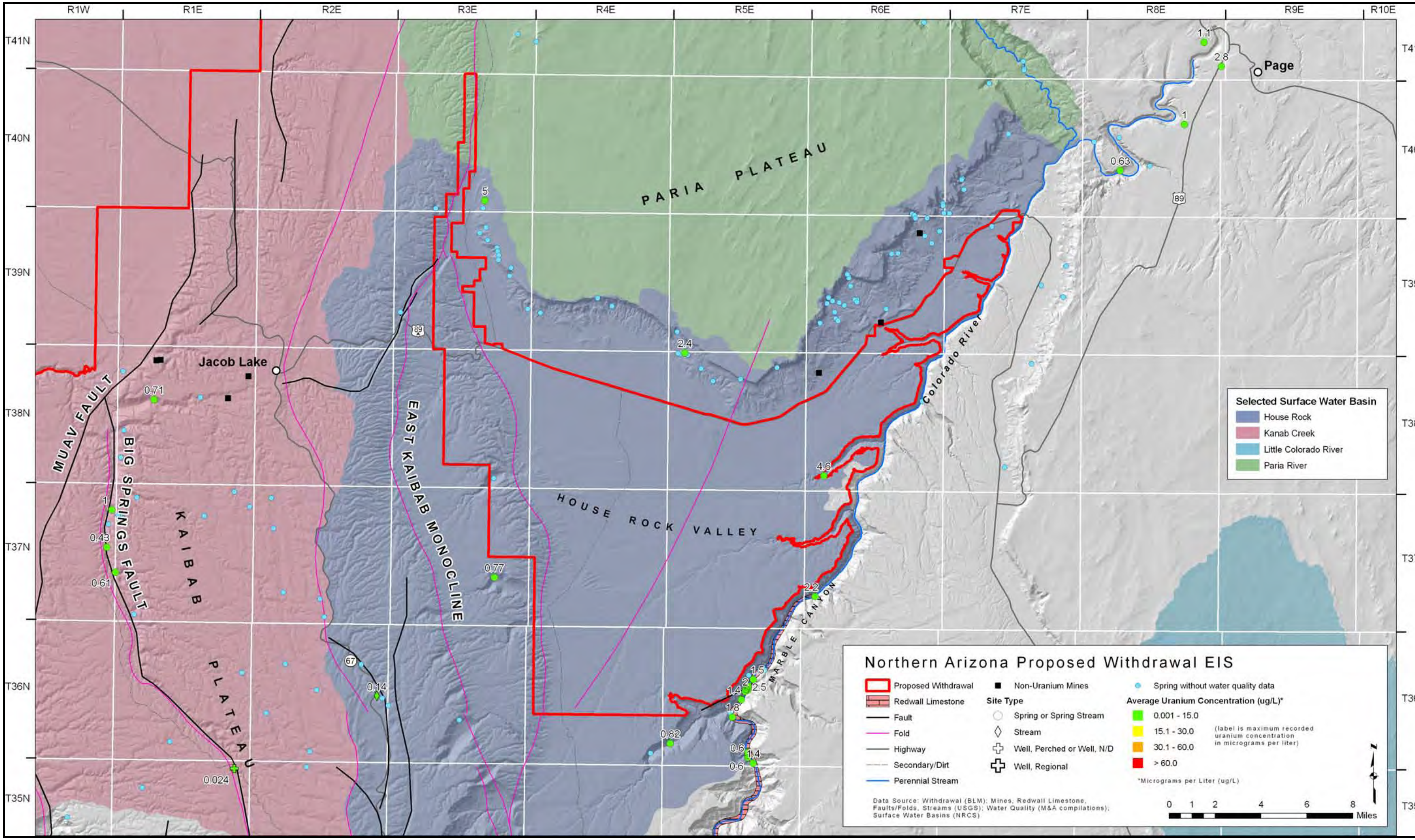


Figure 3.4-17c. Uranium concentration of springs, streams, and wells for the East Parcel and vicinity.

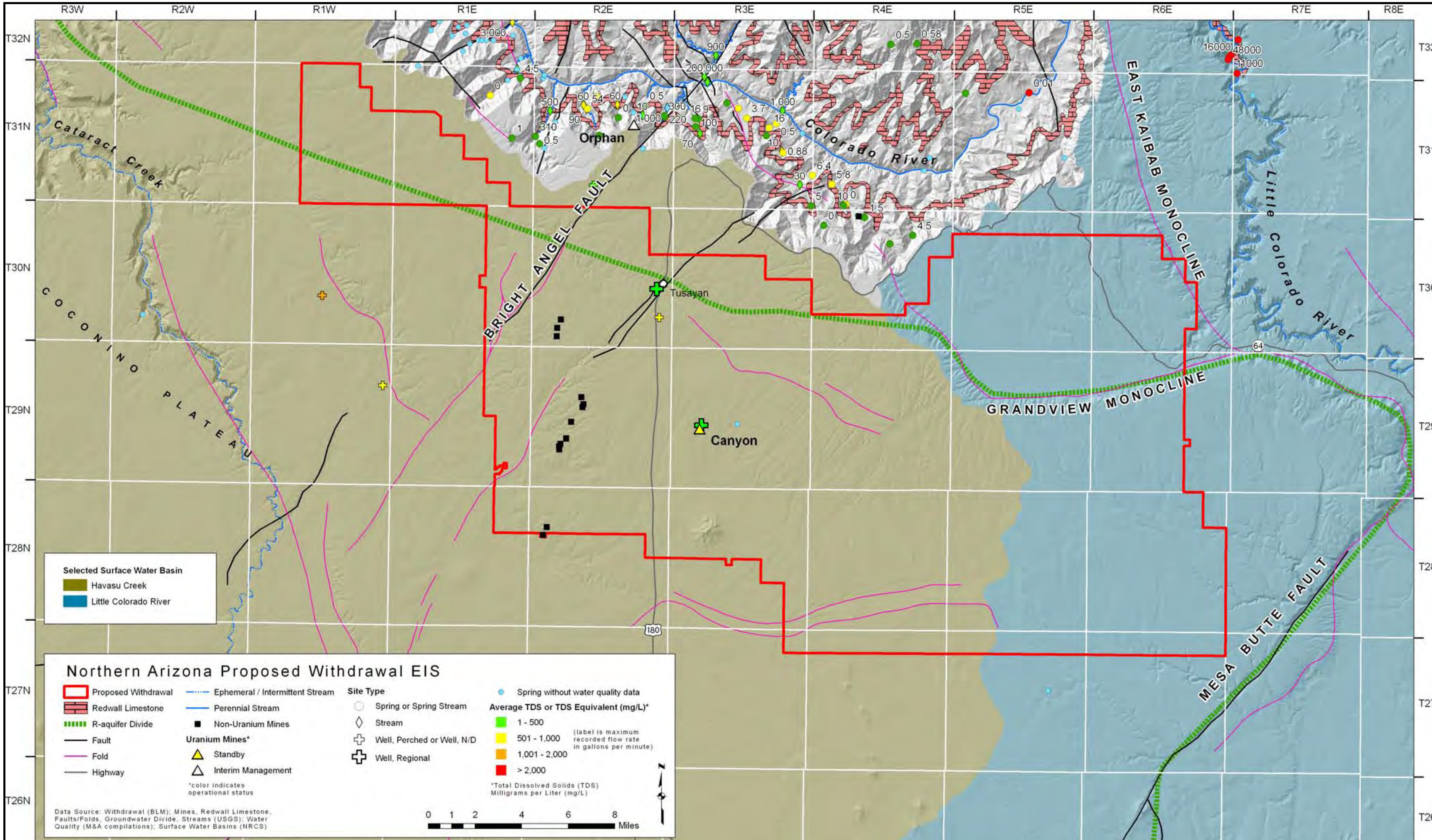


Figure 3.4-18a. Total dissolved solids concentration and discharge of springs, streams, and wells for the South Parcel and vicinity.

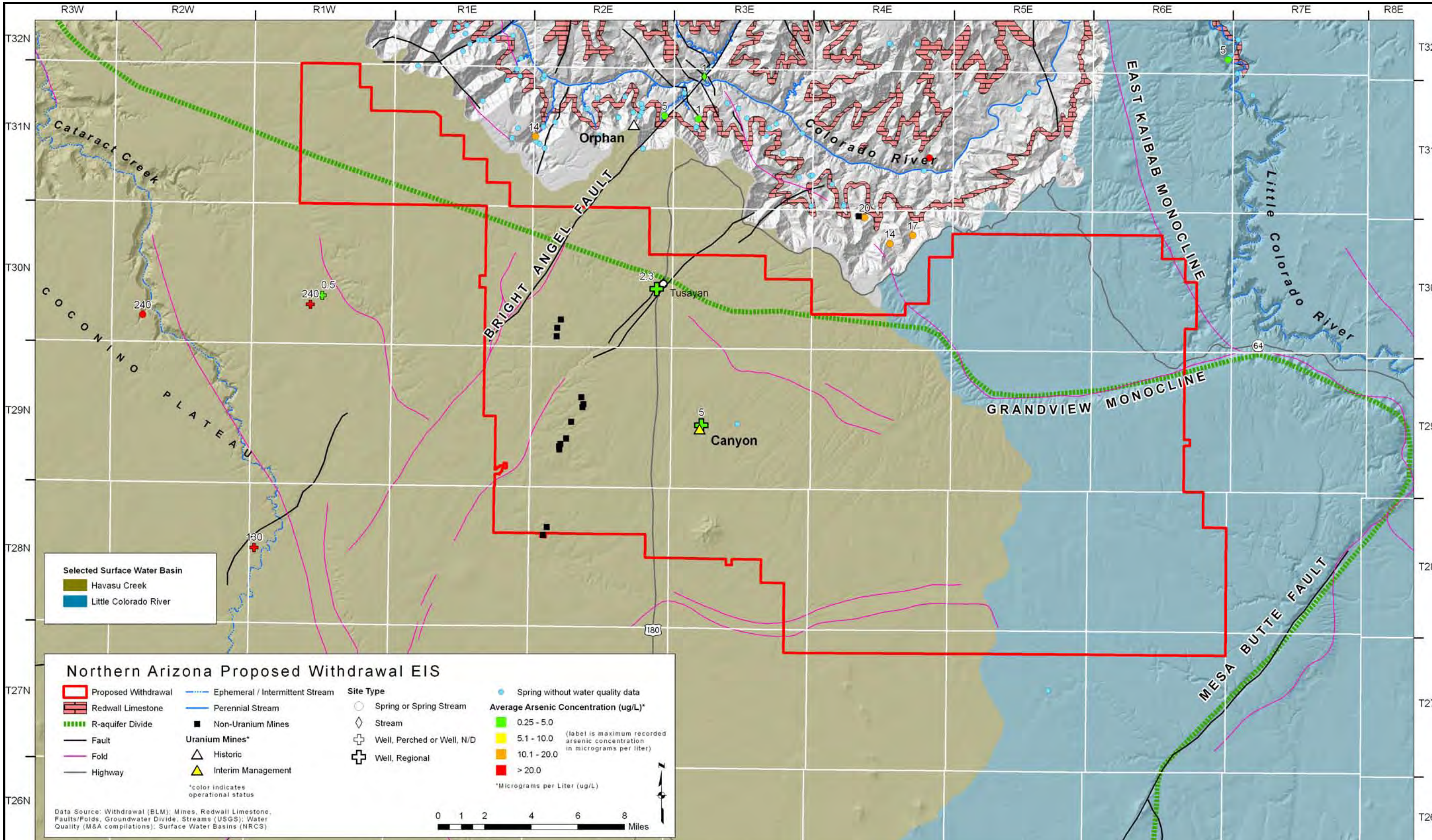


Figure 3.4-18b. Arsenic concentration of springs, streams, and wells for the South Parcel and vicinity.

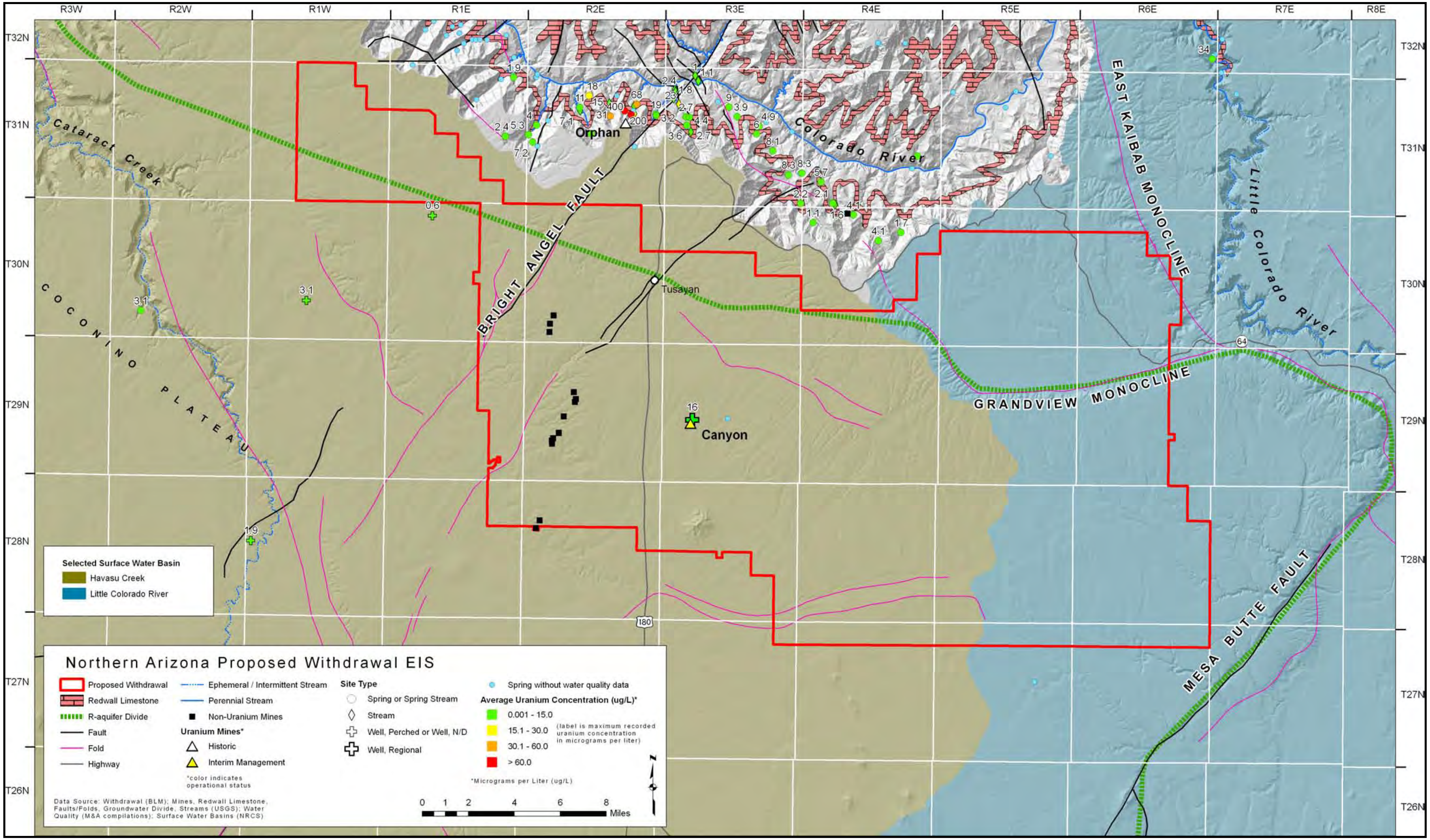


Figure 3.4-18c. Uranium concentration of springs, streams, and wells for the South Parcel and vicinity.

3.4.8 Resource Condition Indicators for Water Resources

Based on the information presented in Chapter 3, the resource condition indicators for water resources to be carried forward for analysis in Chapter 4 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[1] 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.

3.5 SOIL RESOURCES

This section provides a description of existing soil resources in the vicinity of the proposed withdrawal area and the current value of resource condition indicators that will be the basis for evaluating impacts in Chapter 4. The description is based on review and compilation of available data for selected soil properties obtained from the National Resources Conservation Service (NRCS), Forest Service, and BLM, as well as review of information from numerous previous investigations of the Northern Arizona region, including those by the USGS, mining companies, and other consultants.

3.5.1 Soil Resource Condition Indicators

Soil information obtained from NRCS soil surveys for the North and East parcels and from TES results for the South Parcel was reviewed to determine the conditions likely to be affected as a result of the construction, operation, and maintenance of anticipated future access roads, utility corridors, mine facilities, and exploration drill sites in the proposed withdrawal area, as outlined in the RFD scenario. These conditions include the following:

- **Soil Disturbance.** Soil physical properties would be expected to be affected from the surface disturbance that is required for the development of mine facilities, drill sites, access roads, and power lines. The indicator values are the anticipated acreage (area) of disturbed soils. Existing soil disturbance associated with previous and current mining is about 713 acres, of which roughly 603 acres have been reclaimed.

[1] 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.

- **Soil Erosion.** Rates of soil loss would be expected to increase as a result of vegetation removal, soil compaction, and changes in drainage patterns related to anticipated surface disturbance. The indicators are qualitative evaluations of potential increased erosion rates, and the extent of off-site effects, relative to undisturbed conditions. These impacts are assessed relative to erosion hazard ratings, which identify areas of erosion-sensitive soils; such areas are typified by steep topography and/or thin soils.
- **Soil Contamination.** Soil chemical quality would be expected to be altered by distribution of mine-related constituents in soil 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 values are expected levels of mine-related contaminants in soil compared to background levels and ADEQ Soil Remediation Levels (SRLs). Investigation of legacy mining impacts on the North Parcel determined that the two most abundant elements associated with uranium mining detected in impacted soils are uranium and arsenic (Otton et al. 2010). This study indicated average concentrations of uranium and arsenic in soils on-site (reclaimed) and off-site ranged from below regional ambient levels to as much as one order of magnitude above ambient levels. Soils in the area surrounding reclaimed mines and those in operation for a short time were generally less impacted than unreclaimed mines or mines in operation for longer periods. Although concentrations of the constituents of concern exceeded ambient conditions at some locations, concentrations were generally below the SRL for uranium. Concentrations were generally above the SRL for arsenic but below the maximum reported concentration for an unmined, mineralized breccia pipe in the study area.

3.5.2 General Description of Study Area

Soil types within the study area vary widely, reflecting differences in the environmental and geomorphic conditions under which soils were formed and differences in the parent materials. The environmental and geomorphic conditions are controlled primarily by the topography of the region, which ranges from nearly level valley bottoms and gently sloping plateaus to vertical cliffs; elevations range from less than 2,000 feet amsl in the Grand Canyon to more than 8,000 feet amsl on the Kaibab Plateau. Although the proposed withdrawal area is characterized primarily by plateaus, several canyons associated with Kanab Creek are incised into the Kanab Plateau in the North Parcel, and the Marble Canyon section of the Grand Canyon, including several tributary canyons, is located directly adjacent to the East Parcel. Soil characteristics range from shallow, weakly developed, rocky soils on plateaus, cliffs, and ridges to deeper, more productive soils on alluvial fans and in valley bottoms. In general, soils in the proposed withdrawal area are fine textured and contain a wide range of rock fragments, both internally and at the surface. The dominant parent materials that occur in the proposed withdrawal area are sedimentary rocks, including sandstone, carbonate (chiefly limestone and dolomite), mudstone, shale, and gypsum. Igneous rocks, including basalt, basalt cinders, and granite, are also prevalent (Hendricks 1985).

The dominant soil orders that occur in the proposed withdrawal area are Alfisols, Aridisols, Entisols, and Mollisols; these soil orders are described by Hendricks (1985) and via personal communication (Christopher MacDonald, Forest Service 2010a), as follows:

- Alfisols and Aridisols are the more developed soils of arid and semi-arid environments, with Aridisols occurring at lower elevations and in drier climates. Alfisols generally form under forest vegetation and have subsoils composed primarily of clays. Aridisols are typically light colored and very low in organic matter content.
- Entisols occur in young landscapes and develop from parent materials resistant to weathering. These soils are commonly shallow and overlie rock on steep slopes.

- Mollisols are typically dark-colored soils with high organic matter content near the surface and occur at higher elevations under subhumid to semiarid climates in landscapes dominated by grassland vegetation.

Soils identified in the study area have a mesic soil temperature regime (mean annual soil temperature of about 46–59°F) and an aridic (6–10 inches annual precipitation) to semiaridic (10–15 inches annual precipitation) soil moisture regime. Soil mineralogy is generally carbonatic, mixed, or smectitic (NRCS 2006b). Some areas also exhibit a carbonatic gypsic mineralogy (personal communication, Robert Smith, BLM 2010b).

3.5.3 Soil Extents and Characteristics

Available soil surveys were obtained from the NRCS State Soil Geographic (STATSGO) and Soil Survey Geographic (SSURGO) databases,[2] and Terrestrial Ecosystem Survey (TES) information was obtained from the Forest Service, Kaibab National Forest (Brewer et al. 1991).[3] Soil surveys and terrestrial ecosystem surveys are conducted in accordance with the National Cooperative Soil Survey, which is a nationwide partnership of federal, regional, state, and local agencies, along with private entities and institutions. This partnership works to cooperatively investigate, inventory, document, classify, interpret, disseminate, and publish information about soils of the United States and its trust territories and commonwealths (NRCS 2007).

The NRCS has completed detailed soil surveys that encompass the North and East parcels. The Kaibab National Forest has completed a detailed TES that encompasses the South Parcel. Detailed soil data were obtained from the following surveys:

- AZ625 – Mohave County Area, AZ, Northeastern Part and Part of Coconino County (NRCS 2008). Soil survey coverage includes the western portion of the North Parcel.
- AZ629 – Coconino County Area, AZ, North Kaibab Part (NRCS 2009). Soil survey coverage includes the eastern portion of the North Parcel and the East Parcel.
- Kaibab National Forest TES (Brewer et al. 1991). Coverage of the TES includes all of the South Parcel, except for a few very small areas to which the survey may be reasonably extrapolated.

Generalized digital soil survey data were also obtained from the NRCS for generation of regional soils maps for the North and East parcels (NRCS 2006a). Generalized digital soil map data for the South Parcel were obtained from the Forest Service's Southwestern Region General Terrestrial Ecosystem Survey (GTES) data set (Forest Service 1998).

Soil mapping of the Northern Arizona region indicates that soil types are distributed in a repetitive pattern consistent with the topography, parent rock, and/or climatic setting across the proposed withdrawal area. Figure 3.5-1 presents the distribution of soils mapped at a scale of 1:250,000 in each area, grouped by soil association, or by soil group names for the TES, to represent the dominant occurring soil types. Figure 3.5-1 for the North and East parcels was developed using the general soils map for the United States (NRCS 2006a), modified using the detailed soil surveys (NRCS 2008, 2009). The GTES data were used to generate a soils map for the South Parcel (Forest Service 1998). Soil associations consist of several major soils and some minor soils but are named for major soils. The dominant soil associations or group names that occur in each parcel are summarized in Table 3.5-1 and described below. Detailed soil maps at a scale of 1:24,000 may be obtained for the parcels from the soil surveys and TES referenced above.

[2] Available at: <http://websoilsurvey.nrcs.usda.gov/app/>.

[3] Available at: <http://www.fs.fed.us/>.

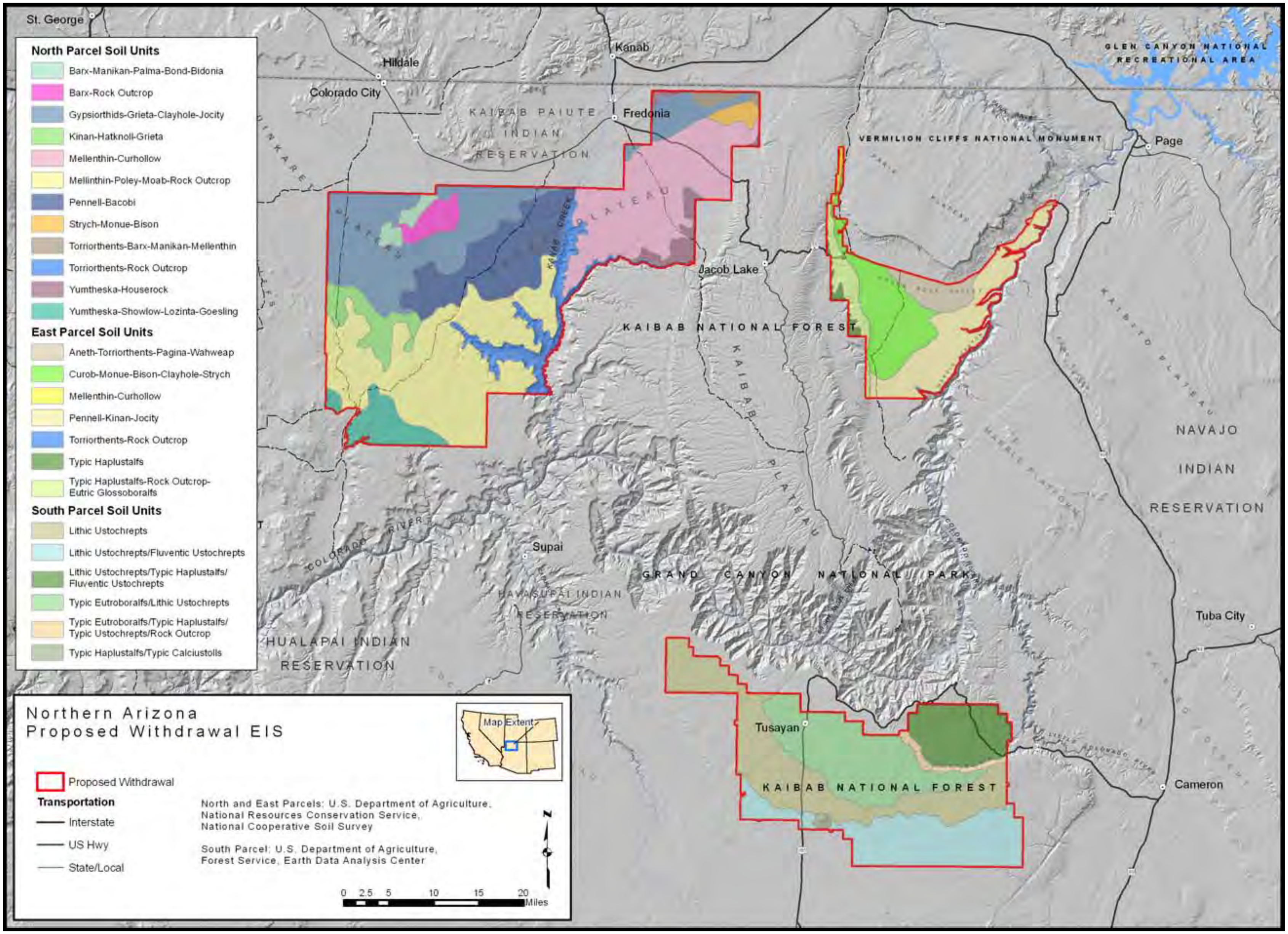


Figure 3.5-1. General soil survey.

Table 3.5-1. Area and Proportionate Extent of Soils

Parcel	Soil Association or Group Name	Approximate Area (acres)	Extent (%)
North	Mellinthin-Poley-Moab-Rock Outcrop	162,391	26.9
	Gypsiorthids-Grieta-Clayhole-Jocity	123,105	20.4
	Mellenthin-Curhollow	114,807	19.0
	Pennell-Bacobi	74,527	12.3
	Torriorthents-Rock Outcrop	35,562	5.9
	Yumtheska-Showlow-Lozinta-Goesling	25,835	4.3
	Kinan-Hatknoll-Grieta	22,374	3.7
	Yumtheska-Houserock	13,497	2.2
	Barx-Rock Outcrop	12,427	2.1
	Barx-Manikan-Palma-Bond-Bidonia	8,041	1.3
	Strych-Monue-Bison	6,564	1.1
	Torriorthents-Barx-Manikan-Mellenthin	5,171	0.9
	Subtotal	*604,301*	*100*
East	Pennell-Kinan-Jocity	56,261	38.8
	Curob-Monue-Bison-Clayhole-Strych	49,367	34.0
	Aneth-Torriorthents-Pagina-Wahweap	16,280	11.2
	Typic Haplustalfs-Rock Outcrop-Eutric Glossoboralfs	15,158	10.5
	Typic Haplustalfs	3,211	2.2
	Torriorthents-Rock Outcrop	3,161	2.2
	Mellenthin-Curhollow	1,510	1.0
	Other soils with minor representation	64	<1
	Subtotal	*145,011*	*100*
South	Lithic Ustochrepts	107,026	32.9
	Typic Eutroboralfs-Lithic Ustochrepts	85,772	26.3
	Lithic Ustochrepts-Fluventic Ustochrepts	81,480	25.0
	Lithic Ustochrepts-Typic Haplustalfs-Fluventic Ustochrepts	43,298	13.3
	Typic Eutroboralfs-Typic Haplustalfs-Typic Ustochrepts-Rock Outcrop	6,134	1.9
	Typic Haplustalfs-Typic Calciustolls	1,930	0.6
	Subtotal	*325,641*	*100*

North Parcel

Twelve soil associations were identified in the North Parcel. The northwestern portion of the parcel is dominated by the Gypsiorthids-Grieta-Clayhole-Jocity and Pennell-Bacobi associations (see Figure 3.5-1). In general, the soils in these associations are well drained, shallow to deep, moderately coarse to moderately fine textured, nearly level to rolling and occur on sandstone and shale plateaus (NRCS 2008). The northeastern and southern portions of the parcel are dominated by the Mellenthin-Curhollow and Mellinthin-Poley-Moab-Rock Outcrop associations, respectively. These associations comprise well-drained, shallow, medium- to fine-textured, undulating to rolling soils on plains and plateaus (NRCS 2008, 2009).

East Parcel

The East Parcel is characterized by seven soil associations. The northwestern portion of the parcel is dominated by the Curob-Monue-Bison-Clayhole-Strych and Aneth-Torriorthents-Pagina-Wahweap associations (see Figure 3.5-1). Soils in these associations are generally well-drained, shallow to deep, moderately coarse to moderately fine textured, and nearly level to rolling (NRCS 2009). The southeastern portion of the parcel is dominated by the Pennell-Kinan-Jocity association. Soils in this association are generally well drained, shallow, medium to fine textured, and undulating to rolling and occur on plains and plateaus. Torriorthents-Rock Outcrop soils occur along the eastern edge of the parcel adjacent to Marble Canyon; this association comprises well-drained, shallow to deep soils developed on 25% to 65% slopes from gypsiferous colluvium and/or alluvium derived from sedimentary rock.

South Parcel

Soils on the South Parcel are dominated by Typic, Lithic, and Fluventic Ustochrepts. The northeastern and northwestern portions of the parcel are dominated by Typic Ustochrepts (see Figure 3.5-1). These shallow to moderately deep, well-drained, gravelly, fine- to loamy-skeletal-textured soils occur on hills, ridges, plateaus and mesas, with slopes ranging from 0% to 120% (Brewer et al. 1991). The north-central portion of the parcel is dominated by Typic and Lithic Eutroboralfs. These moderately deep to deep well-drained, fine- to very fine-textured soils occur on hills, plateaus and benches, with slopes ranging from 5% to 40%. The southern portion of the parcel is dominated by Lithic Ustochrepts. These shallow, well-drained, gravelly and cobbly, loamy-skeletal-textured soils occur on flat to rolling terrain with slopes ranging from 0% to 15%.

3.5.4 Current Resource Conditions

This section describes the current conditions of soil resources in the proposed withdrawal area in terms of the resource indicators summarized earlier. These resource conditions are described in general terms relevant to the most likely impacts. Quantitative indicator values are presented where possible; otherwise, conditions are described qualitatively.

Existing Soil Disturbance

Construction activities, such as grading, excavation, and removal of vegetation and ground cover, related to the installation of support infrastructure for mining operations would inevitably result in soil disturbance. This disturbance would be expected to alter soil physical properties from compaction and/or displacement. Soil displacement could include loss of horizons, changes in thickness, and alteration of soil slope and drainage patterns. Disturbance from exploration activities would generally be less significant than disturbance associated with mining. According to the RFD scenarios, exploration activities do not usually require construction of access roads or drill sites. Disturbance would be expected to be limited to the area surrounding the drill sites but may include limited excavation for mud pits, site grading, and removal of vegetation. In addition, the drill rig and service vehicles would be expected to cause some soil compaction along off-road access routes and at the drill sites.

Review of mine reports submitted to ADEQ and the BLM indicates that previous mining activities in the North Parcel, including installation of access roads and utility lines, resulted in about 237 acres of total disturbance (Energy Fuels Nuclear, Inc. 1984, 1986, 1987, 1988a, 1988b). This is equivalent to an average surface disturbance of about 26 acres per mine for nine mine sites, including the Hack Canyon Mine (pre-1980s mine that produced mostly copper, silver, and manganese). In the South Parcel, approximately 17 acres of surface disturbance are associated with the Canyon Mine (Forest Service

1986a). According to information provided in the RFD scenarios, the total estimated area of historic disturbance related to exploration drilling is approximately 459 acres, or about 1.1 acres per exploration project. This estimate covers only the period during the peak of uranium mineral exploration and development between 1980 and 1988. The total amount of soil disturbance that has occurred to date is about 713 acres, of which roughly 603 acres have been reclaimed. The remaining 110 acres represent a very small fraction (0.011%) of the 1,010,776 acres proposed for withdrawal.

Existing Soil Erosion and Hazard Ratings

Increased rates of erosion, or soil loss, would be expected to occur following surface disturbance resulting primarily from increased runoff related to soil compaction, removal of vegetative cover, and re-routing of drainage pathways. Soil loss in undisturbed areas within the parcels is controlled by vegetative cover and soil physical characteristics, such as texture and topography (slope). Thus, rates of erosion vary, depending on site-specific conditions, but generally would be expected to be greatest where ground cover is minimal, soils are fine grained, and the surface slope is steep. Erosion hazard ratings for soils relate the physical properties and occurrence of different soils to the potential for increased soil loss under various uses, thus providing a useful tool in land management. Hazards related to the potential for accelerated erosion following land disturbance include hazards of off-road erosion, hazards of erosion on roads, and wind erodibility.

NORTH AND EAST PARCELS

Descriptions and data for soil properties related to increased erosion for the North and East parcels are drawn from the NRCS soil survey reports (NRCS 2008, 2009) and the National Soil Survey handbook (NRCS 2010).

- **Erosion Hazard from Off-Road Areas.** Soil loss potential from water action in off-road areas is determined from slope and soil erosion factor “K,” which is related to the susceptibility of a soil to sheet and rill erosion based on soil texture, organic matter content, soil structure, and saturated hydraulic conductivity (NRCS 2008, 2009). The soil loss is caused by sheet or rill erosion in areas without roads where 50% to 75% of the surface has been exposed by disturbance. Soil loss by water from other processes, such as gully erosion and mass wasting, are not considered. The hazard is classified as being slight, moderate, severe, or very severe. A rating of slight indicates that erosion is unlikely under ordinary climatic conditions. A rating of moderate indicates that some erosion is likely and that erosion-control measures may be needed. A rating of severe indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised. A rating of very severe indicates that significant erosion is expected, and erosion-control measures are costly and generally impractical.
    - **North Parcel.** The off-road erosion hazard is moderate to severe for the vast majority of soils in the North Parcel, which indicates that off-road erosion is likely under ordinary climatic conditions (personal communication, Robert Smith, BLM 2010a). Areas north of Snake Gulch and adjacent to the Kaibab National Forest are generally rated higher than the rest of the parcel. Soils within the canyon of Kanab Creek are not rated but would be expected to exhibit a moderate to severe off-road erosion hazard, depending on slope.
    - **East Parcel.** Most soils in the East Parcel are rated as having a moderate off-road erosion hazard, which indicates that erosion is likely under ordinary climatic conditions (personal communication, Robert Smith, BLM 2010a). Localized areas within the tributary washes of the Marble Canyon area have a higher off-road erosion hazard than most of the rest of the parcel (NRCS 2009).

- **Erosion Hazard from Unsurfaced Roads.** Soil loss potential due to water erosion from unsurfaced roadways is based on soil erosion factor K, slope, and content of rock fragments (NRCS 2008, 2009). The hazard is classified as being slight, moderate, or severe. A rating of slight indicates that little or no erosion is likely. A rating of moderate indicates that some erosion is likely, that the roads may require occasional maintenance, and that simple erosion-control measures are needed. A rating of severe indicates that significant erosion is expected, that the roads require frequent maintenance, and that costly erosion-control measures are needed.
  - **North Parcel.** Road erosion hazard ratings are generally moderate for soils in the North Parcel (personal communication, Robert Smith, BLM 2010a). There are localized areas with a severe road erosion hazard rating in the northeastern portion of the parcel, adjacent to the Kaibab National Forest and southeast of the town of Fredonia (NRCS 2009).
  - **East Parcel.** The road erosion hazard is moderate for the majority of soils in the East Parcel (personal communication, Robert Smith, BLM 2010a). In the eastern portion of the parcel along Marble Canyon, the hazard rating is severe, which indicates that significant erosion is expected under normal climatic conditions (NRCS 2009).
- **Wind Erodibility.** Soil loss from wind action is related to properties of surface layers, such as soil texture, organic matter content, rock and pararock fragment content, moisture content, and mineralogy, especially carbonate content (NRCS 2010). Soils are categorized based on the similarity of these properties as related to resistance of the soil to wind erosion in cultivated areas, also referred to as Wind Erodibility Groups (WEGs). Numeric estimates of susceptibility to wind erosion are assigned to each WEG, known as the Wind Erodibility Index (WEI). The WEI is expressed in tons per acre per year (tons/acre/year). WEG categories range from 1 to 8, with 8 indicating no susceptibility to wind erosion and 1 corresponding to a WEI of between 160 and 310 tons/acre/year. A soil in WEG category 5 has a WEI of 56 tons/acre/year.
  - **North Parcel.** WEG ratings in the North Parcel range from 5 to 8 in the southern and western portions of the parcel; local areas in the north central part of the parcel are category 3 (NRCS 2008). Ratings are 7 to 8 along the eastern margin of the North Parcel adjacent to the Kaibab National Forest; much of the remainder of the eastern portion is category 4, with local areas rated category 3 and 5.
  - **East Parcel.** The East Parcel is characterized by WEG ratings ranging from 5 to 8 along the southwestern margin of the parcel to ratings of 1 adjacent to Vermilion Cliffs (NRCS 2009). The central and northwestern portions of the parcel are rated between category 3 and 5. The eastern margin of the parcel is predominantly rated category 3; ratings of 6 occur locally.

SOUTH PARCEL

Descriptions and data for soil properties related to erosion for the South Parcel were obtained from the TES for the Kaibab National Forest (Brewer et al. 1991) and the TES handbook (Forest Service 1986b). These soil property descriptions are not directly analogous to the properties determined for NRCS soil surveys; however, some TES soil properties are applicable to erosion hazards in disturbed areas. The applicable soil properties are described as follows:

- **Erosion Hazard.** This property is similar to the NRCS Erosion Hazard from Off-Road Areas rating system. The TES erosion hazard is generally defined as the relative susceptibility to erosion following removal of vegetative cover and is based on soil loss from sheet/rill erosion as estimated by the Universal Soil Loss Equation (Brewer et al. 1991). Soil loss by water from other processes, such as gully erosion and mass wasting, are not considered. Soil losses are predicted for the four following categories: 1) the potential soil loss (PSL) is the rate of soil loss that would occur under conditions of complete removal of groundcover (i.e., maximum rate), 2) tolerance soil loss (TSL) is the highest rate of soil loss that can occur while sustaining inherent site productivity (i.e., threshold rate), 3) current loss is the rate of soil loss occurring under existing conditions of groundcover, and 4) natural loss is the rate of soil loss that would occur under conditions associated with a climax plant community (i.e., minimum rate).

TES erosion hazard ratings are slight, moderate, and severe (Forest Service 1986b). A rating of slight is assigned where the PSL rate does not exceed the TSL rate. Degradation of soil productivity is of low probability, and areas within this erosion hazard class generally stabilize under natural conditions. Areas rated moderate exhibit PSL rates that exceed TSL rates, and loss of soil productivity is probable; reasonable and economically feasible mitigation measures are required to prevent significant losses in productivity. Severe hazard ratings are assigned to areas where PSL rates exceed TSL rates and where loss of productivity is inevitable. Areas with severe erosion hazards require significant mitigation measures to be applied to prevent irreversible loss in soil productivity, and there is a high probability of some productivity loss before mitigation can be applied.

  - **South Parcel.** Erosion hazard ratings range from slight to moderate for most of the parcel (Brewer et al. 1991). Significant areas rated moderate are located in the western, northwestern, and northeastern portions of the parcel. Severe ratings occur primarily along the Coconino Rim (Grandview Monocline, see Figure 3.4-10), the Red Butte area, and other steep areas in the northeastern part of the parcel. Severe ratings also occur locally in many small canyons throughout the parcel.

- **Unsurfaced Road Limitations.** Although the TES has no comparable measure to the NRCS road erosion hazard ratings, the TES unsurfaced road limitation property could be applied in a similar manner for the general analyses in this EIS. The TES unsurfaced road category pertains to the suitability for the use of native soils for unsurfaced roads in terms of construction and maintenance requirements (Brewer et al. 1991). These roads would be of low design and minimum construction cost (such as haul roads and for most exploratory drilling). A rating of slight indicates that there are few limitations or risks associated with unsurfaced roads. A rating of moderate or severe indicates that there would be problems in construction and maintenance of unsurfaced roads. Since most of these roads would be expected to receive little maintenance, alternative routes may be considered to avoid mitigation limitations and significant damage to soils rated moderate or severe.
  - **South Parcel.** Most soils in South Parcel are rated as having severe limitations for use as unsurfaced roads (Brewer et al. 1991). Localized areas, mostly valley floors, are rated moderate. The area at the base of the Coconino Rim in the northeastern part of the parcel is rated slight to moderate.

- **Wind Erodibility.** There is no soil property related to wind erosion defined in the TES. However, except in areas subject to severe wildfire damage, erosion from wind action is expected to be minimal throughout the parcel because of the significant level of vegetative cover present (personal communication, Christopher MacDonald, Forest Service 2010b).

Existing Soil Contamination

The chemical quality of soil and stream sediments in the vicinity of new uranium mine sites may be subject to alteration from the dispersal and subsequent deposition of uranium and other trace metals from mine waste and ore exposed to wind and water action at land surface. Containment of mine drainage in surface impoundments presents an additional risk to soil at mine sites in the event of liner failure. Uranium and, to a lesser extent, arsenic were identified as the most abundant trace elements of concern at the mine sites (Otton et al. 2010). ADEQ has established SRLs for soil in a non-residential setting (ADEQ 2007). SRLs were generally developed as risk-based screening criteria for the remediation of soils; the risk-based SRL for uranium is 200 ppm. The SRL for arsenic is 10 ppm, which is based on estimated background levels for Arizona rather than risk-based criteria.

This section evaluates available reports and data to establish regional, local (study area), and site-specific (ore-bearing breccia pipes) background levels of uranium and arsenic in soil and sediment. To address current impacts on soil chemistry, the following summarizes the recent USGS study (Otton et al. 2010), which examined historic effects from mining in the North Parcel in detail.

NATURALLY OCCURRING CONCENTRATIONS OF URANIUM AND ARSENIC IN SOIL AND SEDIMENT

Otton et al. (2010) reviewed existing data and collected new analytical data from soil and sediment samples to determine background levels of uranium and trace metals for the study area. Geochemical data obtained from the National Uranium Resource Evaluation (NURE) database were analyzed for the twelve 7.5-minute quadrangles surrounding the mine sites in the North Parcel to determine background levels for uranium. The NURE samples in this area were collected in 1979, prior to the majority of mining activities in the North Parcel (Otton et al. 2010). This analysis indicated that samples from undisturbed soil in the study area had reported an average uranium concentration of 2.4 ppm and a maximum concentration of 3.4 ppm (106 samples). No arsenic results were available from NURE. Otton et al. (2010) collected nine samples of stream alluvium from the nearby unmined, unmineralized Jumpup Canyon to determine background levels for the study area in stream sediments. The results of these stream sediment analyses were as follows: the average concentration of uranium was 1.7 ppm, with a maximum of 1.9 ppm; the average arsenic concentration was 4.6 ppm, with a maximum of 5 ppm.

Average concentrations in soil for the western United States are reported by Smith and Logsdon (1999) to be 2.5 ppm for uranium and 5.5 ppm for arsenic; these values are consistent with the results from Otton et al. (2010). The slightly higher regional arsenic estimate provided by Smith and Logsdon could be because of the small sample size, small area, or difference in media (sediment rather than soil) of the Otton et al. (2010) sample set obtained from Jumpup Canyon.

The results for soil and alluvium background concentrations by Otton et al. (2010) are consistent with an earlier USGS study conducted in the Snake Gulch area prior to development of the Pigeon Mine (Hopkins et al. 1984b). The Hopkins et al. (1984b) survey showed that uranium ranged from 0.4 to 1.4 ppm for soils (six samples) and from 0.2 to 2.0 ppm for sediment (31 samples) in the Snake Gulch area. Arsenic results for all samples analyzed by Hopkins et al. (1984b) were below the detection limit of 200 ppm. Another study conducted in 1999 investigated the geochemical impact on sediments in Hack Canyon from the mining activities at the Hack Canyon Mine complex: sediment samples obtained upstream of the Hack Canyon Mine complex showed uranium concentrations ranging from 0.6 to 1.5 ppm and arsenic concentrations ranging from 1.2 to 11.5 ppm (Carver 1999).

In addition to the study area and regional background concentrations described in the previous paragraph, Otton et al. (2010) also reviewed available results for samples obtained across the surface expression of known mineralized breccia pipes. Hopkins et al. (1984b) obtained three soil samples from the surface of the Pigeon Pipe prior to initiation of mining: uranium ranged from 2.2 to 5.6 ppm, and arsenic was below the detection limit of 200 ppm for these samples. The Canyon Pipe, located in the South Parcel, was surveyed by Van Gosen and Wenrich (1991) prior to development of the site for mining. The investigation of the Canyon Pipe surface expression conducted by Van Gosen and Wenrich (1991) consisted of 14 soil samples outside the perimeter of the pipe and 18 soil samples within the pipe surface. Results indicated that uranium and arsenic concentrations are similar, regardless of whether samples were obtained within or beyond the pipe surface expression. The Canyon Pipe soil sample results are as follows: uranium concentrations ranged from 2.6 to 4.3 ppm, with an average of 3.2 ppm; arsenic concentrations ranged from less than 10 to 20 ppm, with an average of less than 10 ppm. Van Gosen and Wenrich (1991) investigated another mineralized breccia pipe, the SBF Pipe, located adjacent to the Hualapai Reservation, about 45 miles southwest of the Canyon Pipe. The surface expression of the SBF Pipe is characterized by a 7-foot-high rim consisting of Kaibab Formation encompassing a soil-filled, circular basin floored by Moenkopi Formation sandstone and siltstone. Similar geological conditions occur for other pipes located on the Coconino and Kaibab plateaus and for pipes on much of the Kanab Plateau (see Figures 3.4-5 and 3.4-8). Results from the SBF Pipe indicated that, although there was little difference in soil uranium concentrations inside and outside the pipe surface area, arsenic concentrations were much higher within the pipe area. Average uranium concentrations for the SBF Pipe were about 2.9 ppm inside the pipe surface area (20 samples) and about 2.6 ppm outside the pipe (16 samples); maximum uranium concentration detected was 3.7 ppm and was for a sample from inside the surface area of the pipe. Arsenic concentrations within the SBF Pipe surface area ranged from 10 to 110 ppm; average concentration was 33 ppm. Arsenic concentrations outside the pipe ranged from 4.2 to 32 ppm; average concentration was 12 ppm (Van Gosen and Wenrich 1991).

The regional analysis of undisturbed soil and alluvium samples described by Otton et al. (2010) provides a reasonable approximation of overall ambient conditions in the area. However, naturally occurring levels of uranium and arsenic in the vicinity of specific ore-bearing breccia pipes are likely to vary from site to site because of variability in surface rock compositions and environmental conditions (reduction-oxidation potential). Site-specific concentrations may be higher than the regional levels estimated by Otton et al. (2010). This conclusion is supported by the somewhat variable sample results for undisturbed soils at the Pigeon, Canyon, and SBF pipes (Hopkins et al. 1984b; Van Gosen and Wenrich 1991) and by results for sediment samples obtained upstream of the Hack Canyon mines (mineralized, unmined area) and Jumpup Canyon (unmineralized, unmined area) (Carver 1999; Otton et al. 2010). Thus, levels of contaminants of concern at specific sites should be considered in light of both average and maximum naturally occurring concentrations. The average and maximum naturally occurring concentrations for the primary constituents of concern are listed in Table 3.5-2.

Table 3.5-2. Concentrations of Naturally Occurring Uranium and Arsenic in Undisturbed Soil and Sediment

	Regional Average (ppm)	Source for Average	Study Area Maximum (ppm)	Source for Maximum
Uranium	2.5	Smith and Logsdon (1999)	5.6	Hopkins et al. (1984b)
Arsenic	5.5	Smith and Logsdon (1999)	110	Van Gosen and Wenrich (1991)

EFFECTS FROM HISTORIC (1980s) MINING

A study of existing mine sites in the North Parcel was conducted by the USGS in 2009 to characterize current impacts of historic uranium mining activities on soil and sediment near former and inactive mine and exploration sites (Otton et al. 2010). Reclaimed mine sites, including Pigeon Mine, the Hack Canyon Mine complex, and Hermit Mine, and the inactive Kanab North Mine, were evaluated for the study. The Kanab South Pipe drill site was also investigated. Assessment included sampling and geochemical analysis of surface soils, stream sediments, rock, and mine wastes for uranium and trace elements. Samples were generally taken inside and outside reclaimed/disturbed areas; most samples were collected within about 500 feet of the reclaimed areas. All samples were obtained from a depth of 0 to 2 inches; the study did not include investigation of subsurface materials, such as mine waste or drill cuttings potentially buried during reclamation.

In addition to the soil and sediment samples collected for the USGS study, radioactivity surveys were conducted at each site, including measurements at each sample location and at some unsampled areas (Otton et al. 2010). These surveys were conducted using Ludlum Model 19 MicroR exposure meters. MicroR meters measure radiation exposure from gamma-ray and x-ray emissions. MicroR measurements are reported in microrads per hour (μR/h).

Findings of Otton et al. (2010) are summarized as follows.

- **Pigeon Mine.** The Pigeon Mine was operational for 5 years and was reclaimed in 1989. The mine facilities consisted of the mine site (at the pipe), operations site, and wastewater surface impoundment. The operations and impoundment sites were both located about 1,000 feet northwest of the mine site. In 26 soil samples collected inside the reclaimed mine site area, median uranium concentration was 4.4 ppm, and median arsenic concentration was 41 ppm (Table 3.5-3). These results are believed to represent cover materials used to reclaim the site. Two samples obtained within the reclaimed area were much higher in uranium (68 and 79.1 ppm) and arsenic (377 and 407 ppm). These two samples were believed to represent soil impacted by exposed waste rock, hence the reporting of median results for this site rather than the numeric averages reported for the other sites investigated. Excluding these two anomalously high soil sample results, uranium concentrations within the reclaimed area ranged from 2.2 to 8.1 ppm, and arsenic concentrations ranged from 6 to 93 ppm.

  Of 16 soil samples collected within about 500 feet beyond the reclaimed area, the median uranium concentration detected was 6.3 ppm, and the median arsenic concentration was 25 ppm (see Table 3.5-3). Concentrations detected for two samples obtained on a hillslope about 200 feet northeast from the disturbed area were 26.5 and 36.6 ppm for uranium and 62 and 66 ppm for arsenic. These anomalously high sample results were thought to possibly be the result of off-site dispersion of mine-waste constituents from wind erosion. Concentrations detected for a third sample collected on a hillslope southeast of the reclaimed area were 11.1 ppm for uranium and 393 ppm for arsenic. Both wind-dispersed mine waste rock and weakly mineralized limonite-cemented sandstone (parent material) in the area may be the source of these elevated concentrations. Excluding the three anomalously high concentrations, uranium concentrations for soil samples collected outside the reclaimed area ranged from 3.2 to 12.9 ppm, and arsenic concentrations ranged from 7 to 46 ppm. Uranium levels in the five samples collected farthest from the site, about 500 feet or more north, northeast, and northwest of the site, ranged from 3.2 to 10.6 ppm (average 5.1 ppm); arsenic levels detected in these five samples ranged from 10 to 31 ppm (average 23 ppm) (see Table 3.5-3).

  Ephemeral stream sediment samples obtained downstream of the reclaimed Pigeon Mine appear to be slightly elevated in uranium and arsenic, compared with samples obtained upstream of the site. The source of these elevated concentrations may be distribution of mine-related contaminants and/or mineralized bedrock in the area.

  The average concentration of 15 soil samples obtained in the vicinity of the operations area was about 11.9 ppm for uranium and about 29 ppm for arsenic (excluding one anomalously high sample result with a uranium concentration of 206 ppm, and an arsenic concentration of 455 ppm). Several isolated deposits of mine waste remaining on-site, primarily in the operations area, were sampled; uranium concentrations as high as 1,230 ppm and arsenic concentrations as high as 1,980 ppm were detected in these samples.

  Otton et al. (2010) concluded that some soils at the Pigeon Mine reclaimed site are impacted to levels above cited background averages by off-site dispersion of trace elements in dust and by transport, via slope wash, of constituents related to exposed waste-rock fragments within the reclaimed area.

Table 3.5-3. Summary of Soil and Sediment Sample Results from Mines

	Pigeon (reclaimed)	Kanab North (unreclaimed)	Hermit (reclaimed)	Hack Canyon‡ (reclaimed)
Inside Mine Site				
Number of Samples	26	13	22	N/A
Uranium, Range of Results (ppm)*	2.2–8.1	6.4–2,840	1.6–19.9	N/A
Uranium, Average of Results (ppm)†	4.4	1,135	4.6	N/A
Uranium, Outliers (ppm)	68 and 79.1	N/A	N/A	N/A
Arsenic, Range of Results (ppm)*	6–93	4–1,980	4–27	N/A
Arsenic, Average of Results (ppm)†	41	380	8	N/A
Arsenic, Outliers (ppm)	377 and 407	N/A	N/A	N/A
Outside Mine Site				**(up to 0.8 mile downstream)**
Number of Samples	16	22	35	4
Uranium, Range of Results (ppm)*	3.2–12.9	2.9–80.2	1.1–5.9	4.8–10.2
Uranium, Average of Results (ppm)†	6.3	27.8	1.9	6.6
Uranium, Outliers (ppm)	26.5 and 36.6	N/A	N/A	N/A
Arsenic, Range of Results (ppm)*	7–46	3–27	3–10	10–17
Arsenic, Average of Results (ppm)†	25	12	5	13
Arsenic, Outliers (ppm)	62, 66, and 393	N/A	N/A	N/A
Approximate Distance of Farthest Samples	≥ 500 feet	300 and 420 feet	≥ 325 feet	1.6 and 4.0 miles
Uranium Concentration of Farthest Samples (ppm)	3.2–10.6	10.3 and 6.9	1.2–1.9	3.2 and 2.4
Arsenic Concentration of Farthest Samples (ppm)	10–31	9 and 8	3–5	11 and 9

Source: Otton et al. (2010).

* Excluding outliers at Pigeon Mine.

† Median values reported for Pigeon Mine; includes outliers.

‡ Sediment samples. Concentrations detected in four sediment samples collected upstream from the Hack Canyon mines ranged from 2.1 to 3.9 ppm for uranium (2.9 ppm average) and ranged from 10 to 14 ppm for arsenic (12 ppm average).

- **Kanab North Mine.** Extraction of ore at the Kanab North Mine occurred between 1988 and 1990; the mine has been under interim management since 1992. The Kanab North Mine consists of a single fully bermed (except at the main gate) surface facility; the facility houses the mine access, management offices, a lined wastewater surface impoundment, and waste and ore stockpiling areas. The site is situated about 150 feet (closest edge) west from the edge of the canyon of Kanab Creek, which is approximately 1,200 feet below the plateau surface at this location. Mined waste rock and uranium ore have been exposed at the surface of the unreclaimed mine site for the duration of the interim management period. Investigation of the Kanab North Mine included sampling within the mine perimeter for disturbed soil, graded surfaces, and sediment in the surface impoundment, as well as undisturbed soils adjacent to the site. Results for 13 samples obtained within the mine site indicated that uranium concentrations ranged from 6.4 to 2,840 ppm (average 1,135 ppm), and arsenic concentrations ranged from 4 to 1,980 ppm (average 380 ppm) (see Table 3.5-3).

  Results for 22 soil samples obtained up to 420 feet outside the mine site perimeter indicated that uranium concentrations ranged from 2.9 to 80.2 ppm (average 27.8 ppm), and arsenic concentrations ranged from 3 to 27 ppm (average was 12 ppm) (see Table 3.5-3). These samples were generally collected within about 250 feet of the site perimeter; two of these samples were collected about 300 and 420 feet northwest of the site. Uranium concentrations detected in these two farthest samples were 10.3 and 6.9 ppm, respectively; arsenic concentrations were 9 and 8 ppm, respectively (see Table 3.5-3). Results of the samples taken outside the perimeter indicate that concentrations are greatest to the east from the site, which is likely the prevailing wind direction. Thus, wind is believed to be the likely transport mechanism of constituent dispersion outside the site perimeter. On the basis that only one sample collected outside the site approximated the NURE uranium background average of 2.4 ppm, Otton et al. (2010) further concluded that mine-related materials may have dispersed beyond the limit of sampling (420 feet). It is unlikely that waterborne sediment migrated off-site because the containment berm surrounding the site was intact when the Otton et al. (2010) investigation was conducted in 2009.

- **Kanab South Pipe.** The Kanab South Pipe is located about 3,700 feet south of the Kanab North Mine. Erosion of the pipe surface has led to widening of a small wash that crosses the pipe surface and enters the canyon of Kanab Creek about 500 feet to the northeast. Six soil samples were obtained from the disturbed drill site area; concentrations detected in these samples ranged from 1.3 to 2.7 ppm for uranium and from 5 to 23 ppm for arsenic. Stream sediment samples were also collected upstream of and on the site; concentrations detected in these six samples ranged from 1.5 to 3.6 ppm for uranium and from 4 to 20 ppm for arsenic. Limonite-cemented sandstone bedrock occurring along the drainage pathway upstream of the site was also sampled; the results indicate that bedrock in the area may contain up to 54.9 ppm of uranium and 896 ppm of arsenic. Genetically similar sandstones were noted at the Pigeon Mine site; it was postulated that such mineralized zones in these sandstones may have formed by fluids circulating near the pipes during deposition of uranium ore.
- **Hermit Mine.** The Hermit Mine was operational for less than 1 year and was reclaimed in 1989. The Hermit Mine had a single surface facility with components that were similar to the Kanab North Mine. The mine was located in a relatively flat area about 8 miles west of the Kanab North Mine; surface water drainage at the site appears to flow to the north into a small stock tank. Concentrations of uranium in 22 soil samples collected within the reclaimed area ranged from 1.6 to 19.9 ppm (average 4.6 ppm), and arsenic concentrations ranged from 4 to 27 ppm (average 8 ppm) (see Table 3.5-3). Concentrations of uranium in 35 soil samples collected outside the reclaimed area ranged from 1.1 to 5.9 ppm (average 1.9 ppm), and arsenic concentrations ranged from 3 to 10 ppm (average 5 ppm) (see Table 3.5-3). All arsenic samples with concentrations greater than 6 ppm were obtained in the reclaimed area, the access road, and the stock tank. Otton et al. (2010) concluded that limited off-site dispersion of mine-related constituents had occurred at the Hermit Mine. Uranium and trace element concentrations in soil were determined to be at or below the background levels cited by Otton et al. (2010) within a few hundred feet outside the reclaimed edge of the Hermit Mine site.
- **Hack Canyon Mine Complex.** The Hack Canyon Mine complex includes the Hack Canyon Mine, which was operational for uranium production in the 1950s and 1960s, and Hack Canyon Mines 1, 2, and 3, which operated from 1981 to 1987. Reclamation of all four Hack Canyon mines was completed in 1988. During mine operations, a significant flood event occurred on August 19, 1984, in the tributary that was occupied by Hack 1; radioactive materials were reported to have been recovered by mine personnel up to 1 mile downstream following the flood. All four of these mines were situated in canyon bottoms—either Robinson Canyon (Hack 3), an unnamed tributary canyon (Hack 1), or Hack Canyon Mine itself (Hack Canyon and Hack 2 mines). A total of 10 ephemeral stream sediment samples were obtained during the investigations. Four of these samples were obtained upstream of the mine sites, one sample was collected between Hack 2 and Hack 1, and five samples were obtained downstream of the mine sites. Concentrations detected in all stream sediment samples ranged between 2.1 and 10.2 ppm for uranium and between 9 and 17 ppm for arsenic. The upstream samples, which were said to

represent background conditions for this area, ranged from 2.1 to 3.9 ppm for uranium (2.9 ppm average) and from 10 to 14 ppm for arsenic (12 ppm average). Concentrations of trace elements in the stream samples obtained about 2 to 3 miles downstream of the Hack Canyon Mine complex were determined to be about the same as those upstream of the complex; this result is consistent with conclusions made by Carver (1999) that "mean concentrations above the mine are equal to the mean concentrations below the mine." Uranium concentration detected in a sediment sample collected several miles downstream, near Willow Spring, was 2.4 ppm.

Flood events were determined to be the likely transport mechanism for several isolated fragments of mineralized rock, believed to be mine waste, found up to 0.5 mile downstream of the reclaimed sites by Otton et al. (2010). The rock fragments ranged between 2 and 18 inches in diameter. Five of the fragments were sampled, and analyses detected uranium concentrations ranging from 122 ppm to greater than 10,000 ppm, and arsenic concentrations ranging from 547 ppm to greater than 10,000 ppm. The presence of these fragments was attributed to flood events that transported waste rock off-site during mining or that eroded cover material in reclaimed areas, exposing and transporting buried mine wastes off-site after reclamation. The source of many of these fragments was believed to be the reclaimed terrace near Hack 1, which consists of several feet of waste rock covered by gravel that has been eroded by the ephemeral stream to expose the deposits. Although discrete fragments of rock containing large concentrations of mine-related constituents were identified by Otton et al. (2010), much lower concentrations of constituents were detected in fine-grained sediments (discussed in the previous paragraph), which shows limited dispersion of contaminants downstream. It was concluded that mine-derived particulates in stream sediments are diluted by large quantities of native fine-grained sediments during flooding, thus limiting the effects of these contaminants on the overall chemical quality of the sediment.

- **MicroR Meter Surveys.** The radioactivity surveys conducted indicated that radiation exposure detected at all of the sites was elevated, compared with readings obtained from the Jumpup Canyon area. The highest readings were obtained at the Kanab North Mine, followed by the Pigeon Mine, then the Hack Canyon mines. Considerably lower levels of radiation were detected at the Hermit Mine, and very little radiation above background levels was observed at the Kanab South Pipe. Radiation levels decrease rapidly within 400 feet of the Kanab North Mine perimeter. At the Pigeon and Hack Canyon mines, field surveying indicated that radioactivity decreased significantly within a few feet of the anomalous point sources, such as isolated ore and waste-rock fragments.

Soil and sediment analyses conducted by Otton et al. (2010) detected uranium concentrations at all of the reclaimed, inactive (unreclaimed) mine sites that ranged from below regional average levels to above regional average levels (see Table 3.5-2). The degree to which soil is affected at each mine site varies, based on physiographic setting, the length of time mine rock was exposed at the surface, and the effectiveness of reclamation efforts. Salient conclusions made for this EIS regarding the potential distribution and accumulation of mine-related contaminants in soil and alluvium are as follows:

- Assessment of existing mine sites by Otton et al. (2010) indicates that significant changes in soil conditions as a result of past uranium mining are generally localized to within a few hundred feet of the areas of operation, except where mine sites may be subject to significant flash flooding (Hack Canyon mines). Soil samples collected 500 feet or more from the reclaimed area at the Pigeon Mine averaged 5.1 ppm for uranium and 23 ppm for arsenic, which are 2.5 and 17.5 ppm above the respective regional averages listed in Table 3.5-2 but are generally within the upper range of naturally occurring concentrations for uranium (5.6 ppm) and arsenic (110 ppm) in the study area. Similarly, the farthest two samples collected about 300 and 420 feet from the Kanab North site contained uranium concentrations of 10.3 and 6.9 ppm, which are respectively about 5 and 1 ppm above the high end of the range of estimates for naturally occurring uranium (see

Table 3.5-2). Results from the Hermit Mine site, which was more compact and operated for a much shorter duration than the Pigeon Mine, indicate that concentrations of mine-related constituents are generally at or below regional averages about 100 feet beyond the reclaimed area. The primary mechanism of off-site dispersion of mine-related constituents at sites removed from major drainage channels is fugitive dust generated at ore and waste-rock stockpiles during mining operations; a potential, but limited, secondary mechanism is slope wash transport of exposed waste materials remaining on-site after reclamation. This potential secondary mechanism is supported by a few samples collected at the Pigeon Mine site; however, there is little evidence of significant off-site movement of contaminants from slope wash.

Where mine sites are located within drainage channels subject to flash flooding or are adjacent to steep areas or canyons, mine-related constituents have the potential to be dispersed more than a few hundred feet from the mine site. Evidence collected at the Hack Canyon Mine complex indicates that waste materials have been transported up to 0.5 mile downstream from the sites. Some of these ore/waste-rock deposits observed downstream of the Hack Canyon Mine complex could be the result of mining activities at the Hack Canyon Mine, rather than 1980s-era mining. Although trace element concentrations may be very high in mine waste fragments displaced by flooding, evidence collected by Otton et al. (2010) and Carver (1999) indicates that the overall impact to the fine-grained stream sediments is limited. An example of a mine site located adjacent to steep topography is provided by the Kanab North Mine. Samples collected within about 200 feet northeast from the Kanab North site perimeter contained up to 77.7 ppm more than the regional average background concentration for uranium (see Table 3.5-2). These samples were obtained in the prevailing downwind direction and immediately adjacent to the canyon of Kanab Creek, which suggests that mine-related contaminants may have dispersed off-site into the canyon. The total potential distance that sediment could be transported would be larger for a mine adjacent to a canyon, compared with a mine located away from a canyon, because particles would be expected to maintain their trajectory longer as they descend into the canyon. Similarly, waterborne sediments that enter a canyon or other steep area have the potential to move farther away from their source than sediments that remain in relatively level areas.

- Duration and scale of mining operations directly correlate to the magnitude and extent of contamination (e.g., compare Pigeon Mine effects with Hermit Mine effects). The area outside mine sites at reclaimed mines are also generally less impacted (at present)–than mine sites under very long-term interim management.
- This investigation was conducted at least 20 years after completion of reclamation efforts at the mines and about 20 years after the Kanab North Mine was deactivated. At reclaimed mines where significant amounts of erosion have not occurred, such as the Hermit Mine, surface conditions reported in Otton et al. (2010) are likely similar to conditions immediately after reclamation was completed. At mine sites where erosion may have exposed buried mine waste, such as the Hack Canyon mines, recently observed concentrations may be lower than conditions that may have existed immediately following the first significant erosive event, which would have removed cover materials, eroded buried waste, and re-deposited waste immediately downstream.
This could occur because subsequent events may have dispersed contaminants to the extent that they were not detectable or diluted them to the levels observed in Otton et al. (2010). Effects on soils at inactive mines, such as Kanab North, are likely to be at their greatest because continual wind dispersion of materials off-site would be expected to generate a cumulative effect on the chemistry of downwind surface soils (assuming the soils themselves have not been subject to significant erosion).
- In general, Otton et al. (2010) compared average sample results at given sites with average regional background concentrations, which may not be appropriate for all locations because natural conditions may vary from site to site. Given that most samples were collected within a

few hundred feet of reclaimed areas, particularly at the Kanab North Mine, the areal extent of sample collection may not have been large enough to clearly establish site-specific background conditions or the range of concentrations for naturally occurring elements present in the vicinity of the site. Thus, some comparisons presented by Otton et al. (2010) may over estimate or under estimate actual impacts.

- In some cases, particularly the Pigeon and Kanab North mines, samples collected outside reclaimed or disturbed areas may represent variability in natural conditions for the specific site, rather than elevated concentrations of trace elements as a result of mining activities. For example, mineralized bedrock noted at some sites (Pigeon Mine and Kanab South Pipe), which could be the parent materials for soil or source material for alluvium, may contribute to the apparently elevated concentrations of uranium and arsenic measured near mine sites in the area.
- Uranium concentrations reported in soil samples collected at all sites ranged from below to above the average regional background concentration (2.5 ppm); however, the concentrations were generally below the ADEQ non-residential SRL of 200 ppm.
- The arsenic non-residential SRL of 10 ppm was exceeded in many samples at each site. Because the arsenic SRL is based on background levels, 10 ppm may not be appropriate for all sites; arsenic concentrations in soils were generally below the maximum reported concentration in an undisturbed mineralized pipe (110 ppm at the SBF Pipe) but were generally above the average regional background of 5.5 ppm.
- Isolated waste-rock and ore fragments that contain significantly elevated levels of uranium and arsenic were identified at the Pigeon Mine and in the vicinity of the Hack Canyon Mine complex. Such fragments could contribute to localized contamination of soils in the immediate vicinity of the fragments as a result of leaching processes.
- The primary mechanism for dispersion of mine-related contaminants appears to be wind erosion of waste-rock and ore stockpiles during mining operations. A secondary mechanism for dispersion is water erosion of cover materials and buried waste rock after reclamation. Waste materials exposed by erosion of cover materials might result in minor contaminant dispersion by wind. Also, for mines located in large drainage channels or canyons, floods could disperse mine-related constituents from stockpiles during operations.
- The potential effect on subsurface soils (greater than 2 inches deep) is not known. Leaching of buried mine wastes could result in accumulation of contaminants in materials beneath or downslope of such mine-waste deposits. Although such impacts are conceivable, if cover materials remain intact, leaching from buried mine waste would be expected to be minimal.

3.6 VEGETATION RESOURCES

The Colorado Plateau ecoregion contains diverse flora and fauna. The isolation, complex geological features, and substantial climate change from glacial to postglacial times have led to the existence of many relict populations of endemic species that are exclusively native to this region. More than 300 plant species are endemic to the Colorado Plateau (Tuhy et al. 2002), and the Colorado Plateau provides habitat for numerous vertebrates, many of which are identified as “species of greatest conservation need” by the Southwest Regional Gap Analysis Project (Boykin et al. 2007). Several plant species are listed as federally protected species and are discussed in more detail in Section 3.8. Additionally, there are ACECs within and near the proposed withdrawal area, some of which were designated to protect threatened plant species (see Section 3.1.2), shown in Figure 3.6-1.

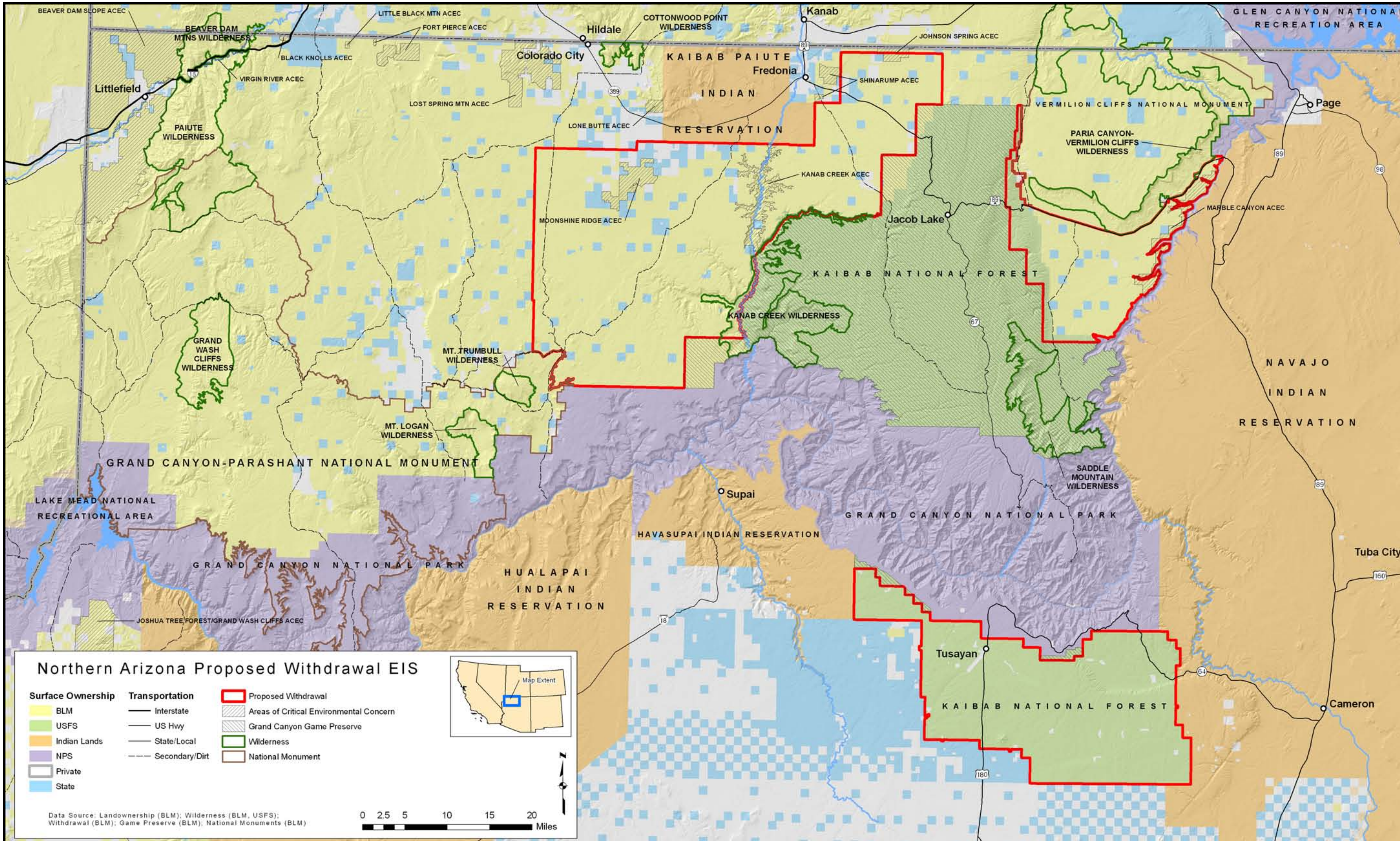


Figure 3.6-1. Proposed withdrawal area and Areas of Critical Environmental Concern.

3.6.1 Vegetation Communities

The Colorado Plateau ecoregion contains a variety of vegetation communities. In the proposed withdrawal area, the communities include riparian, Great Basin Grassland, Great Basin Desertscrub, Great Basin Conifer Woodland, and Petran Montane Conifer Forest. Table 3.6-1 lists dominant plant species for each of these eight communities. Figure 3.6-2 illustrates the distribution of these major vegetation types. Digital representation of these communities was developed by the Nature Conservancy in Arizona based on the map “Biotic Communities of the Southwest” by Brown and Lowe (1980) in order to provide for easier interagency discussion of the vegetation types. These areas have been mapped in more detail as “ecological zones” in the Arizona Strip FEIS BLM (2007). Detailed community descriptions of the vegetation communities found in the proposed withdrawal area are based on BLM (2008b) and Forest Service (2009c), unless indicated otherwise.

Table 3.6-1. Vegetation Communities and Dominant Plant Species on the Colorado Plateau within the Proposed Withdrawal Analysis Area

Vegetation Community	Dominant Plant Species
Riparian	Cottonwood (*Populus* spp.), willow (*Salix* spp.), saltcedar (*Tamarix* spp.)
Great Basin Grassland	Grasses, including wheatgrass (*Pascopyrum smithii*), grama (*Bouteloua* spp.), galleta (*Pleuraphis jamesii*), three-awn (*Aristida* spp.), muhly (*Muhlenbergia* spp.), needlegrass (*Achnatherum* spp.), fescue (*Festuca* spp.), dropseed (*Sporobolus* spp.)
Great Basin Desertscrub	Sagebrush (*Artemesia* spp.), shadscale (*Atriplex confertifolid*), saltbush (*Atriplex* spp.), winterfat (*Krascheninnikovia lanata*), blackbrush (*Coleogyne ramosissima*), greasewood (*Sarcobatus vermiculatus*)
Great Basin Conifer Woodland	Pinyon pine (*Pinus* spp.), juniper (*Juniperus* spp.)
Petran Montane Conifer Forest	Ponderosa pine (*Pinus ponderosa*), Gambel oak (*Quercus gambelii*)

Sources: BLM (2008b, 2010e).

Riparian

The only major riparian vegetation community in the proposed withdrawal area occurs along Kanab Creek in the North Parcel. In the vicinity of the proposed withdrawal area, riparian communities are associated with surface water habitats such as rivers, streams, seeps, and springs, primarily along the Colorado River and its many side canyons and include resources such as Vasey’s Paradise. At seeps and springs, natural conditions may include small wetland and/or riparian zones along short reaches of the drainages in which the springs and seeps occur. Riparian areas are a transition between permanently saturated areas and upland areas with visible vegetation or physical characteristics reflective of permanent surface or subsurface water influence. Native riparian vegetation in these areas includes cottonwood (*Populus* spp.), willow (*Salix* spp.), seep willow (*Baccharis salicifolia*), arrowweed (*Pluchea sericea*), ash (*Fraxinus* spp.), cattail (*Typha* spp.), rush (*Juncus* spp.), and sedge (*Carex* spp.), as well as a variety of grasses and forbs (BLM 2008b). However, in many of the riparian areas, including Kanab Creek and associated side canyons, native vegetation is being displaced by invasive species such as saltcedar (*Tamarix* spp.). Saltcedar is now a dominant riparian shrubby tree in the Colorado River basin below 6,000 feet amsl. Kanab Creek also hosts populations of tree of heaven (*Ailanthus altissima*) and pampus grass (*Cortaderia* sp.). Other nonnative species occurring in these riparian communities are Russian olive (*Elaeagnus angustifolia*), rabbit foot grass (*Polypogon monspeliensis*), dallisgrass (*Paspalum dilatatum*), Bermuda grass (*Cynodon dactylon*), cocklebur (*Xanthium* spp.), and thistles (Family *Asteraceae*) (BLM 2007). Brome grasses (*Bromus* spp.) and knapweeds (*Centaurea* spp.) are also common.

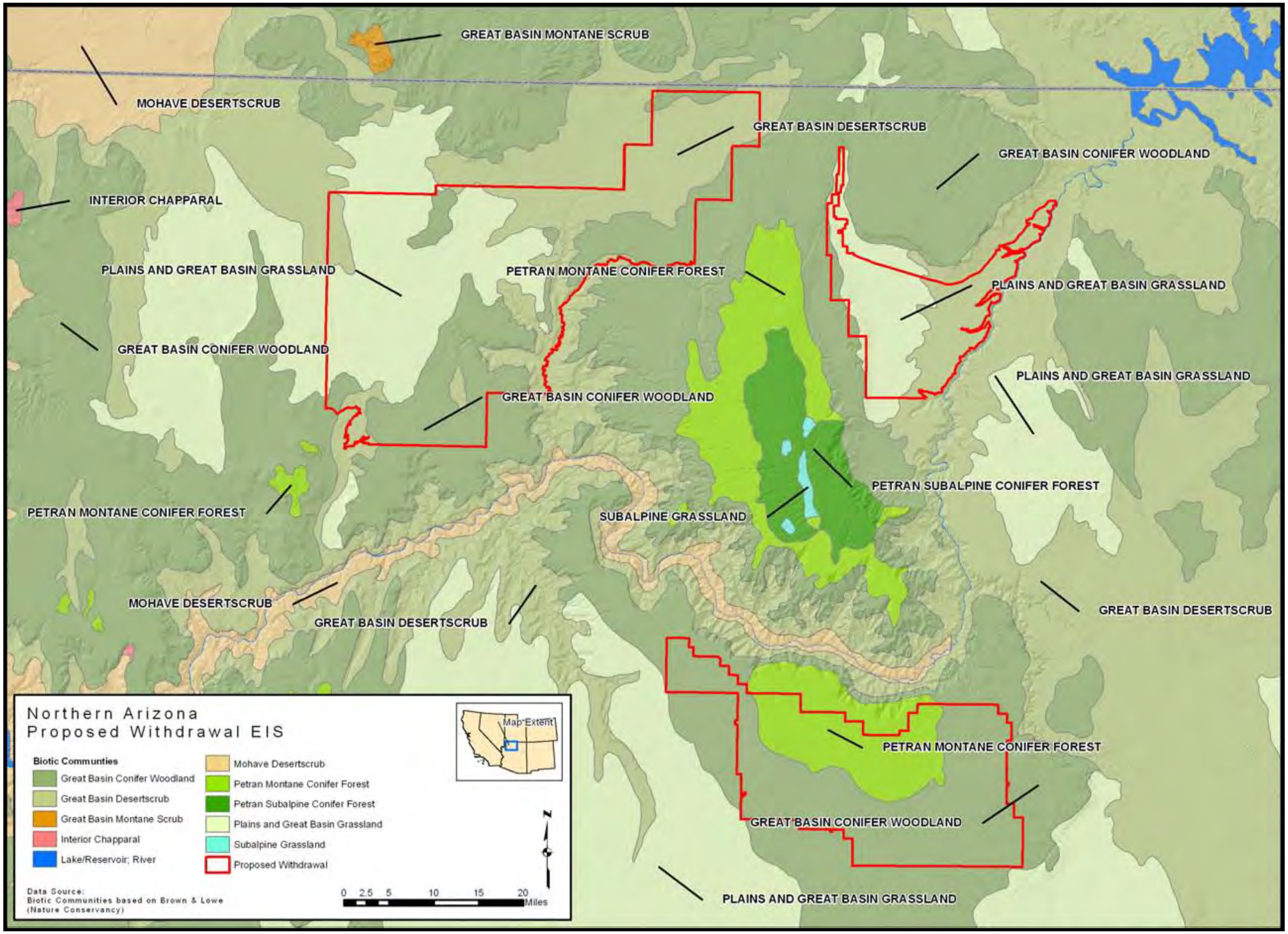


Figure 3.6-2. Vegetation communities (from Brown and Lowe 1980).

Human diversion or impoundment of free-flowing water by dams, diversions, irrigation, or channelization has been a major factor in the degradation of the natural functions of riparian areas on the Colorado Plateau (BLM 2008b). Without natural hydrologic systems, water tables have lowered, and surface sediments have dried out. Cottonwood and willow are particularly susceptible to water stress and may decline as groundwater becomes less available. With less flooding, there is less channel shifting and less suitable habitat for cottonwood and willow seedlings, which are dependent on recently inundated sediments to become established. Historically, fire was probably uncommon in this vegetation community (BLM 2008b). However, flammable fuel loads have increased dramatically in riparian areas because of drought, limited flooding that ordinarily would remove litter and woody debris, and dense buildup of saltcedar, which is highly flammable.

Great Basin Grassland

Portions of the North and South parcels contain Great Basin Grassland vegetation communities that extend beyond the boundaries of this study. These grasslands occur on nearly level, wind-desiccated geomorphic surfaces of sedimentary and igneous origin. There are few trees in the ecological zone, consisting mostly of scattered pinyon and juniper. Occasionally, cacti or shrubs may also be present, usually along the edge of the grassland or in microhabitats. Dominant grass species include western wheatgrass (*Pascopyrum smithii*), needle and thread (*Hesperostipa comata*), blue grama (*Bouteloua gracilis*), galleta (*Pleuraphis jamesii*), New Mexico feathergrass (*Hesperostipa neomexicana*), and various species of three-awn (*Aristida* spp.). Common shrubs include big sagebrush (*Artemisia tridentata*), black sagebrush (*Artemisia nova*), fourwing saltbush (*Atriplex canescens*), and Mormon tea (*Ephedra trifurca*). One-seed juniper (*Juniperus monosperma*) and Utah juniper (*Juniperus osteosperma*) woodlands and savannas are adjacent to Colorado Plateau grasslands.

Historically, perennial and annual grasses covered much of this vegetation community in a clumpy, relatively continuous carpet interspersed with shrubs and forbs. The natural fire regime for this zone involves frequent fires, which occur an average of 10 years apart, nearly all of which have stand replacement fire severity. Frequent fires are limited to woody species with a varied vegetation pattern across the landscape. Changes in fuel continuity from past management practices and fire suppression activities essentially eliminated fire from this ecological zone, resulting in increased shrub densities, the loss of perennial grasses, and the spread of non-native, invasive species (BLM 2008b).

Great Basin Desertscrub

Great Basin Desertscrub occurs in the North and East parcels. Most of the mid- to lower-elevation basins and benchlands along major canyon systems are covered by this vegetation type, the majority of which is managed by the BLM and NPS (AGFD 2006a). This vegetation community is shrub dominated. Species diversity is low, with dominant shrubs occupying large tracts of land. Characteristic vegetation is low-growing, widely spaced hemispherical, non-sprouting shrubs with widely spaced bunchgrasses. Dominant shrubs include big sagebrush, black sagebrush, Bigelow sagebrush (*Artemisia bigelovii*), shadscale (*Atriplex confertifolia*), fourwing saltbush, rabbitbrush (*Chrysothamnus* spp.), winterfat (*Krascheninnikovia lanata*), hopsage (*Grayia spinosa*), horsebrush (*Tetradymia* spp.), blackbrush (*Coleogyne ramosissima*), and greasewood (*Sarcobatus vermiculatus*). Associated grasses may include blue grama, galleta, Indian ricegrass (*Achnatherum hymenoides*), western wheatgrass, junegrass (*Koeleria macrantha*), muttongrass (*Poa fendleriana*), and several muhleys (*Muhlenbergia* spp.) and dropseeds (*Sporobolus* spp.). Forbs include several gilia (*Gilia* spp.), buckwheat (*Eriogonum* spp.), penstemon (*Penstemon* spp.), lupine (*Lupinus* spp.), and globemallow (*Sphaeralcea* spp.) species. Cacti are poorly represented in Great Basin Desertscrub, compared with their occurrence in warm deserts. Cacti in the proposed withdrawal vicinity include several species of prickly pear (*Opuntia* spp.), hedgehog (*Echinocereus* spp.), and cholla (*Cylindropuntia* spp.).

Great Basin Conifer Woodland

Great Basin Conifer Woodland is present in all three proposed withdrawal parcels but is best represented within the North and South parcels. This vegetation community is classified as evergreen woodland dominated by juniper (*Juniperus* spp.) and pinyon pine (*Pinus* spp.) trees. Juniper tends to dominate at elevations below 6,560 feet amsl, while pinyon pine dominates at higher elevations. These trees are low growing, rarely exceeding 40 feet in height. The understories of pinyon-juniper and dense mature juniper woodlands are very species-poor, containing only widely scattered shrubs, forbs, and small clumps of grass. Grasses are the most common understory component.

The species of pinyon most often present in the Great Basin Conifer Woodland is the common pinyon (*Pinus edulis*), with singleleaf pinyon (*Pinus monophylla*) occasionally being found. Utah juniper is the most common juniper present, with one-seed juniper occasionally found. The understory contains only widely scattered shrubs, forbs, and small clumps of grass. Grasses are the most common understory component. Dominant grass species include grama, Arizona fescue (*Festuca arizonica*), junegrass, Indian ricegrass, needlegrass (*Achnatherum* spp.), dropseed, and squirreltail (*Elymus elymoides*). Shrubs may include big sagebrush, cliffrose (*Purshia stansburiana*), broom snakeweed (*Gutierrezia sarothrae*), Utah serviceberry (*Amelanchier utahensis*), rabbitbrush, shadscale, and winterfat.

This habitat type has expanded in distribution and density predominantly on public lands managed by the Kaibab National Forest, Grand Canyon National Park, ASLD, and BLM (AGFD 2006a). The community is replacing grassland vegetation in many locations as a result of livestock grazing, fire suppression, introduction of nonnative species, and other activities, many of which cause changes in vegetative composition through the creation of conditions that favor woody species over perennial grasses and forbs. Much of the vegetative diversity provided by grassland communities is lost when pinyon-juniper vegetation becomes established in nearly monotypic stands (AGFD 2006a).

Petran Montane Conifer Forest

Within the proposed withdrawal area, this vegetation community is found only on the South Parcel. It is dominated by ponderosa pine (*Pinus ponderosa*), with Gambel oak (*Quercus gambellii*) being the most common associate. Other species include New Mexican locust (*Robinia neomexicana*) and serviceberry, both usually growing as shrubs or small trees. At lower elevations, ponderosa pine may be found mixed with pinyon and juniper. The understory of more open stands supports abundant grasses and forbs. Shrubs present include those from adjoining communities, along with scattered individuals of mountain snowberry (*Symphoricarpos oreophilus*), Oregon grape (*Mahonia repens*), and Oregon boxleaf (*Paxistima myrsinites*).

Most of the Petran Montane Conifer Forest in the Colorado Plateau ecoregion is found on the Kaibab Plateau north and south of the Grand Canyon. This forested land is managed by the Forest Service and NPS. While disagreement exists in the academic and scientific communities regarding estimates of pre-settlement conditions, it remains obvious that the structure and makeup of the montane conifer forests are different, in many respects, from historic conditions (AGFD 2006a). The large, mature, “old-growth” forests of the ecoregion were replaced by dense stands of even-age ponderosa pine as a result of heavy commercial logging and associated fire-suppression activities. The more than 100 years of fire suppression has resulted in dense, closed-canopy ponderosa pine forests with abundant litter and limited herbaceous vegetation. Heavy fuel loads have caused stand replacement fires in large wildfire events over the past 25 to 30 years.

3.6.2 Invasive and Noxious Species

There are occurrences of invasive species in the proposed withdrawal area. Some of these have been designated as "noxious" weeds in the state of Arizona, meaning they have been determined to be detrimental to public health, agriculture, recreation, wildlife, or property (BLM 2009e). Although it appears that there are relatively fewer noxious weed infestations on the Kanab Plateau and House Rock Valley than in nearby areas, the North and East parcels are apparently susceptible to invasions from the north and the south (BLM 2008e). Nine noxious weed species are found on the Arizona Strip: Russian knapweed (*Acroptilon repens*), camelthorn (*Alhagi maurorum*), globed-podded hoary cress/whitetop (*Cardaria draba*), diffuse knapweed (*Centaureau diffusa*), spotted knapweed (*Centaureau maculosa*), halogeton (*Halogeton glomeratus*), three-lobed morning glory (*Ipomoea triloba*), puncturevine (*Tribulus terrestris*), and Scotch thistle (*Onopordum acanthium*). The locations of known noxious weeds on the Kanab Plateau and Kaibab National Forest are depicted on Map 3.12 in BLM (2007a:Vol. 1, Ch. 3). There also are six additional invasive species on the Arizona Strip that have not been designated as noxious but that are non-native in this region: perennial pepperweed (*Lepidium latifolium*), saltcedar, Russian olive, cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), and Malta star thistle (*Centaurea melitensis*). Medusahead (*Taeniatherum caput-medusae*), a non-native species, is established north of the proposed withdrawal area and may occur within the proposed withdrawal area in the future (BLM 2008b).

Noxious and invasive weeds found on the Kaibab National Forest include cheatgrass, Dalmatian toadflax (*Linaria dalmatica*), diffuse knapweed, Scotch thistle, bull thistle (*Cirsium vulgare*), and leafy spurge (*Euphorbia esula*) (Forest Service 2009a). Cheatgrass occurs throughout the Kaibab National Forest and Grand Canyon National Park. Dalmatian toadflax has been found on and around the Kaibab National Forest, including along SR 64, and along roadsides in Grand Canyon National Park. Diffuse knapweed has been found on the Kaibab National Forest and along SR 64, crossing the eastern boundary of Grand Canyon National Park to the Navajo Nation boundary. Scotch thistle has been found along SR 64 at the eastern boundary with Grand Canyon National Park and on many forest roads on the Kaibab National Forest. A few scattered bull thistle plants have been found in the interior of the Kaibab National Forest and in scattered locations in Grand Canyon National Park. Leafy spurge has been found within the Hull Cabin Historic District on the Kaibab National Forest. Most of these populations have been treated using manual, chemical, or biological control methods. Invasive non-native weed monitoring, new treatments, and re-treatments occur annually on the Arizona Strip and in Grand Canyon National Park. Currently, the Kaibab National Forest, Grand Canyon National Park, and several field offices of the BLM are engaged with multiple other parties as part of a Memorandum of Understanding to manage noxious weeds as the Washington County Cooperative Weed Management Area (CWMA). This memorandum outlines a formal agreement to "promote an integrated weeds management program throughout the Washington County CWMA that includes public relations, education and training in the noxious weed arena, as well as coordination of weed control efforts and methods, sharing of resources and designing other desirable resource protection measures relative to weed management."

3.6.3 Resource Condition Indicators

For vegetation resources, condition indicators include the

- amount of disturbance that would result in loss of vegetation;
- change in productivity;
- loss of diversity;
- degree of infestation of invasive species;
- degree and amount of fragmentation;
- degree and amount of contamination and loss of water resources for vegetation.

For a more detailed description of changes in vegetation spatial pattern and area occupied, see the habitat fragmentation discussion in the Fish and Wildlife section (Section 3.7).

3.7 FISH AND WILDLIFE

The proposed withdrawal area is located within the greater Colorado Plateau ecoregion, which supports a wide variety of terrestrial and aquatic wildlife species. With the exception of Kanab Creek on the Kaibab Plateau, perennial aquatic systems and associated riparian habitats are extremely rare within the proposed withdrawal area; therefore, fish and riparian-dependent wildlife species are naturally limited. However, aquatic and riparian habitats are relatively abundant, adjacent to the proposed withdrawal area along the Colorado River, seeps and springs, and associated drainages in Grand Canyon National Park.

The USGS reviewed historic hydrologic data and analyzed water samples to determine uranium levels in Northern Arizona (Bills et al. 2010). Preliminary results suggest that dissolved uranium concentrations in areas without mining were generally similar to those with active or reclaimed mines, except for Horn Creek, which has high levels of uranium, arsenic, and other toxic metals. Horn Creek is located within the Park and has been previously impacted from the Orphan Mine. Historical water-quality and water-chemistry data evaluated for approximately 1,000 water samples determined that approximately 16% have exceeded maximum contaminant levels for arsenic, iron, lead, manganese, radium, sulfate, and uranium (Bills et al. 2010). These data suggest that water recharged from the surface or from perched water-bearing zones may contain dissolved gypsum from overlying rock units or may have been in contact with sulfide-rich ore. The USGS summarize that a few springs and wells in the region contain concentrations of dissolved uranium greater than the EPA MCL of 30 μg/L (Bills et al. 2010). These springs and seeps are in close proximity to or in direct contact with orebodies. Sixty-six percent of natural water sample concentrations of dissolved uranium in the dataset were 5 μg/L or less, and they may be subjectively be classified as low concentrations for human consumption within the study area (Bills et al. 2010).

The USGS also performed a literature review and analysis (Hinck et al. 2010) to document taxa-specific (i.e., birds, fish, amphibians, reptiles, small mammals, large mammals, etc.) plant and wildlife threshold levels for uranium or other metals. Based on the finding of this report, it is apparent that many plant and wildlife species are susceptible at levels below the EPA drinking water standards for humans. Impacts include reproductive issues, added pressure from more uranium tolerant species, and mortality.

General wildlife species associated with northern Arizona and the proposed withdrawal area are discussed in Table 3.7-1 and within various subsections of Section 3.7. Federally protected species, resource agency management indicator species (MIS), and agency-listed sensitive species are addressed in Section 3.8. The term ‘possible’ is defined as being when a species has a high probability of occurring because documented habitat components are present, the species may exist in close proximity to the proposed withdrawal area, or the species may be affected by actions proposed in one or more of the alternatives.

3.7.1 Wildlife Linkages

Establishing linkages between natural lands has long been recognized as important for sustaining natural ecological processes and biological diversity. For any linkage analysis, it is important to identify a suite of species on which recommendations will be focused, as the concept of focal species in reserve design and wildlife connectivity is a central theme in local and regional conservation planning (Miller et al. 1998; Soulé and Terborgh 1999). Focal species are typically identified to symbolize ecological conditions that are critical to healthy, functioning ecosystems (Lambeck 1997). The proposed withdrawal area overlaps with or is located immediately adjacent to five linkages identified by the Arizona Wildlife Linkages Workgroup (2006) (Figure 3.7-1). Focal species identified for these five linkages by the Arizona

Wildlife Linkages Workgroup (2006) include large-game species, BLM and Forest Service Sensitive species, and NPS Species of Concern. No federally listed threatened or endangered species were included among the focal species identified for these linkages.

- **Linkage 3: Cedar Rim–Fredonia Pronghorn Crossing**. Linkage 3 consists of private, State Trust land, tribal, and BLM lands (although BLM lands make up only 9% of the linkage). Focal species associated with this linkage include mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), mountain lion (*Puma concolor*), and a variety of bats. Primary threats to this linkage include urbanization and SR 389.

Table 3.7-1. General Wildlife Species Summary

Species	Documented in the Proposed Withdrawal Area?	Documented in Close Proximity to the Proposed Withdrawal Area?	ESA status	Forest Service Management Indicator Species?	General Wildlife (per BLM and Forest Service)?	AGFD Species of Greatest Conservation Need in Arizona?	Potentially Impacted by Proposed Withdrawal?
Mammals							
Desert bighorn sheep (*Ovis canadensis nelsoni*)	Yes	Yes	No	Yes	Yes	No	Yes
Mule deer (*Odocoileus hemionus*)	Yes	Yes	No	Yes	Yes	No	Yes
Pronghorn (*Antilocapra americana*)	Yes	Yes	No	Yes	Yes	No	Yes
Elk (*Cervus canadensis*)	Yes	Yes	No	Yes	Yes	No	Yes
Mountain lion (*Puma concolor*)	Possible	Yes	No	No	Yes	Yes	Yes
Bison (*Bison bison*)	Yes	Yes	No	No	Yes	No	Yes
Birds							
Merriam's turkey (*Meleagris gallopavo merriami*)	Yes	Yes	No	Yes	No	No	Yes
Plain (Juniper) titmouse (*Baeolophus ridgwayi*)	Yes	Yes	No	Yes	No	No	Yes
Pygmy nuthatch (*Sitta pygmaea*)	Yes	Yes	No	Yes	No	No	Yes
Lucy's warbler (*Vermivora luciae*)	Yes	Yes	No	Yes	No	No	Yes
Yellow-breasted chat (*Icteria virens*)	Possible	Yes	No	Yes	No	No	Yes
American three-toed woodpecker (*Picoides tridactylus*)	Possible	Possible	No	No	No	Yes	Yes
Western purple martin (*Progne subis*)	Possible	Possible	No	No	No	Yes	Yes
Red-naped sapsucker (*Sphyrapicus nuchalis*)	Possible	Possible	No	No	No	Yes	Yes
Lewis's woodpecker (*Melanerpes lewis*)	Possible	Possible	No	No	No	Yes	Yes
Lincoln's sparrow (*Melospiza lincolnii*)	Possible	Possible	No	No	No	Yes	Yes
MacGillivray's warbler (*Oporornis tolmiei*)	Possible	Possible	No	No	No	Yes	Yes
Downy woodpecker (*Picoides pubescens*)	Possible	Yes	No	No	No	Yes	Yes
Green-tailed towhee (*Pipilo chlorurus*)	Possible	Possible	No	No	No	Yes	Yes
Ruby-crowned kinglet (*Regulus satrapa*)	Possible	Yes	No	No	No	Yes	Yes
Golden-crowned kinglet (*R. Calendula*)	Possible	Yes	No	No	No	Yes	Yes
Aquatics							
Bluehead sucker (*Catostomus discobolus*)	Possible	Yes	No	No	No	Yes	Yes
Aquatic invertebrates	Yes	Yes	No	Yes	No	No	Yes

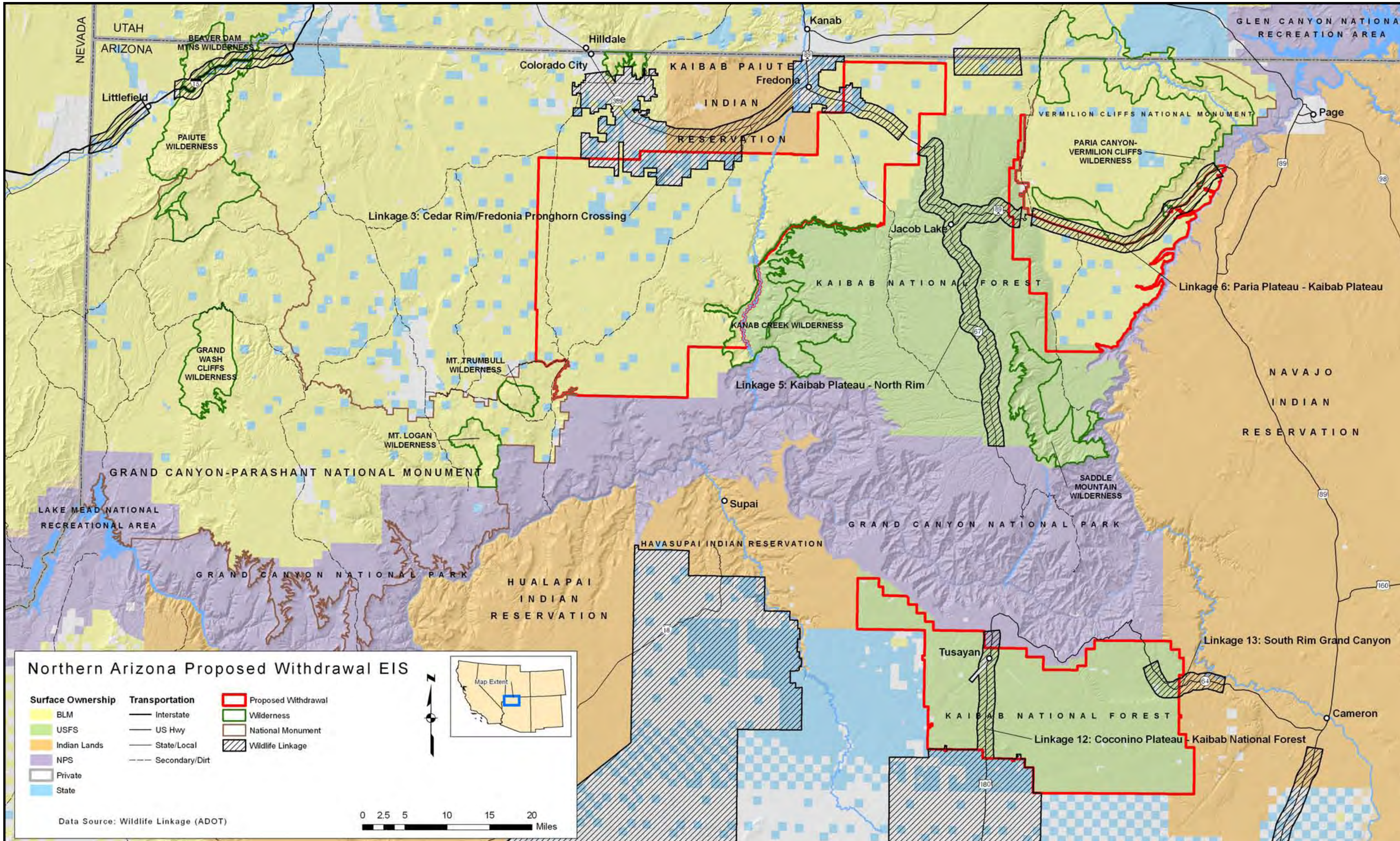


Figure 3.7-1. Wildlife linkages.

- **Linkage 5: Kaibab Plateau North Rim.** Linkage 5 consists primarily of National Forest Sytem land, with small amounts in private ownership or managed by NPS and BLM. Among the focal species associated with this linkage are mule deer, mountain lion, and wild turkey (*Meleagris gallopavo*). The major threat to this linkage is SR 67.
- **Linkage 6: Paria Plateau–Kaibab Plateau.** Linkage 6 consists primarily of BLM land, with small amounts of Forest Service, NPS, ASLD State Trust, tribal, and private land. Among the focal species associated with this linkage are pronghorn, mule deer, desert bighorn sheep (*Ovis canadensis nelsoni*), chisel-toothed kangaroo rat (*Dipodomys microps*), and western burrowing owl (*Athene cunicularia hypugea*). Threats to this linkage are listed as U.S. 89A, BLM Road 1065, and recreational traffic.
- **Linkage 12: Coconino Plateau–Kaibab National Forest.** Linkage 12 consists primarily of private and State Trust land, with small amounts of Forest Service and NPS land. Focal species include elk (*Cervus canadensis*), mule deer, mountain lion, northern goshawk (*Accipiter gentilis*), and pronghorn. Threats to this linkage include SR 64, the Grand Canyon railroad, and urbanization.
- **Linkage 13: South Rim Grand Canyon.** Linkage 13 consists primarily of tribal and Forest Service land, with a small amount of private land. Focal species include mule deer, elk, desert bighorn sheep, and mountain lion. Threats include SR 64, urbanization, and recreational traffic.

3.7.2 Fish and Aquatic Resources

The majority of standing surface waters in the Colorado Plateau ecoregion was created by impoundment of major river systems. The exception being the Colorado River and several small lakes associated with seeps and springs located both north and south of the Grand Canyon, including within the proposed withdrawal area. Human-made flood-control impoundments can significantly influence the flows, sediment transport, water quality, and aquatic habitat characteristics. Loss of natural flow, temperature, and nutrient cycling regimes can occur and have associated impacts on native aquatic species. This is compounded in most instances by the introduction of non-native fish, crustacean, and amphibian species for sport fishing. Unnatural conditions can also be created on the stream banks as well with the rapid expansion of invasive non-native plant species such as saltcedar. For a more detailed description of water resources associated with the proposed withdrawal area, see Section 3.4 and Figures 3.4-9, 3.4.10, 3.4-11, and 3.4.13.

Unique habitats that form a small part of the overall habitats represented in the proposed withdrawal area, or on adjacent lands, can be quite important to biota, as evidenced by the large number of endemic species in northern Arizona. Numerous springs and seeps associated with the Colorado River drainage support particularly rare or endemic species (NPS 2009a). With the exception of a short perennial stretch (less than 0.5 mile long) of Kanab Creek, where Clear Water Spring flows into Kanab Creek about 14 miles south of Fredonia on the Kanab Plateau, and within the North Parcel (BLM 2008b), there are no perennial stream reaches on the proposed withdrawal area. It should be noted that Kanab Creek, downstream of the North Parcel, is also perennial and has potential to be impacted by the Proposed Action. Springs and seeps also are rare features on the proposed withdrawal area (BLM 2008b; Forest Service 2009a). Consequently, there are no sizable wetlands within the proposed withdrawal area and few in the ecoregion (BLM 2008b). Water sources in the proposed withdrawal area consist of small, ephemeral water bodies that develop in low-lying areas where seasonal runoff collects and water developments such as earthen tanks for livestock exist.

3.7.3 General Wildlife Species

Species representative of aquatic/riparian, grassland, desertscrub, pinyon-juniper woodland, and ponderosa pine forest are listed in Table 3.7-2. Descriptions and species listed are from Brown and Lowe (1980). A variety of game species (including mule deer, elk, pronghorn, and turkey) and non-game wildlife species are discussed below under MIS. Two additional game species—desert bighorn sheep, a Forest Service Sensitive species, and bison (*Bison bison*), no special status—are not included in the MIS section. Desert bighorn sheep is discussed in Section 3.8.3, below. Bison is included in the discussion of the Grand Canyon Game Preserve, below.

Table 3.7-2. Representative Wildlife by Vegetation Community

Vegetation Community	Representative Wildlife Species
Aquatic/Riparian	Birds characteristic of well-developed riparian communities include Bell's vireo (*Vireo belli*). Spring habitats are important for distinct populations of invertebrates (e.g., springsnails [*Pyrgulopsis* spp.] and ambersnails [*Oxyloma* spp.]). Aquatic habitats are important for amphibians and fish (e.g., speckled dace [*Rhinichthys osculus*]).
Great Basin Grassland	The most well-known Great Basin Grassland mammal representative is the pronghorn (*Antilocapra americana*). Associated smaller mammals found in this community include pocket gopher (*Geomys* spp.), harvest mouse (*Reithrodontomys* spp.), and chisel-toothed kangaroo rat (*Dipodomys microps*). Grassland birds may include Brewer's sparrow (*Spizella breweri*), western meadowlark (*Sturnella neglecta*), prairie falcon (*Falco mexicanus*), and western burrowing owl (*Athene cunicularia hypugaea*).
Great Basin Desertscrub	A distinctive fauna is centered in the Great Basin Desertscrub vegetation community in northern Arizona. Mammals such as Townsend's ground squirrel (*Spermophilus townsendi*), long-tailed pocket mouse (*Perognathus* f*ormosus*), and northern grasshopper mouse (*Onychomys leucogaster*) are closely associated with sagebrush in the Great Basin Desertscrub. Large ungulates are poorly represented here, but mule deer and bighorn sheep are known to use this vegetation community. Birds characteristic of this community include sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), and Vesper sparrow (*Pooecetes gramineus*). Characteristic reptile and amphibian species include sagebrush lizard (*Sceloporus graciosus*) and Great Basin spadefoot toad (S*pea intermontanus*), respectively. A number of reptile subspecies such as desert horned lizard (*Phrynosomo platyrhihnos platyrhinos*) and Great Basin and Plateau tiger whiptails (*Aspidoscelis tigris tigris* and *A. tigris septentrionalis,* respectively) are indicative of Great Basin Desertscrub.
Great Basin Conifer Woodland	Vertebrate species closely tied to or centered within this vegetation community in northern Arizona include pinyon mouse (*Peromyscus truei*), pinyon jay (*Gymnorhinus cyanocephalus*), gray flycatcher (*Empidonax wrightii*), bushy-tailed woodrat (*Neotoma cinerea*), gray vireo (*Vireo vicinior*), juniper titmouse (*Baeolophus ridgwayi*), black-throated gray warbler (*Dendroica nigrescens*), Scott's oriole (*Icterus parisorum*), and Plateau striped whiptail (*A. velox*) (Brown 1994). Pinyon-juniper woodlands are also seasonal habitats for a number of montane animals; as such, they are often of great importance as winter range for elk and mule deer.
Petran Montane Conifer Forest	Several species of wildlife are dependent on ponderosa pine, including Kaibab and Abert's squirrel (*Sciurus aberti kaibabensis* and *S. aberti,* respectively), northern goshawk, and Merriam's turkey. The list of characteristic nesting avifauna includes flammulated owl (*Otus flammeolus*), white-breasted nuthatch (*Sitta carolinensis*), pygmy nuthatch (*S. pygmaea*), brown creeper (*Certhis familiaris*), western bluebird (*Sialia mexicana*), yellow-rumped warbler (*Dendroica coronata*), western tanager (*Piranga ludoviciana*), pine siskin (*Carduelis pinus*), and chipping sparrow (*Spizella passerine*). Ponderosa pine forests support a wide variety of neotropical migratory songbirds.

Grand Canyon Game Preserve

The Grand Canyon Game Preserve is located between the Kanab Plateau and House Rock Valley on the Kaibab Plateau, a portion of which is within the northern reaches of the South Parcel. The Grand Canyon Game Preserve was established through presidential proclamation in 1906 by Theodore Roosevelt and specifically designated within the Grand Canyon Forest Reserve (now the Kaibab National Forest). The reason for establishment of the preserve was related to concerns about the extirpation of game species through unregulated hunting. In order to maximize populations of game species, government-sanctioned hunters virtually eliminated predators in the preserve, leading to overpopulation by the Kaibab deer herd in the 1920s. Management of the game preserve now falls under the Kaibab LMP/ROD (Forest Service 1996), which incorporates mangement directed toward ecosystem enhancement preserve for a broad range of habitat types and variety of wildlife species. Numerous cooperating agencies work to achieve the management goals and objectives specified in the Arizona wildlife and fisheries comprehensive plan (AGFD 2007a) and cooperative agreement for the management of the Grand Canyon National Game Preserve.

Prior to the establishment of the game preserve, a herd of bison was introduced into House Rock Valley in 1906 (BLM 2008b). A portion of the herd still uses this area during the winter months and is managed as part of the Houserock Valley Wildlife Area. During the warm season, however, most of the bison move upslope to graze in the game preserve and Grand Canyon National Park. On the game preserve, the bison are managed under a Memorandum of Understanding between the Forest Service and AGFD, initially signed on August 8, 1950.

Management Indicator Species

The role of MIS in National Forest System planning is described in the 1982 implementing regulations for the National Forest Management Act of 1976. Forest Service Manual 2620.5 defines management indicators as “plant and animal species, communities or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent” (Forest Service 1991). These regulations require that certain vertebrate and/or invertebrate species present in the area be identified as MIS and that these species be monitored, as “their population changes are believed to indicate the effects of management activities” [36 CFR 219.19(a)(1)].

Table 3.7-3 is a list of MIS species for National Forest System lands associated with the proposed withdrawal area. The list is based on MIS of the Kaibab National Forest, as described in Foster et al. (2010), and input from Kaibab National Forest biologists. Included in the table are the habitat types or habitat components for which these MIS species are indicators. MIS species information is from Foster et al. (2010) and Forest Service (2008d), unless indicated otherwise.

Table 3.7-3. Wildlife Management Indicator Species on the Proposed Withdrawal Areas

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

Although northern goshawk is addressed in the Special Status Species section of this chapter, management recommendations developed for goshawk by Reynolds et al. (1992) are a major driver of forest management in the southwestern United States, including the Kaibab National Forest in the proposed withdrawal area, and are therefore described briefly here. The Kaibab LRMP/ROD (Forest Service 1988) prescribes the goshawk guidelines to all forest and woodland habitats on the Kaibab National Forest, with the exception of Mexican spotted owl (*Strix occidentalis lucida*) protected, restricted, and designated critical habitat, all of which have their own guidelines, which take precedence.

Goshawk management recommendations describe desired forest conditions for nesting, post-fledging, and foraging habitat while emphasizing conditions that support diverse prey populations (Foster et al. 2008). Fire, forest thinning, and snag retention are important components of the plan. The Kaibab LMP/ROD prescribes leaving snags in forested habitats to support goshawk prey species (Forest Service 1996).

PINYON-JUNIPER WOODLAND

The two MIS associated with pinyon-juniper woodland in the proposed withdrawal vicinity are juniper titmouse (*Baeolophus ridgwayi*) and mule deer.

Juniper titmouse (*Baeolophus ridgwayi*)

Juniper titmouse is an obligate secondary cavity nester. They typically nest in natural cavities such as knotholes or broken branches but will also use woodpecker-excavated cavities or stump holes as well as nest boxes. They are most abundant where juniper is dominant and where large, mature trees provide natural cavities for nesting. They are non-migratory and reside mainly in pinyon-juniper woodlands throughout the year. Juniper titmice occasionally wander into other habitats that are adjacent to or near pinyon-juniper woodlands, including cottonwood, willow, buffaloberry (*Shepherdia argentea*), and sagebrush shrublands, during the nonbreeding season.

Changes in historic fire regimes and habitat conversion resulting from livestock grazing are two major potential management impacts on the juniper titmouse.

Mule deer (*Odocoileus hemionus*)

Mule deer are generalists that use ponderosa pine, mixed-conifer, woodland, and chaparral habitats. Forage items mostly consist of a variety of woody browse, but they feed more on grasses and forbs during the spring and summer months. Important forage plants include mountain-mahogany (*Cercocarpus ledifolius*), buckbrush (*Ceanothus cuneatus*), cliffrose, sagebrush, buckthorn (*Rhamnus* spp.), juniper, and oak.

Mule deer apparently were not common on BLM Arizona Strip lands prior to the arrival of early settlers (BLM 2008b). Populations began increasing during the early 1900s and peaked during the 1960s following decades of intensive predator control measures. The AGFD considers the current mule deer population on the Arizona Strip to be low but stable (BLM 2008b). Numerous water sources have been developed to make more habitats accessible to deer.

PONDEROSA PINE FOREST

The five MIS associated with ponderosa pine forest in the proposed withdrawal area are Merriam’s turkey (*Meleagris gallopavo merriami*), hairy woodpecker (*Picoides villosus*), pygmy nuthatch (*Sitta pygmaea*), elk, and Abert’s squirrel (*Sciurus aberti*).

Merriam's turkey (*Meleagris gallopavo merriami*)

National forests contain the majority of turkey habitat in Arizona. Merriam's turkeys are found primarily in ponderosa pine forests with a mix of meadows, oak, and juniper. Roosting and nesting habitat consists of large, open-crowned trees, often on steep slopes. Good brood-rearing habitats include natural or created openings, riparian areas, abundant herbaceous vegetation adjacent to forest cover, and mid-day loafing and roosting areas. Turkeys are migratory in parts of their range, moving to lower elevations during winter. Timing of movements can differ annually, depending on snowfall. Current conditions on National Forest System lands provide suitable habitat for turkeys. Small-scale thinning and prescribed burning create open areas for foraging while preserving denser areas for nesting.

Hairy woodpecker (*Picoides villosus*)

Hairy woodpecker is one of the most abundant primary cavity nesters in northern Arizona. It is widely distributed wherever there are mature forests with substantial snags. Hairy woodpeckers occur in both deciduous and coniferous forests but may show preference for open pine forests in the Southwest. Although it is more abundant in Arizona pine forests, hairy woodpeckers are also found in pinyon-juniper woodland in the north and some Upper Sonoran deciduous woodlands and riparian areas in the south. Hairy woodpeckers are strongly associated with burned areas, an important historical component of northern Arizona forests resulting from frequent intervals of fire.

As primary cavity nesters, hairy woodpeckers are dependent on dead or dying portions of live trees and snags. They excavate their nests in both live and dead conifers and deciduous trees such as quaking aspen (*Populus tremuloides*) with fungal heart rot. The primary conifer species used for nesting in northern Arizona is ponderosa pine. Hairy woodpeckers prefer to drill their cavities on the underside of a curved limb in a somewhat open location.

Hairy woodpeckers primarily eat insects from the surface and subsurface of trees but also consume a diversity of fruits and seeds. In the western United States, they prefer to forage on conifers. In northern Arizona, they forage on ponderosa pine and are found in greater densities in burned areas. In turn, they are an important prey resource to many raptors, including the northern goshawk, Cooper's hawk (*Accipiter cooperi*), sharp-shinned hawk (*Accipiter striatus*), and great-horned owl (*Bubo virginianus*).

Hairy woodpecker populations are believed to be stable on the Kaibab National Forest. Based on the existing snag policy, guidelines for habitat manipulations, and the increasing severity of forest fires and number of acres burned in the Southwest, it is likely that hairy woodpecker populations will increase in the future.

Pygmy nuthatch (*Sitta pygmaea*)

Pygmy nuthatch is one of the most abundant species in ponderosa pine forests. It is virtually limited to long-leaf pine systems, including ponderosa pine and Jeffrey pine (*Pinus jeffreyi*). In northern Arizona, pygmy nuthatches breed and feed in ponderosa pine communities and also in shallow ravines that contain white fir (*Abies concolor*), Douglas-fir, Arizona white pine (*P. monticola*), quaking aspen, and an understory of maple (*Acer* spp.). Pygmy nuthatches prefer old-growth, mature forests. However, this species can also be found in densely forested areas with smaller-diameter trees as long as there is nesting and roosting sites available, such as snags or trees with dead portions suitable for excavation. Ponderosa pine foliage volume positively correlates with pygmy nuthatch abundance, but abundance inversely correlates with trunk volume, which suggests that the species prefers heterogeneous stands of well-spaced, old pines and vigorous trees of intermediate age.

Pygmy nuthatches are both primary and secondary cavity-nesters, excavating dead or well-rotted wood, but also using existing cavities in northern Arizona. They nest primarily in ponderosa pine but occasionally use other conifers and quaking aspen if cavities are present. Pygmy nuthatches are primarily insectivorous. They forage in needle clusters and on cones, twigs, branches, and trunks. Pygmy nuthatches are assumed to be stable to declining on the Kaibab National Forest.

Elk (*Cervus canadensis*)

Elk are currently considered common on the Kaibab National Forest (South Parcel) but apparently only occur intermittently on the Kanab Plateau (North Parcel) and House Rock Valley (East Parcel). In addition to occupying ponderosa pine forests, elk graze grassland and woodland habitats within the Kaibab National Forest. Although they prefer grasses over forbs, they are associated with deciduous thickets and early-seral stages that contain an interspersion of grasses and forbs. Elk occupy mountain meadows and forests in summer and move to lower-elevation pinyon-juniper woodland, conifer forest, and grasslands in winter, where they will browse woody shrubs. The population trend for elk has been stable to increasing on the Kaibab National Forest.

Mountain lion (*Puma concolor*)

Mountain lions in Arizona use desert mountains with broken terrain and steep slopes, along with dense vegetation, caves, and rocky crevices that provide shelter. Stream courses and ridgetops are frequently used as travel corridors and hunting routes. Riparian vegetation along streams provides cover for lions traveling in open areas (AGFD 2007b). Mountain lions are active throughout the year, any time, day or night, but most hunting occurs at dawn or dusk. They are essentially solitary animals, with the exception for a few days during mating and periods of juvenile dependence. In Arizona, both whitetail (*Odocoileus virginianus*) and mule deer are the principal prey species, while in other areas, javelina (*Pecari tajacu*), elk, pronghorn, bighorn sheep, and/or livestock can be major components of their diets (AGFD 2007b).

Population densities vary, depending on habitat components and density of prey items. Home range size for adult males is approximately 20 to 150 square miles, while for females it is approximately 10 to 50 square miles, both of which probably vary seasonally (AGFD 2007b). Territories of males and females may overlap, but males tend to avoid other males. Loss of habitat is probably the greatest threat to mountain lion populations throughout its range. Large tracts of roadless habitat are necessary to maintain individual populations, and the corridors that connect these tracts are required for dispersal of lions between populations. In addition, any loss of habitat of their prey species (deer) may cause a reduction in the mountain lion population.

Abert’s squirrel (*Sciurus aberti*)

Abert’s squirrel is a tassel-eared squirrel occurring south of the Grand Canyon. The species lives, nests, and forages in ponderosa pine forests. Preferred habitat structure is intermediate-aged ponderosa pine forest intermixed with larger trees, where groups of trees have crowns that are interlocking or in close proximity. Thickets of medium-sized trees, with fewer large trees per acre, also can provide favorable habitat for Abert’s squirrel. Nests are typically built in the branches of large ponderosa pines. Other nest sites include cavities in Gambel oak and in dwarf mistletoe (*Arceuthobium* spp.). Abert’s squirrels depend on the interspersion of habitat types within the forest to provide arboreal travel routes and food both on the ground and in the trees. Closed canopies and abundant snags represent forest conditions favorable for Abert’s squirrels. Abert’s squirrel populations are currently considered stable on the Kaibab National Forest.

GRASSLAND

The one MIS associated with grassland habitat in the proposed withdrawal area is pronghorn.

Pronghorn (*Antilocapra americana*)

Pronghorn are associated with grasslands and savannahs with scattered shrubs and rolling hills. It prefers forbs and grasses as forage but will browse on woody shrubs when forbs and grasses are not available. Rangeland with a low vegetative structure, averaging 15 to 24 inches in height, is considered prime pronghorn habitat. Pronghorn movements vary seasonally. Animals using habitat on the Tusayan Ranger District (South Parcel), for example, spend time on different game management units (GMUs), including areas south of the Kaibab National Forest.

Pronghorn are native to the proposed withdrawal area. However, they apparently were eliminated from the Arizona Strip in the early 1900s and reintroduced beginning in the 1960s (BLM 2008b). Much of the pronghorn habitat on the Arizona Strip is found in the Clayhole area (North Parcel) and House Rock Valley area (East Parcel). On the Kaibab National Forest, pronghorn occur primarily in the Upper Basin in the northeastern portion of the Tusayan Ranger District, the southeastern portion of the Tusayan Ranger District, and small grasslands and sagebrush-grass communities (Forest Service 2009b).

The development of private lands, fence lines, railroads, roads, and highways has resulted in the fragmentation of pronghorn habitat. On the Arizona Strip, pronghorn populations since the 1980s have been low but stable (BLM 2008b). Management actions to help restore pronghorn to their former ranges within the Arizona Strip include modifying fences to allow pronghorn movement, improving forage species composition and diversity, and developing or making other water sources available for pronghorns (BLM 2008b).

RIPARIAN

The three MIS associated with riparian habitat in the proposed withdrawal area are Lucy's warbler (*Vermivora luciae*), yellow-breasted chat (*Icteria virens*), and aquatic macroinvertebrates.

Lucy's warbler (*Vermivora luciae*)

The species is only one of two warblers in the United States that nest regularly in cavities. In Arizona, it is a common resident of low-elevation mesquite (*Prosopis* spp.) bosques, cottonwood-willow forests, and densely vegetated xeric-riparian washes. They are also found in mid-elevation ash-walnut-sycamore-live oak associations. Although considered a generalist, the preferred habitat for Lucy's warbler is dense mesquite. It has also recently begun breeding in saltcedar communities in the Grand Canyon region.

Within the proposed withdrawal area, only Kanab Creek is considered suitable habitat for Lucy's warbler. Because Lucy's warbler can nest in saltcedar, it is likely this species will persist on the Kaibab National Forest in Kanab Creek. Bird surveys conducted in Kanab Creek in 2001 failed to detect any Lucy's warblers. Lucy's warblers are likely stable within the limited habitat available on the Kaibab National Forest.

Yellow-breasted chat (*Icteria virens*)

The species prefers early-seral, shrubby thickets that are composed of low, dense vegetation with sparse canopy cover. This habitat type is found along forest edges, the margins of riparian or wetland habitat, regenerating burned areas, partially clearcut forests, and fencerows and thickets on abandoned farmland. In the arid western United States, chats are mainly confined to riparian and shrubby habitats. In Arizona, chats occur primarily in cottonwood-willow associations with a dense understory of mesquite and saltcedar along major rivers and ponds.

In the arid West, yellow-breasted chats build cup nests in dense, brushy, low-lying trees and shrubs, including Arizona alder (*Alnus oblongifolia*), Arizona ash (*Fraxinus velutina*), Russian olive, Siberian elm (*Ulmus pumila*), box-elder (*Acer negundo*), Goodding's willow (*Salix gooddingii*), coyote willow, blue-stem willow (*S. irrorata*), seep willow, canyon grape (*Vitis arizonica*), Virginia creeper (*Parthenocissus quinqurfolia*), net-leaf hackberry (*Celtis reticulata*), sumac (*Rhus trilobata*), and New Mexico forestiera (*Forestiera neomexicana*). In early successional shrubby habitats, where chats were more abundant, the preferred nesting substrates were seep willow, coyote willow (*S. exigua*), and canyon grape.

Very little riparian habitat suitable for this species is available within or adjacent to the proposed withdrawal area. What does occur consists primarily of dense, nonnative saltcedar and other native shrubs along Kanab Creek. The sometimes extensive saltcedar stands do not provide good foraging habitat and are increasing in distribution.

AQUATIC MACROINVERTEBRATES

Aquatic macroinvertebrates live in a variety of riparian habitats where water is present. As a group, they provide a vital link in the food chain between primary producers (algae and macrophytes) and fish and amphibians. Many species are useful indicators of aquatic habitat conditions. Within the proposed withdrawal area, MIS aquatic macroinvertebrates include mayflies (Order Ephemeroptera), stoneflies (Order Plecoptera), caddisflies (Order Trichoptera), and true flies (Order Diptera). Aquatic macroinvertebrates were selected for monitoring the health of late-seral, riparian habitats because a diverse and abundant array of these species is indicative of healthy riparian habitats on the Kaibab National Forest. Aquatic macroinvertebrates are sensitive to changes resulting from forest practices, such as timber harvest, grazing, and road building (NPS 2009a).

Aquatic macroinvertebrates are not considered an effective MIS on the proposed withdrawal area because of the absence of well-developed riparian areas. They are not effective management indicators when stream courses have cycles of spring runoff that subside into slow or stagnant reaches of warm, isolated, receding waters, as in Kanab Creek, although some reaches within the North Parcel are not stagnant.

3.7.4 Migratory Birds

The Migratory Bird Treaty Act of 1918 gives federal protection to all migratory birds, including nests and eggs. Under the MBTA [16 USC 703–711], it is unlawful to take, kill, or possess migratory birds except as permitted by regulations [50 CFR Subpart B]. EO 13186 of January 10, 2001 (*Federal Register* 66[11]:3853–3856), directs federal agencies to support migratory bird conservation and to "ensure that environmental analyses . . . evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern" [50 CFR Section 3d(6)]. Species of concern are defined as "those species listed in the periodic report 'Migratory Nongame Birds of Management Concern in the United States,' priority migratory bird species as documented by established plans (such as Bird Conservation Regions in the North American Bird Conservation Initiative or Partners in Flight physiographic areas), and those species listed in 50 C.F.R. 17.1" [50 CFR Section 2i].

The Bald and Golden Eagle Protection Act [16 USC 668–668c], enacted in 1940, and amended several times since then, prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles (*Haliaeetus leucocephalus*), including their parts, nests, or eggs. This law provides for the protection of the bald eagle and the golden eagle (*Aquila chrysaetos*) by prohibiting, except under certain specified conditions, the taking, possession and commerce of such birds. Amendments were made in 1972 and 1978 and a 1994 Memorandum (*Federal Register* 59:22953, April 29, 1994) from President William J. Clinton to the heads of Executive Agencies and Departments sets out the policy concerning collection and distribution of eagle feathers for Native American religious purposes.

The USFWS has the legal mandate and the trust responsibility to maintain healthy migratory bird populations for the benefit of the American public. Management recommendations for migratory birds can be found in the *USFWS Migratory Bird Program Strategic Plan 2004–2014* (USFWS 2010a). A list of species protected as migratory birds can be found in USFWS (2010b) and Appendix 2.G of the Arizona Strip ROD/RMP (2008b). Latta et al. (1999) describe priority bird species of concern by vegetation type in Arizona. These vegetation types are in turn grouped into the pertinent physiographic areas at the Partners in Flight (2010) website. The following vegetation (habitat) types are found in the proposed withdrawal area: Great Basin Woodland, Great Basin Desertscrub, Petran Montane Conifer Forest, Great Basin Grassland, Riparian Wetland, and Cliff/Rock.

Numerous migratory bird species occur within the boundaries of the proposed withdrawal area. Many of the species classified as MIS also are classified as migratory (e.g., northern goshawk, Lucy's warbler, yellow-breasted chat), as are many of the species analyzed in the Section 3.8 (e.g., northern goshawk, bald eagle, and peregrine falcon [*Falco peregrinus*]). In addition, bald eagle and golden eagle, which are both migratory species, have been observed within the proposed withdrawal area. Both are afforded added protection under the Bald and Golden Eagle Protection Act [16 USC 668–668c]. Vegetation (habitat) types and associated priority bird species of concern that may potentially occur in or adjacent to the proposed withdrawal area are listed in Table 3.7-4 and described based on information in Latta et al. (1999).

Table 3.7-4. Arizona Priority Bird Species by Vegetation Type

Vegetation Type	Species	Important Habitat Components
Great Basin Woodland		
Pinyon pine and/or juniper (may include several species)	Gray flycatcher (*Empidonax wrightii*)	Breeds in semi-arid woodlands and brushy areas that include pinyon pine and/or juniper woodlands, tall sagebrush/greasewood plains, and open ponderosa or Jeffrey pine forests with pinyon and/or juniper understory.
	Pinyon jay (*Gymnorhinus cyanocephalus*)	Pinyon pine seeds provide the primary source of reproductive energy for nesting. Food availability seems to be the most important factor determining colony breeding site selection. Open cup nests (usually one nest/tree) are placed in ponderosa pine, pinyon pine, Gambel oak, juniper, and occasionally blue spruce (*Picea pungens*).
	Gray vireo (*Vireo vicinior*)	Breeds in Arizona in open mature pinyon-juniper woodlands on canyon and mesa slopes from 3,200–6,800 feet amsl. A broadleaf shrub component is typically present, often composed of Utah serviceberry and single-leaf ash (*Fraxinus anomala*).
	Black-throated gray warbler (*Dendroica nigrescens*)	Primarily associated with pinyon pine and juniper woodlands (occasionally with scattered ponderosa pine) and mixed oak-pine woodlands. Breeding habitat is frequently characterized by a brushy undergrowth of scrub oak (*Quercus turbinella*), ceanothus (*Ceanothus* spp.), manzanita (*Arctostaphylos* spp.), or mountain mohagany (*Cercocarpus montanus*).
	Juniper titmouse (*Baeolophus ridgwayi*)	Highly restricted to pinyon-juniper woodlands. It occasionally wanders into other habitats (usually riparian) within its range that are adjacent to or near pinyon-juniper woodlands during the nonbreeding season.

Table 3.7-4. Arizona Priority Bird Species by Vegetation Type (Continued)

Vegetation Type	Species	Important Habitat Components
Great Basin Desertscrub		
Sagebrush, blackbrush, shadscale, and greasewood	Sage thrasher (*Oreoscoptes montanus*)	In Arizona, primarily occupies big sagebrush but occurs in areas of sandsage (*Artemisia filifolia*), saltbush, and greasewood.
	Sage sparrow (*Amphispiza belli*)	Closely associated with pure stands of big sagebrush throughout their range or stands intermingled with bitterbrush (*Purshia sp.*), saltbush, shadscale, rabbitbrush, or greasewood.
	Brewer's sparrow (*Spizella breweri*)	Breeds exclusively in cold desertscrub, primarily sagebrush, but also in saltbush, shadscale, and greasewood.
Petran Montane Conifer Forest		
Ponderosa pine matrix (may include some Douglas-fir, Gambel oak, pinyon pine and/or juniper, aspen, and white fir)	Northern goshawk (*Accipiter gentilis*)	Generally, nest sites are in mature and old-growth forest stands with relatively high canopy closure. In Arizona, primarily use ponderosa pine and mixed-conifer forests. In ponderosa pine habitat in Arizona, selected nest sites with higher canopy density, larger-diameter stems, and a higher frequency of large stems.
	Purple martin (*Progne subis*)	In Arizona ponderosa pine forests, prefers areas with a high snag density adjacent to or in open areas.
Great Basin Grassland		
Includes Great Basin grassland (with scattered pinyon-juniper)	Ferruginous hawk (*Buteo regalis*)	In Arizona, uses the open scrublands, woodlands, and grasslands in the northern and southeastern parts of the state. Most occupied areas include nearby slopes or knolls of widely scattered junipers.
	Burrowing owl (*Athene cunicularia hypugea*)	Found in open, dry grasslands, agricultural and range lands, and desert. Also inhabits grass, forb, and open shrub stages of pinyon pine and ponderosa pine habitats. In Arizona, predominantly associated with prairie dog (*Cynomys* spp.) towns and round-tailed ground squirrel (*Spermophilus tereticaudus*) populations.
Riparian Wetland		
Cottonwood, willow, ash, seepwillow, some saltcedar, and arrowweed	Western yellow-billed cuckoo (Cocc*yzus americanus occidentalis*)	A riparian obligate species found to be most abundant in cottonwood/willow associations. Breeds in riparian habitats, primarily below the Mogollon Rim in the Colorado and Gila river drainages.
	Southwestern willow flycatcher (*Strix occidentalis lucida*)	A riparian obligate species that requires dense habitats along rivers, streams, or other wetland areas, usually with surface water, where 10- to 30-foot-tall willows, seepwillow, arrowweed, buttonbush (*Cephalanthus occidentalis*), alder, or other shrubs and trees are present, often with a scattered overstory of cottonwood. Nests in thickets dominated by saltcedar and Russian olive.
	Lucy's warbler (*Vermivora luciae*)	Although classified as a generalist, the preferred habitat is dense mesquite. Will also use saltcedar, screwbean mesquite (*Prosopis pubescens*), and cottonwood willow (non-gallery).
Cliff/Rock		
Cliff, canyon wall, rock outcrop, talus slope	White-throated swift (*Aeronautes saxatalis*)	Occupies a wide variety of habitats, with the common attribute being the availability of nearby cliffs.
	Peregrine falcon (*Falco peregrinus*)	Occupies cliffs, canyon walls, and rock spires, usually near rivers or other water sources where prey is more abundant.
	Canyon wren (*Catherpes mexicanus*)	Found where topography provides appropriate substrates for foraging and nesting; steep slopes and canyons.

Source: Latta et al. (1999).

3.7.5 Resource Condition Indicators

For fish and wildlife resources, resource condition indicators include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and chemistry at aquatic sites), and the influence of these habitat changes on the reproductive success, population size, health, and diversity of organisms (Table 3.7-5). Many of these changes in habitat are similar to the condition indicators for vegetation. The concept of MIS was developed by the Forest Service to monitor selected ecological conditions (e.g., habitat quality) on National Forest System lands. The MIS concept is described in greater detail in Section 3.7.3, above.

Recognized threats to wildlife in the region include habitat loss and alteration, disturbance, introduction of non-native species, and increases to exposure of radiation and toxicity. The loss of habitat contiguity (i.e., fragmentation) is considered a particularly important reason for regional declines in native species and has been targeted as the most serious threat to biological diversity worldwide (Saunders et al. 1991; Wilcox and Murphy 1985). Countering this threat requires a systematic approach to identifying, protecting, and restoring functional connections across the landscape to allow essential ecological processes to continue operating. Habitat fragmentation typically leads to the isolation of populations, thus creating local subpopulations scattered across a landscape (Dobson et al. 1999). Isolation of these subpopulations may lead to local extinctions because, over time, populations restricted to isolated patches may experience a reduction in genetic diversity as a result of increased inbreeding, increased risk of local extinction from population dynamics and catastrophic events, and decreased ability to recolonize (Hanski 1999; Hanski and Simberloff 1997; Yanes et al. 1995).

Table 3.7-5. Fish and Wildlife Resource Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Wildlife habitat	Issues associated with wildlife habitat include fragmentation of habitat by roads, noise from exploration or development activities that is disruptive to wildlife, wildlife being disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator:* Acres and type of habitat lost and duration of loss. *Indicator:* Changes in migratory or foraging behavior. *Indicator:* Changes in road densities in migration corridors. *Indicator:* Avoidance or adaptation of species to noise source/visual intrusion. *Indicator:* Acres of habitat loss or degradation as a result of establishment of invasive species caused by mineral exploration or development activities.
Wildlife populations	Potential loss of critical wildlife winter range. Potential for exploration or development to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator:* Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Wildlife mortality and reproductive success	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle-wildlife accidents and associated wildlife mortality. In addition to vehicle wildlife accidents; increased uranium levels in surface and groundwater and soil contamination has potential to cause increased mortality and decreased reproductive success due to exposure of chemicals and radiation.	*Indicator:* Estimated number of vehicle-wildlife collisions associated with exploration or production activity. *Indicator:* Changes in uranium and other heavy metal levels in soils as well as on the surface and in surface waters such as rivers, streams and seeps, springs, and stock tanks fed by wells.

3.8 SPECIAL STATUS SPECIES

Special status species addressed below include 1) species listed or being considered for listing by the USFWS under the ESA; 2) BLM Sensitive species; 3) Forest Service Sensitive species; 4) NPS species of concern; and 5) AGFD Species of Greatest Conservation Need (SGCN). Figures depicting plant and animal locations are based on BLM (2008b) and data files provided by the BLM, Forest Service, and NPS. Table 3.8-1 summarizes species status and potential occurrence within the proposed withdrawal area and adjacent lands. It should be noted that some species are listed as special status species by multiple agencies. For those species that are listed as special status species by multiple agencies, the species description is included only once within Section 3.8.

Wildlife can be exposed to chemical and radiation hazards through various pathways, including ingestion (soil, food, and water), inhalation, and various cell absorption processes. In addition to the resource condition indicators discussed in Section 3.7, Fish and Wildlife Species, resource condition indicators for special status species include changes in habitat, specifically patch size, contiguity, structure, and quality (including water quality and quantity at aquatic sites), that affect overall species health and abundance, as well as potential impacts (modify or destroy) to designated critical habitat. It should be noted that several species discussed in this report, are associated with the Virgin River, which is located more than 30 miles from the proposed withdrawal area. Species that are associated with the Virgin River are included in analysis because they are listed on the USFWS Mohave County Species threatened and endangered species list and groundwater (R-aquifer) from portions of the North Parcel are associated with the Virgin River watershed (see Section 3.4, Water Resources).

3.8.1 Threatened, Endangered, and Candidate Species

The Endangered Species Act of 1973, as amended, provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The law requires federal agencies, in consultation with the USFWS and/or the U.S. National Oceanic and Atmospheric Administration Fisheries Service, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. Table 3.8-1 summarizes general information on special status species and agency involvement and documents whether that species is analyzed in detail in Chapter 4.

In addition to threatened, endangered, and candidate species, this section also addresses species proposed for listing, species undergoing status review as potential candidates for listing, species covered under Conservation Agreements, and recently delisted species. The species listed in Table 3.8-2 and discussed below were based on review of the most recent USFWS species lists for Mohave and Coconino counties, Arizona, a search of the Arizona Heritage Data Management System and pertinent literature, correspondence with the USFWS, and meetings with the USFWS, NPS, Forest Service, and BLM. Table 3.8-2 contains 43 species that may be found within the proposed withdrawal area or adjacent to the proposed withdrawal area. Information on species trends (when available) and proximity to mining claims (when applicable) is included. The term ‘possible’ is defined as when a species has a high probability of occurring because documented habitat components are present or the species may exist in close proximity to the proposed withdrawal area.

Table 3.8-1. Special Status Species Summary

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Birds							
Bald eagle (*Haliaeetus leucocephalus*)	Yes	Yes	Delisted	Yes	No	No	Yes
California condor (*Gymnogyps californianus*)	Yes	Yes	Endangered w/CH in Conservation Agreement only	No	No	No	Yes
Mexican spotted owl (*Strix occidentalis lucida*)	Yes	Yes	Threatened w/CH in North Parcel	No	No	No	Yes
Southwestern willow flycatcher (*Empidonax traillii extimus*)	Possible	Yes	Endangered w/CH	No	No	No	Yes
Yuma clapper rail (*Rallus longirostrus yumanensis*)	No	Yes	Endangered w/o CH	No	No	No	Yes
American peregrine falcon (*Falco peregrinus anatum*)	Yes	Yes	Delisted	Yes	No	No	Yes
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Possible	Yes	Candidate w/o CH	No	No	No	Yes
California brown pelican (*Pelecanus occidentalis californicus*)	No	No	Delisted	No	No	No	No See Table 4.8-1
California least tern (*Sterna antillarum browni*)	No	No	Endangered w/CH	No	No	No	No See Table 4.8-1
Northern goshawk (*Accipiter gentilis*)	Yes	Yes	No	Yes	No	No	Yes
Western burrowing owl (*Athene cunicularia hypugea*)	Yes	Yes	No	Yes	Yes	No	Yes
Mammals							
Greater western mastiff bat (*Eumops perotis californicus*)	Possible	Yes	No	Yes	No	Yes	Yes
Desert bighorn sheep (*Ovis canadensis nelsoni*)	Yes	Yes	No	Yes	No	No	Yes
Western red bat (*Lasiurus blossevillii*)	Possible	Yes	No	Yes	No	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Mammals, continued							
Spotted bat (*Euderma maculatum*)	Yes	Yes	No	Yes	No	Yes	Yes
Allen's lappet-browed bat (*Idionycteris phyllotis*)	Yes	Yes	No	Yes	Yes	Yes	Yes
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	Yes	Yes	No	Yes	No	Yes	Yes
Small-footed myotis (*Myotis ciliolabrum*)	Yes	Yes	No	No	Yes	No	Yes
Long-eared myotis (*Myotis evotis*)	Yes	Yes	No	No	Yes	No	Yes
Fringed myotis (*Myotis thysanodes*)	Yes	Yes	No	No	Yes	No	Yes
Long-legged myotis (*Myotis volans*)	Yes	Yes	No	No	Yes	Yes	Yes
Big free-tailed bat (*Nyctinomops macrotis*)	Yes	Yes	No	No	Yes	Yes	Yes
Pocketed free-tailed bat (*Nyctinomops femorosaccus*)	Possible	Yes	No	No	Yes	Yes	Yes
Mexican long-tongued bat (*Choeronycteris mexicana*)	Possible	Yes	No	No	No	Yes	Yes
Southwestern myotis (*Myotis auriculus*)	No	Yes	No	No	No	Yes	Yes
Black-footed ferret (*Mustela nigripes*)	No	Yes	Endangered w/o CH	No	No	No	No See Table 4.8-1
Southwestern river otter (*Lontra canadensis sonora*)	No	Yes	No	No	No	Yes	No See Table 4.8-1
House Rock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*)	Yes	Yes	No	Yes	Yes	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Mammals, continued							
Merriam's shrew (*Sorex merriami*)	Yes	Yes	No	Yes	No	No	Yes
Mogollon vole (*Microtus mogollonensis*)	Yes	Yes	No	Yes	No	No	Yes
Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)*	No	No	Endangered w/o CH	No	No	No	No See Table 4.8-1
Plants							
Brady pincushion cactus (*Pediocactus bradyi*)	Yes	Yes	Endangered w/o CH	No	No	No	Yes
Jones cycladenia (*Cycladenia humilis* var. *jonesii*)	No	Yes	Threatened w/o CH	No	No	No	No See Table 4.8-1
Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*)	No	Yes	Endangered w/o CH	No	No	No	Yes
Siler pincushion cactus (*Pediocactus sileri*)	Yes	Yes	Threatened w/o CH	No	No	No	Yes
Welsh's milkweed (*Asclepia welshii*)	No	Yes	Threatened w/CH in Utah	No	No	No	No See Table 4.8-1
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	Yes	Yes	Candidate w/o CH	No	Yes	No	Yes
Paradine (Kaibab) plains cactus (*Pediocactus paradinei*)	Yes	Yes	Conservation Agreement	No	No	No	Yes
Pipe Springs cryptantha (*Cryptantha semiglabra*)	Possible	Yes	90-day finding indicates listing may be warranted; status review underway	No	No	No	No See Table 4.8-1
Cliff milkvetch (*Astragalus cremnophylax* var. *myriorraphus*)	Yes	Yes	No	No	Yes	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Plants, continued							
San Francisco Peaks groundsel (*Packera franciscana*)	No	No	Threatened w/CH	No	No	No	No See Table 4.8-1
Navajo Sedge (*Carex specuicola*)	No	No	Threatened w/CH	No	No	No	No See Table 4.8-1
Arizona cliffrose (*Purshia subintegra*)	No	No	Endangered w/o CH	No	No	No	No See Table 4.8-1
Arizona bugbane (*Cimicifuga arizonica*)	No	No	Conservation Agreement	No	No	No	No See Table 4.8-1
Morton wild buckwheat (*Eriogonum mortonianum)*	Possible	Yes	90-day finding indicates listing may be warranted; status review underway	Yes	No	No	Yes
Grand Canyon rose (*Rosa stellata* var. *abyssa*)	Yes	Yes	No	No	Yes	Yes	Yes
Marble Canyon milkvetch (*Astragalus cremnohylax* var. *hevronii*)	Yes	Yes	No	No	Yes	No	Yes
Mt. Trumbull beardtongue (*Penstemon distans*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Paria Plateau fishhook cactus (*Sclerocactus sileri*)	Yes	Yes	No	No	Yes	No	Yes
September 11 stickleaf (*Mentzelia memorabilis*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Black rock daisy (*Townsendia smithii*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Toana milvetch/Diamond Butte milkvetch (*Astragalus toanus* var. *scidulus*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Crevice penstemon/Sheep Range beardtongue (*Penstemon petiolatus*)	No	Yes	No	No	Yes	No	No See Table 4.8-1

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Plants, continued							
Silverleaf sunray (*Enceliopsis argophylla*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Sticky wild buckwheat (*Eriogonum viscidulum*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Three hearts (*Tricardia watsonii*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Sandhollow/Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Gierisch mallow (*Sphaeralcea gierischii*)	No	Yes	Candidate	No	Yes*[†]	No	No See Table 4.8-1
Holmgren milkvetch (*Astragalus holmgreniorum*)	No	Yes	Endangered w/CH in Arizona and Utah	No	Yes*[†]	No	No See Table 4.8-1
Beaverdam scurfpea, Beaverdam breadroot (*Pediomelium castoreum*)	No	Yes	No	No	Yes*[†]	No	No See Table 4.8-1
Grand Canyon beavertail cactus (*Opuntia basilaris* var. *longiareolata*)	No	Yes	No	No	No	Yes	Yes
Kaibab agave (*Agave utahensis* ssp. *kaibabensis*)	No	Yes	No	No	No	Yes	Yes
McDougall's yellowtops (*Flaveria mcdougallii*)	No	Yes	No	No	No	Yes	Yes
Grand Canyon cave-dwelling primrose (*Primula specuicola*)	No	Yes	No	No	No	Yes	Yes
Kaibab suncup (Grand Canyon evening-primrose) (*Camissonia specuicola* ssp. *hesperia*)	No	Yes	No	No	No	Yes	Yes
Arizona leatherflower (*Clematis hirsutissima* var. *hirsutissima*)	Yes	Yes	No	Yes	No	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Plants, continued							
Tusayan flameflower (*Talinum validulum*)	Yes	Yes	No	No, but tracked as a rare species	No	No	Yes
Tusayan rabbitbrush (*Chrysothamnus molestus*)	Yes	Yes	No	Yes	No	No	Yes
Fish							
Apache trout (*Oncorhyncus gilae apache*)	No	No	Threatened w/o CH	No	No	No	No See Table 4.8-1
Humpback chub (*Gila cypha*)	No	Yes	Endangered w/CH–Colorado River	No	No	No	Yes
Razorback sucker (*Xyrauchen texanus*)	No	No	Endangered w/CH	No	No	No	Yes
Little Colorado spinedace (*Lepidomeda vittata*)	No	No	Threatened w/ CH	No	No	No	Yes
Bonytail chub (*Gila elegans*)	No	No	Endangered w/ CH	No	No	No	No See Table 4.8-1
Roundtail chub (*Gila robusta*)	No	No	Candidate	No	No	No	Yes
Flannelmouth sucker (*Catostomus latipinnis*)	No	Yes	No	No	Yes	Yes	Yes
Desert sucker (*Catostomus* [*Pantosteus*] *clarki*)	No	Yes	No	No	Yes	Yes	Yes
Speckled dace (*Rhinichthys osculus*)	Possible	Yes	No	No	Yes	No	Yes
Woundfin (*Plagopterus argentissimus*)	No	Yes	Endangered, w/CH along the Virgin River in Utah, Arizona, and Nevada	No	No	No	Yes
Virgin River chub (*Gila seminuda*)	No	No	Endangered w/CH along the Virgin River in Utah, Arizona, and Nevada	No	No	No	Yes

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Fish, continued							
Virgin Spinedace (*Lepidomeda mollispinis mollispinis*)	No	Yes	Conservation Agreement	No	No	No	Yes
Reptiles and Amphibians							
Relict leopard frog (*Lithobates* [Rana] *onca*)	No	No	Candidate with Conservation Agreement and Strategy	No	No	No	Yes
Northern leopard frog (*Lithobates* [Rana] *pipiens*)	Possible	Yes	90-day finding indicates listing may be warranted; status review underway	Yes	No	No	Yes
Lowland leopard frog *(Lithobates* [Rana] *yavapaiensis*	No	Yes	12-Month Status Review	Yes	No	No	Yes
Chiricahua leopard frog (*Lithobates* [Rana] *chiricahuensis*)	No	No	Threatened w/o CH	No	No	No	No See Table 4.8-1
Northern Mexico gartersnake (*Thamnophis eques megalops*)	No	No	Candidate	No	No	No	No See Table 4.8-1
Grand Canyon rattlesnake (*Crotalus oreganus abyssus*)	Possible	Yes	No	Yes	No	No	Yes
Common chuckwalla (*Sauromalus ater*)	Yes	Yes	No	No	Yes	No	Yes
Northern sagebrush lizard (*Sceloporus graciosus graciosus*)	Possible	Yes	No	No	Yes	No	Yes
Desert tortoise (*Gopherus agassizii*) (Mohave population)	No	Yes	Threatened w/CH	No	No	No	No See Table 4.8-1
Desert tortoise (*Gopherus agassizii*) (Sonoran population)	No	Yes	12-month status review	No	No	Yes	No See Table 4.8-1

Table 3.8-1. Special Status Species Summary (Continued)

Species	Documented in any of the Three Proposed Withdrawal Parcels?	Documented in Close Proximity to any of the Three Proposed Withdrawal Parcels?	USFWS Listed Species/Critical Habitat Information	Forest Service Sensitive Species?	BLM Sensitive* Species?	Grand Canyon National Park Species of Concern?	Potentially Impacted by Proposed Withdrawal?
Reptiles and Amphibians, continued							
Banded gila monster (*Heloderma suspectum cinctum*)	Yes	Yes	No	No	Yes	No	Yes
Invertebrates							
Succineid snails (*F. Succineidae*), Niobrara ambersnail (*Oxyloma haydeni haydeni*)	Possible	Yes	Endangered w/o CH	No	No	No	Yes
MacNeill's sootywing (*Hesperopsis gracielae*)	No	Yes	No	No	Yes	No	No See Table 4.8-1
Grand Canyon cave pseudoscorpion (*Archeolarca cavicola*)	No	Yes	No	No	No	Yes	Yes
Hydrobiid spring snails Grand Wash springsnail (*Pyrgulopsis bacchus*) Desert springsnail (*Pyrgulopsis deserta*)	No	Yes	No	No	Yes	No	Yes
Succineid snails (all species in Family Succineidae), including Niobrara ambersnail (*Oxyloma haydeni haydeni*); (Kanab ambersnail *O. h. kanabensis* treated above)	No	Yes	No	No	Yes	No	Yes

Notes: CH = Critical habitat.

USFWS Species list for Coconino and Mohave counties was accessed on January 15, 2010, and again on August 15, 2010.

Arizona Heritage Data Management System accessed on January 15, 2010; received data on January 20, 2010 (buffer set for proposed withdrawal area only).

* BLM (2005a) list.

† Retained because locations mapped by BLM for previous (pre-2005) sensitive species list.

Table 3.8-2. Federally Listed Species and Their Potential for Occurrence in the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Brady pincushion cactus (*Pediocactus bradyi*)	USFWS E	No	Yes	No
Sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*)	USFWS E	No	No	Yes
Holmgren milk-vetch (*Astragalus holmgreniorum*)	USFWS E BLM S	No	No	No
Welsh's milkweed (*Asclepias welshii*)	USFWS T with Critical Habitat	No	No	No
Siler pincushion cactus (*Pediocactus sileri*)	USFWS T	Yes	No	No
Jones' cycladenia (*Cycladenia humilis* var. *jonesii*)	USFWS T	No	No	No
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	USFWS C BLM S	Yes	Yes	Possible*
Paradine (Kaibab) plains cactus (*Pediocactus paradinei*)	USFWS CA	No	Yes	No*
Pipe Springs cryptantha (*Cryptantha semiglabra*)	Positive 90-day finding	Possible	No	No
Morton wild buckwheat (*Eriogonum mortonianum*)	Positive 90-day finding Forest Service S	Possible	No	No
Gierisch mallow (*Sphaeralcea gierischii*)	USFWS C BLM S	No	No	No
San Francisco Peaks groundsel (*Packera franciscana*)	USFWS T with Critical Habitat	No	No	No
Navajo Sedge (*Carex specuicola*)	USFWS T with Critical Habitat	No	No	No
Arizona cliffrose (*Purshia subintegra*)	USFWS E	No	No	No
Arizona bugbane (*Cimicifuga arizonica*)	USFWS Conservation Agreement	No	No	No
Wildlife				
Black-footed ferret (*Mustela nigripes*)	USFWS E	No	No	No
California condor (*Gymnogyps californianus*)	USFWS E with Critical Habitat-CA only	Yes	Yes	Yes
Southwestern willow flycatcher (*Empidonax traillii extimus*)	USFWS E with Critical Habitat	Possible	No	No
Yuma clapper rail (*Rallus longirostrus yumanensis*)	USFWS E	No	No	No
Mexican spotted owl (*Strix occidentalis lucida*)	USFWS T with Critical Habitat	Yes	Possible	Possible
Yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	USFWS C	Possible	No	No
Bald eagle (*Haliaeetus leucocephalus*)	USFWS Delisted Forest Service S	Yes	Yes	Yes
American peregrine falcon (*Falco peregrinus anatum*)	USFWS Delisted Forest Service S	Yes	Possible	Possible
California least tern (*Sterna antillarum browni*)	USFWS E	No	No	No

Table 3.8-2. Federally Listed Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Wildlife, continued				
California brown pelican (*Pelecanus occidentalis californicus*)	USFWS Delisted	No	No	No
Desert tortoise (*Gopherus agassizii*) (Mojave population)	USFWS T with Critical Habitat	No	No	No
Desert tortoise (*Gopherus agassizii*) (Sonoran population)	12-month status review initiated	No	No	No
Chiricahua leopard frog (*Lithobates* [Rana] *chiricahuensis*)	USFWS T	No	No	No
Northern Mexico gartersnake (*Thamnophis eques megalops*)	USFWS C	No	No	No
Relict leopard frog (*Lithobates* [Rana] *onca*)	USFWS C with CA	No	No	No
Northern leopard frog (*Lithobates* [Rana] *pipiens*)	Positive 90-day finding Forest Service S	Possible	No	No
Lowland leopard frog *(Lithobates* [Rana] *yavapaiensis*	12 month status review BLM S Forest Service S	Possible	No	No
Humpback chub (*Gila cypha*)	USFWS E with Critical Habitat	No	No	No
Razorback sucker (*Xyrauchen texanus*)	USFWS E with Critical Habitat	No	No	No
Virgin River chub (*Gila seminuda*)	USFWS E with Critical Habitat	No	No	No
Woundfin (*Plagopterus argentissimus*)	USFWS E with Critical Habitat	No	No	No
Apache trout (*Oncorhyncus gilae apache*)	USFWS T	No	No	No
Little Colorado spinedace (*Lepidomeda vittata*)	USFWS T with Critical Habitat	No	No	No
Bonytail chub (*Gila elegans*)	USFWS T with Critical Habitat	No	No	No
Roundtail Chub (*Gila robusta*)	USFWS C	No	No	No
Virgin spinedace (*Lepidomeda mollispinis mollispinis*)	CA	No	No	No
Kanab ambersnail (*Oxyloma haydeni kanabensis*)	USFWS E	No	Possible	No
Hualapai Mexican vole (*Microtus mexicanus hualpaiensis)*	USFWS E	No	No	No

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

USFWS

C = Candidate. Species for which USFWS has sufficient information on biological vulnerability and threats to support proposals to list as Endangered or Threatened under ESA. However, proposed rules have not yet been issued because such actions are precluded at present by other listing activity.

CA = Conservation Agreement. Formal agreement between the Forest Service and one or more parties to address the conservation needs of proposed or candidate species, or species likely to become candidates, before they become listed as endangered or threatened.

Delisted = Species considered recovered and removed from the list of Endangered and Threatened Wildlife and Plants. Delisted species are monitored for 5 years.

E = Listed Endangered: imminent jeopardy of extinction under ESA.

T = Listed Threatened: imminent jeopardy of becoming endangered under ESA.

12-month status review = Status review being conducted to determine 1) listing not warranted; 2) listing as threatened or endangered warranted; or 3) listing warranted but precluded by other, higher-priority species.

* Adapted from Forest Service (2009a).

Plants

BRADY PINCUSHION CACTUS (*PEDIOCACTUS BRADYI*)

The species is known to occur at several locations in House Rock Valley (Figure 3.8-1). Within House Rock Valley, the BLM currently administers the Marble Canyon ACEC (see Figure 3.6-1) for protection of the species (BLM 2008b). The Marble Canyon ACEC includes one of only two populations known to occur on public lands (BLM 2007). It is also the only area where the species overlaps Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*) (see below). The soils where Brady pincushion cactus occurs are derived from the Moenkopi Formation and characterized by overlying limestone chips. Trend studies have been conducted yearly since 1986 and show a stable population, with some fluctuations related to rodent depredation and precipitation (BLM 2007).

SENTRY MILKVETCH (*ASTRAGALUS CREMNOPHYLAX* VAR. *CREMNOPHYLAX*)

The plant is not known to occur within the proposed withdrawal area. *Astragalus* is the largest genus of flowering plants in Arizona. *Astragalus cremnophylax* and three other species are in the subsection *Humillimi* of *Astragalus* (Maschinski 1993). *A. cremnophylax* is divided into three varieties, including *A. c.* var. *cremnophylax*, *A. c.* var. *myriorrhaphis* (cliff milkvetch) and *A. c.* var. *hevronii* (Hevron's milkvetch). Currently, a population on the North Rim of the Grand Canyon is considered a part of *A. c.* var. *cremnophylax*; however, this population may be a new variety. This population has since been determined by genetic research (Allpin et al. 2005) to be a separate species, proposed to be named *Astragalus septentriorema*. Two populations occur on the South Rim of Grand Canyon National Park, including near El Tovar (AGFD 2005a). This species grows in the uppermost layer of a very particular white layer of limestone (Kaibab limestone). The plants occur in crevices and depressions with shallow, well-drained soils or porous limestone pavement in the pinyon-juniper woodland along the Grand Canyon's edge. Populations of the plant may be declining. According to the Draft Recovery Plan for the Sentry milkvetch (USFWS 2006a), none were found at the Grandview Point locality during surveys completed in 2003–2004; this population is thought to have died out. In 2001, the original population at Maricopa Point contained approximately 665 individuals; however, monitoring completed in 2004 shows a continuing decline in plants, with only 376 plants detected.

HOLMGREN MILKVETCH (*ASTRAGALUS HOLMGRENIORUM*)

The species does not occur within the proposed withdrawal area. Only three populations are known: one in Arizona and two in Washington County, Utah (USFWS 2010c). The primary population is in Mohave County, Arizona (see Figure 3.8-1), near the Virgin River Gorge. All populations are within 9 miles of St. George, Utah. Habitat for the species is shallow, sparsely vegetated soils derived primarily from the Virgin Limestone member of the Moenkopi Formation at 2,700 to 2,800 feet amsl. The number of living plants may not exceed 10,000 (Van Buren and Harper 2003). In drought years, populations are as much as 95% smaller than in years with adequate water.

WELSH'S MILKWEED (*ASCLEPIAS WELSHII*)

The species is not known to occur within the proposed withdrawal area. In Arizona, it occurs north of House Rock Valley along BLM Road 1065 (see Figure 3.8-1); it is also found in Utah north of the Kanab Plateau. It grows on open, sparsely vegetated, semi-stabilized sand dunes and on the lee slopes of actively drifting sand dunes. It is found in small numbers in Vermilion, scattered in the Navajo Sandstone derived Aeolian sand dunes of Coyote Buttes (BLM 2007). In the past, OHV activity was the main threat to this species, but it is now well protected as a result of the designation and management of the Paria Canyon–Vermilion Cliffs Wilderness Area, which encompasses the Coyote Buttes. Critical habitat is located entirely in Utah around Coral Pink Sand Dunes State Park. As denoted with designated critical habitat,

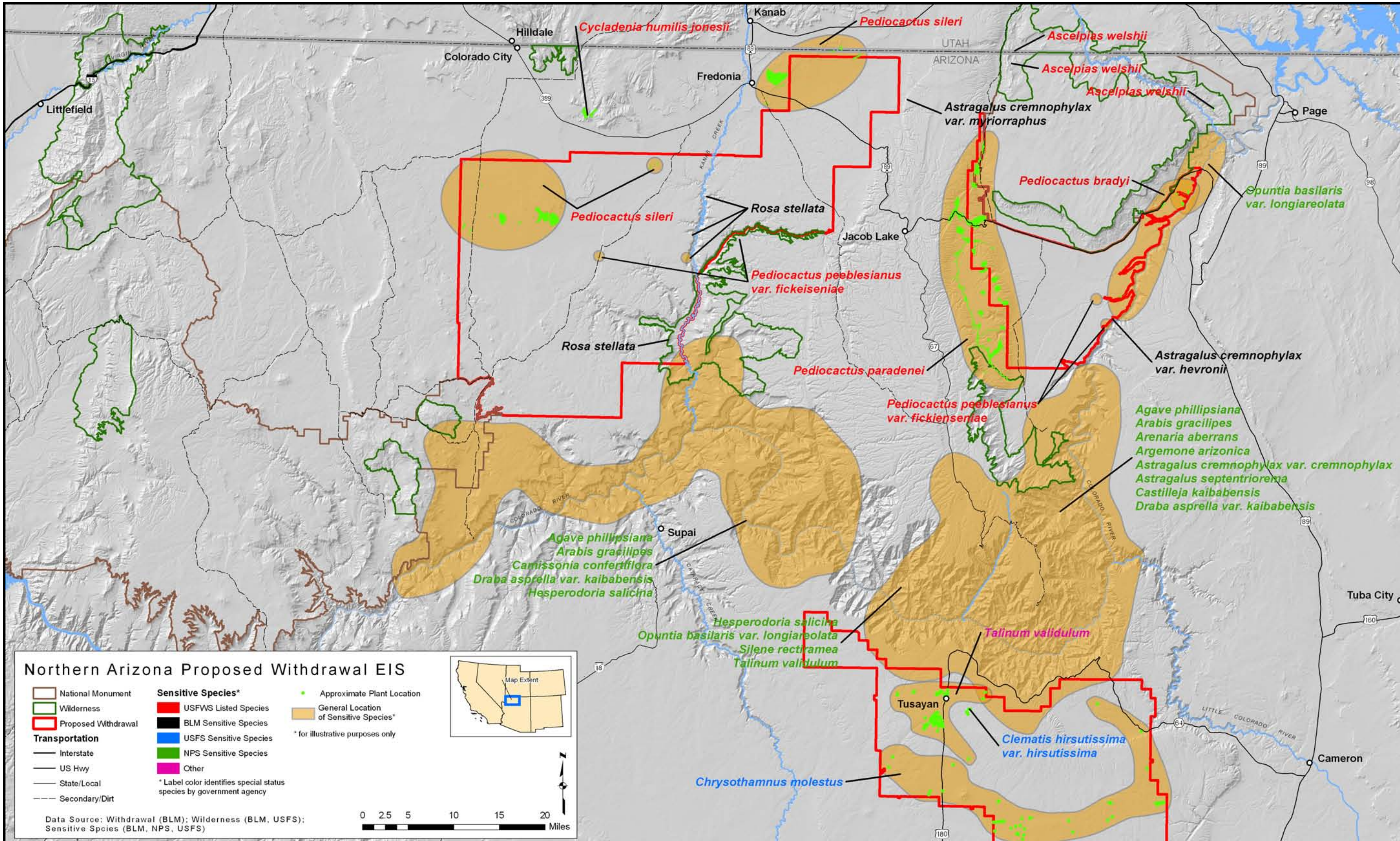


Figure 3.8-1. Special status plants.

this species is found on open, sparsely vegetated semi-stabilized coral pink sand dunes, in sagebrush, juniper, pine and oak communities of the Great Basin desertscrub, at 1,700–1,900 m amsl (AGFD 2005b). Populations of Welsh's milkweed apparently are stable. It is known from four locations, with a total of approximately 20,000 aboveground stems (AGFD 2005b).

SILER PINCUSHION CACTUS (*PEDIOCACTUS SILERI*)

Siler pincushion cactus occurs at several locations on the Kanab Plateau within the proposed withdrawal area (see Figure 3.8-1). Within the North Parcel, both the Johnson Spring and Moonshine Ridge ACECs (see Figure 3.6-1) were established in part to protect this cactus. Several of the known populations occur outside these two ACECs, including along BLM Road 5. The species is found exclusively on gypsiferous clay to sandy soils and appears to be strongly related to the Shnabkaib and middle red members of the Moenkopi Formation (BLM 2007). These soils are high in soluble salts.

Trend studies, first undertaken in the 1980s, demonstrate a relatively stable population with some fluctuations caused by precipitation and rodent depredations (BLM 2007). The species was downlisted to threatened in 1993 because it was later determined to be more abundant and widespread than was believed at the time of listing. Two mining claims are within the boundaries of known populations, and another 25 mining claims are within about 1,300 feet of known populations (Payne et al. 2010).

JONES' CYCLADENIA (*CYCLADENIA HUMILIS* VAR. *JONESII*)

The species is not known to occur within the proposed withdrawal area. Although its range is mostly in Utah, the species occurs in Arizona a few miles north of the Kanab Plateau (see Figure 3.8-1), just west of the Kaibab Indian Reservation in Potter Canyon and an adjacent canyon. The Lone Butte ACEC (see Figure 3.6-1) was established in part to protect this plant. In Arizona, it is found on gypsiferous, saline soils of the Chinle Formation (BLM 2007).

The population in Arizona appears to be well protected from threats resulting from private land and rugged terrain, which limit access. Trend studies have been undertaken at two plots and have shown a stable population with some precipitation-related fluctuations (BLM 2007).

FICKEISEN PLAINS CACTUS (*PEDIOCACTUS PEEBLESIANUS* VAR. *FICKEISENIAE*)

Fickeisen plains cactus occurs within the proposed withdrawal area (see Figure 3.8-1) (Forest Service 2009a). On the North Parcel, it occurs in areas between the canyon draining Kanab Creek, particularly on plateaus between Chamberlain, Hack, and Grama canyons, as well as along the Toroweap Road (BLM Road 109). On the East Parcel, the species occurs within the Marble Canyon ACEC, as well as along the western portion of House Rock Valley within and along the edge of Kaibab National Forest. The Coconino Rim portion of the Kaibab National Forest may contain habitat for the plant, but surveys of this habitat have not been conducted. It tends to occur in shallow soils derived from exposed layers of Kaibab Limestone (BLM 2007). After flowering and fruiting, the cactus retracts into the soil, making it difficult to locate. This cactus occurs in very small populations at several locations on the Arizona Strip.

Trend studies have been ongoing since the middle 1980s and show populations are relatively stable, with occasional fluctuations from precipitation and rodent depredation (BLM 2007). There are no mining claims within known Fickeisen plains cactus populations, but there are four claims within 1,300 feet of known plants (Payne et al. 2010).

PARADINE (KAIBAB) PLAINS CACTUS (*PEDIOCACTUS PARADINEI*)

The species is found within the proposed withdrawal area (see Figure 3.8-1) (Forest Service 2009a). Management considerations for this species is addressed through a Conservation Agreement dated February 11, 1998, and signed by the Forest Service, BLM, and USFWS. It occurs in fairly open, mostly level sites on alluvial fans, valley bottoms, and ridge tops where plants are preferentially associated with grass (blue grama) (AGFD 1999). It prefers soils with coarse fragments in conjunction with the Kaibab Limestone Formation (BLM 2007).

Populations apparently are declining on both BLM and Forest Service land (BLM 2007). The cactus apparently occurs consistently on the Kaibab National Forest. Phillips et al. (2001) conducted surveys on the North Kaibab Ranger District in 1992–1994 and found a fairly substantial population of scattered individuals in pinyon-juniper woodland. Field surveys in July 2000, however, showed an apparent sharp decrease in the numbers of cacti since 1994, probably as a result of conditions caused by a drought from 1998 to the summer of 2000.

PIPE SPRINGS CRYPTANTHA (*CRYPTANTHA SEMIGLABRA*)

The species is found outside the proposed withdrawal area north of the Kanab Plateau in extreme northwestern Coconino County and adjacent extreme northeastern Mohave County, in the area surrounding the town of Fredonia, Arizona (AGFD 2004a). All known localities are within 7 miles of Fredonia, and the type location is 2 miles east of Fredonia. It is found in the arid red detrital clay soils and gray shales of the Moenkopi Formation in the Great Basin Desertscrub biotic community at elevations ranging from 4,600 to 4,900 feet amsl (AGFD 2004a). Trends in populations are unknown (AGFD 2004a). This species appears to be tolerant of disturbance. A positive 90-day finding was published in the *Federal Register* (74[158]:41649–41662) for the Pipe Springs cryptantha and a 12-month status review to determine whether or not to federally list the species will be published in the future.

GIERISCH MALLOW (*SPHAERALCEA GIERISCHII*)

The species does not occur within any of the proposed withdrawal parcels. It is found in extreme northwestern Mohave County near the vicinity of Black Rock Gulch, Black Knolls, and Pigeon Canyon (AGFD 2005k). Habitat includes warm desert shrub community, mainly on gypsiferous outcrops of the Harrisburg Member of the Kaibab Formation as well as on the Moenkopi Formation (AGFD 2005k). Population trends are unknown (AGFD 2005k).

SAN FRANCISCO PEAKS GROUNDSEL (*PACKERA FRANCISCANA*)

The species does not occur within the proposed withdrawal area. This species is found in alpine tundra above southwestern spruce-fir or bristlecone pine (*Pinus aristata*) forests on talus slopes above 3,300 m (10,900 feet) amsl. The current range of this species includes San Francisco Peaks, Coconino County. Critical habitat has been established for this species and includes three alpine areas of Coconino National Forest (USFWS 2008).

NAVAJO SEDGE (*CAREX SPECUICOLA*)

This species does not occur within the proposed withdrawal area. This species is endemic to the Navajo Nation, Coconino, Navajo, Apache counties in Arizona and San Juan County in Utah (AGFD 2005n). Within northern Arizona, this species is known to occur from the Navajo Creek drainage in Coconino County, east to the Tsegi Canyon Watershed and the east side of Shonto Wash south of Shonto in Navajo County, south to the Rock Point/Mexican Water and Canyon de Chelly National Monument, Apache County (AGFD 2005n).

ARIZONA CLIFFROSE (*PURSHIA SUBINTEGRA*)

This species does not occur within the proposed withdrawal area. This species is endemic to Arizona. Within Arizona this species is found in Central Arizona near Horseshoe Lake, Maricopa County; near Cottonwood, Yavapai County; near Burro Creek, Mohave County; and near Bylas, Graham County (AGFD 2001m). Habitat includes rolling, rocky, limestone hills and slopes within Sonoran Desertscrub. This species requires white Tertiary (Miocene and Pliocene) limestone lakebed deposits high in lithium, nitrates, and magnesium (AGFD 2001m).

ARIZONA BUGBANE (*CIMICIFUGA ARIZONICA*)

This species does not occur within the proposed withdrawal area. This species is endemic to Arizona (AGFD 2008a). Within Arizona this species is found in Central Arizona near Bill Williams Mountain (Kaibab National Forest), tributaries to Oak Creek, and West Clear Creek (Coconino National Forest), Coconino County; Workman Creek and Cold Springs Canyon in the Sierra Ancha Mountains (Tonto National Forest), Gila County (AGFD 2008a).

Animals

BLACK-FOOTED FERRET (*MUSTELA NIGRIPES*)

The species does not occur within the proposed withdrawal area. In Arizona, it has been reintroduced into the Aubrey Valley in Coconino County (AGFD 2001b), where there are currently two populations: an experimental, nonessential population [10(j) status]; and a fully protected population located approximately 10 miles southwest of the Kaibab National Forest (Figure 3.8-2). There are no known colonies of Gunnison's prairie dogs (*Cynomys gunnisoni*), their main prey species, on the Kaibab National Forest large enough to support black-footed ferrets (Forest Service 2009a). Habitat includes arid prairies, the same habitat used by prairie dogs, the principal food source of the species.

HUALAPAI MEXICAN VOLE (*MICROTUS MEXICANUS HUALPAIENSIS*)

The species does not occur within the proposed withdrawal area and is endemic to Arizona. This species is known from Mohave County (Hualapai and Music Mountains, Grand Wash Cliffs, Wabayuma Peak vicinity, and upper Blue Tank Wash drainage), Coconino County (Prospect Valley, Laguna Valley, Aubrey Cliffs, Round Mountain, and Trinity Mountain), Yavapai County (Santa Maria and Santa Prieta mountains, and Walnut Creek vicinity, north of Bald Mountain) (AGFD 2003m). The Hualapai Mexican vole is primarily associated with woodland forest types containing grasses and grass-sedge associates and occurs in moist, grass-sedge habitats along permanent or semipermanent waters (such as springs or seeps), but may be able to occupy drier areas when grass/forb habitats are available, particularly during wetter years (AGFD 2003m). This species diet consists mainly of grasses, forbs, and other plants (AGFD 2003m).

CALIFORNIA CONDOR (*GYMNOGYPS CALIFORNIANUS*)

The species has been recorded within the proposed withdrawal area (Figure 3.8-3). The North and East parcels serve as important travel routes for condors traveling from the Grand Canyon, Kaibab Plateau, and Marble Canyon to southern Utah and Zion National Park. Critical habitat for this species occurs in California only. A reintroduction program began on the BLM's Arizona Strip District in 1996, with release sites on both the Vermilion Cliffs and the Hurricane Cliffs. This reintroduced population has been designated experimental, non-essential, as defined under Section 10(j) of the ESA. For ESA Section 7 purposes, the species is treated as a proposed species on BLM and Forest Service lands and as a

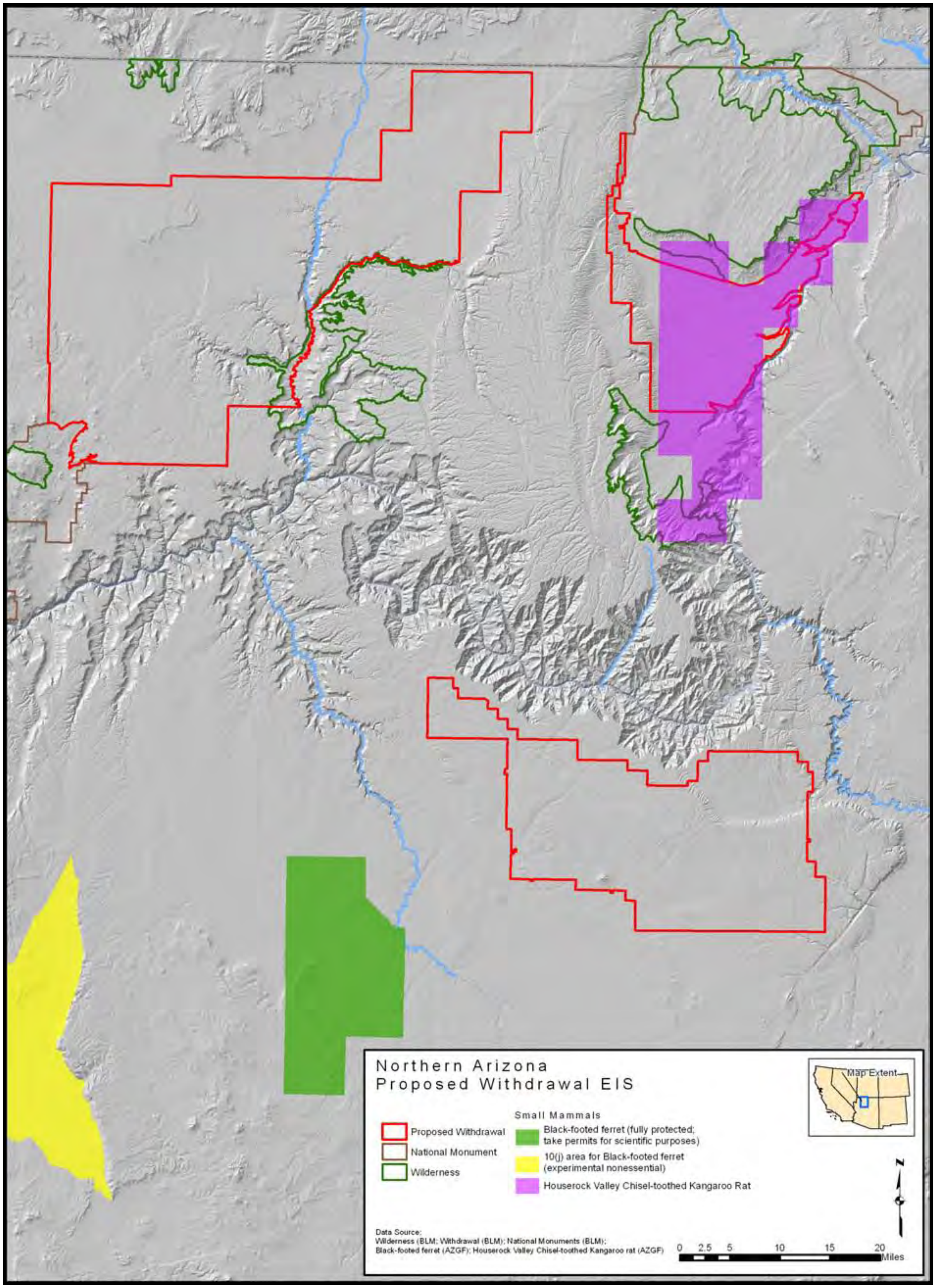


Figure 3.8-2. Black-footed ferret and Houserock Valley chisel-toothed kangaroo rat.

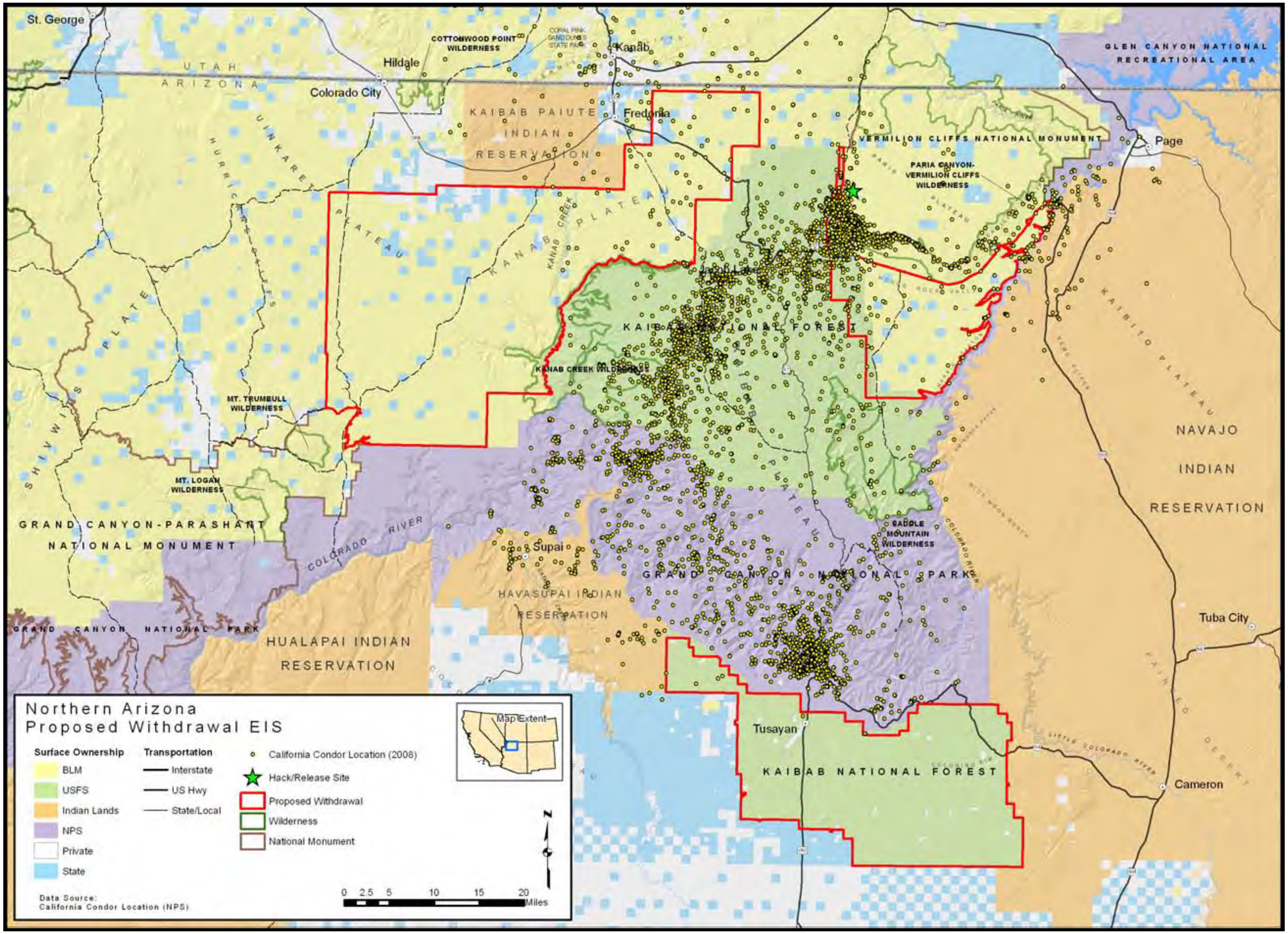


Figure 3.8-3. California condor.

threatened species on NPS lands. As of July 2009, there were 180 free-flying condors, 75 of which are found in Arizona (Payne et al. 2010). This species is a carrion feeder, usually on mammalian carcasses. Foraging for carrion occurs over long distances, as a condor can travel 80 to 160 km (48–96 miles) per day in search of food (USFWS 2001). It is highly attracted to human activity. Condors have been documented having successful breeding in the vicinity of the Vermilion Cliffs and east side of the Kaibab Plateau and within the Grand Canyon. The designated experimental population area in Arizona includes portions of Apache, Coconino, Mohave, Navajo, and Yavapai counties (USFWS 2001). Condors' diet consists of large, terrestrial mammalian carcasses such as deer, goats, sheep, donkeys, horses, pigs, cougars, bears, or cattle. Alternatively, they may feed on the bodies of smaller mammals, such as rabbits or coyotes (USFWS 2001).

SOUTHWESTERN WILLOW FLYCATCHER (*EMPIDONAX TRAILLII EXTIMUS*)

Southwestern willow flycatchers occur along the Colorado River in the Grand Canyon. The species is not known to occur in the proposed withdrawal area (Figure 3.8-4), and there is no critical habitat on the proposed withdrawal area (Figure 3.8-5). Critical habitat is located along the Virgin River and includes riparian areas dominated by native plants which can vary from single-species, single-layer patches to multi-species, multilayered strata with complex canopy and subcanopy structure. The southwestern willow flycatcher diet primarily consists of insects.

Habitat along Kanab Creek may be used during migration by flycatchers for resting and feeding. The BLM has identified two patches of suitable habitat along Kanab Creek (one at Clearwater Spring and the other 0.5 mile downstream from the spring) and several areas of potentially suitable habitat adjacent to Gunsight Point, but no willow flycatchers have been documented at any of these locations (BLM 2007). Willow-cottonwood habitat along Kanab Creek has been replaced largely by saltcedar which is also used by southwestern willow flycatchers. The Kanab Creek ACEC (see Figure 3.6-1), designated at 13,148 acres, was in part established for protection of the species (BLM 2008b).

Nesting sites have been identified in upper Grand Canyon near RMs 24, 28, 50, and 71 (Payne et al. 2010), as well as along the river corridor from Spencer Canyon/RM 246 (Payne et al. 2010) to Lake Mead National Recreation Area (RM 285.3) (McLeod et al. 2008). The locations of the canyon nesting areas are depicted in Figure 3.8.4.

The north-central limit of the breeding range for the species is southern Utah. Historically, it was recorded in southern Utah along the Virgin River (Phillips 1948; Wauer and Carter 1965), Colorado River and Kanab Creek (Behle 1985; Behle et al. 1958; Behle and Higgins 1959; Browning 1993), and perhaps the Paria River (BLM unpublished data, as cited in USFWS 2002b). Recent studies along the Virgin River in St. George have located resident and breeding individuals (Langridge and Sogge 1998; McLeod and Koronkiewicz 2010). According to the range-wide willow flycatcher database, Kanab Creek, in the town of Kanab, has been surveyed from 2000 to 2007, with two territories recorded in 2002 and none in other years (personal communication, S. Durst, USFWS March 2010).

YUMA CLAPPER RAIL (*RALLUS LONGIROSTRUS YUMANENSIS*)

Yuma clapper rail is not known to occur within the proposed withdrawal area. In Arizona this species is found along the Colorado River (AGFD 2006b). However, there reportedly are sightings of it in the marsh habitat at the confluence of Beaver Dam Wash and the Virgin River (BLM 2007). It may also occur along the Virgin and Muddy rivers in Nevada near Lake Mead. Large populations are present on Bill Williams River, the lower Gila River from near Phoenix to the Colorado River, and along the lower Salt and Verde rivers. It prefers the tallest, densest cattail and bulrush (*Scirpus* sp.) marshes available (AGFD 2006b). Yuma clapper rail primarily eats crustaceans and mollusks.

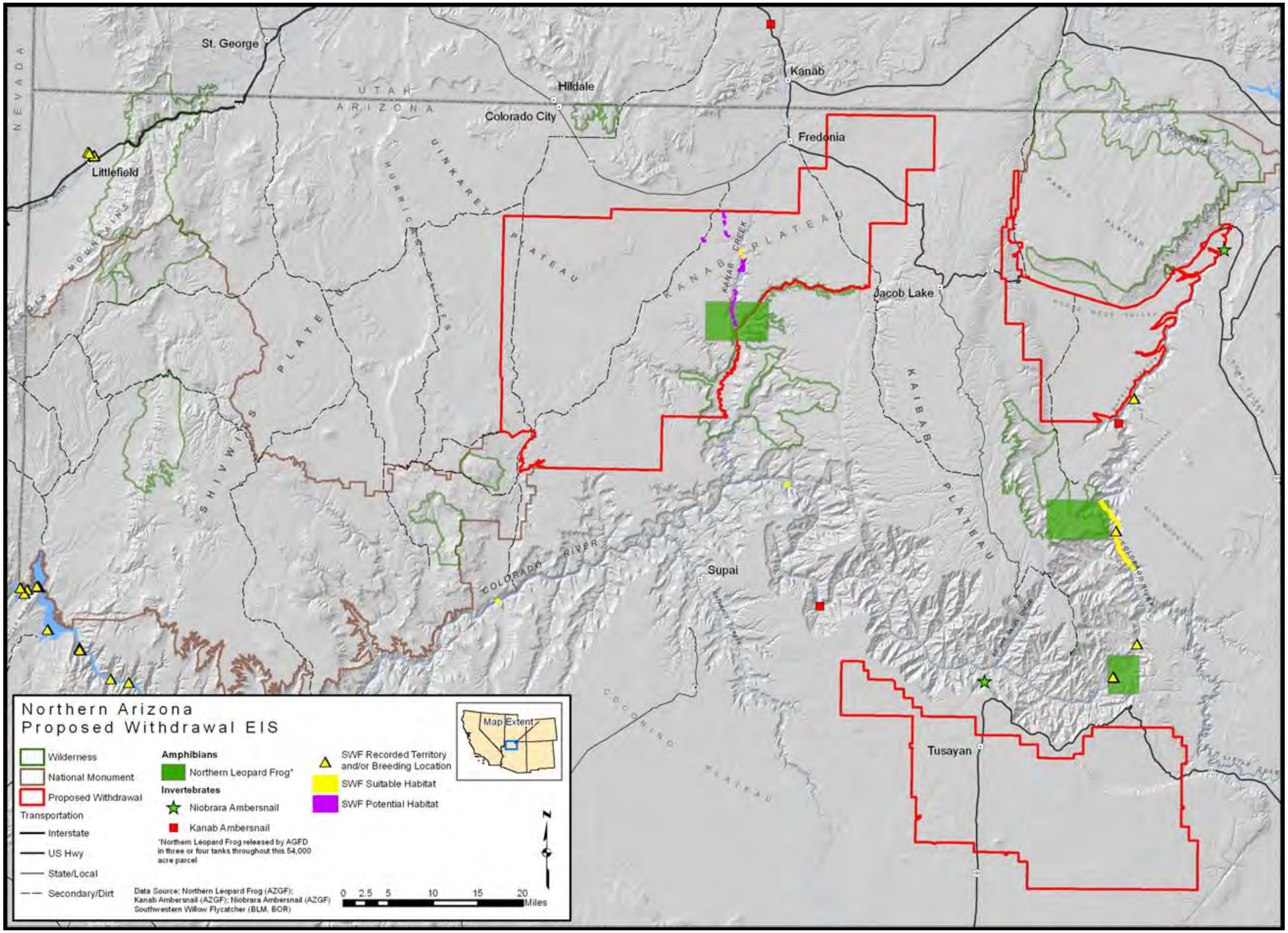


Figure 3.8-4. Ambersnails, northern leopard frog, and southwestern willow flycatcher.

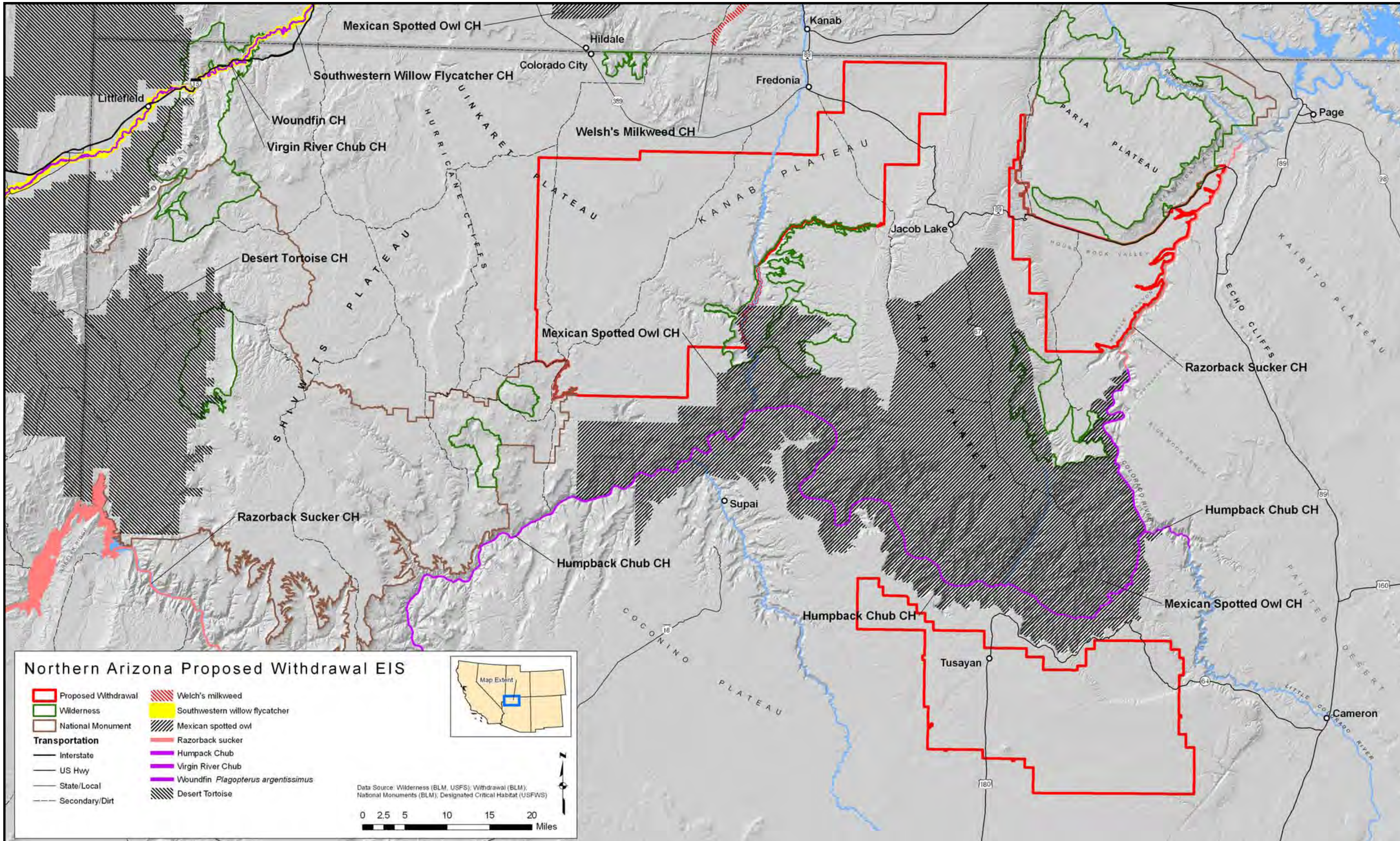


Figure 3.8-5. Critical habitat.

MEXICAN SPOTTED OWL (*STRIX OCCIDENTALIS LUCIDA*)

There are no known Mexican spotted owl nesting records for any of the proposed withdrawal parcels; however, a portion of Kanab Creek, which has been included as critical habitat for this species is located within the North Parcel. A total of 41 Protected Activity Centers (PACs) have been recorded in Grand Canyon National Park within the upper reaches of several large, steep-walled tributary side canyons (Payne et al. 2010). A PAC is delineated at known owl sites to encompass a minimum of 600 acres of the best nesting and roosting habitat at the site. One PAC, along Kanab Creek in Grand Canyon National Park, is immediately south of the Kanab Plateau, and numerous PACs in Grand Canyon National Park are immediately north of the Kaibab National Forest. Because of the proximity of known PACs and the fact that in Grand Canyon National Park the species forage in pinyon-juniper woodland and home ranges (n = 5 adult males) were larger than the PAC sizes recommended in the Recovery Plan (Bowden 2008), the species is considered likely to occur on all of the proposed withdrawal parcels while foraging or during post-nesting dispersal. According to Payne et al. (2010), the Grand Canyon National Park population may serve a critical role in connecting populations via juvenile dispersal. Based on habitat modeling in the canyon, the Park originally estimated that another 40 potential PACs could possibly be delineated. Most of those potential territories would probably be found in the lower gorge west of Powell Plateau.

Mexican spotted owl critical habitat includes dense old growth mixed-conifer forests located on steep slopes, especially deep, shady ravines (AGFD 2005l). These sites have high canopy closure, high basal area, many snags, and many downed logs. For foraging, multistoried forest with many potential patches is desirable. Mexican spotted owls nest and roost primarily in closed-canopy forests or rocky canyons. In the northern portion of the range (southern Utah and Colorado), most nests are in caves or on cliff ledges in steep-walled canyons (AGFD 2005l). The owl’s diet consists of rodents, birds, lizards, insects, and occasionally bats (AGFD 2005l).

In the Colorado Plateau Recovery Unit, the ponderosa pine and pine-oak habitat are not considered nesting habitat for the species; only the mixed-conifer and riparian habitat types are considered nesting or roosting habitat, according to the *Mexican Spotted Owl Recovery Plan* (USFWS 1995a). The Forest Service has informed the BLM that there is no mixed-conifer habitat on the South Parcel. However, the USFWS considers the forested “canyon-like” habitat in the northeastern portion of the North Kaibab Ranger District to be potential nesting habitat unless surveys demonstrate otherwise. On the Kanab Plateau, there are 9,600 acres of designated critical habitat in the North Parcel (within Grama, Hack, Chamberlain, and Water canyons). The BLM considers upper Kanab Creek and the Hack Canyon area (including Grama, Water, and Chamberlain canyons) to be occupied, high-priority areas for the species (BLM 2008b:Appendix A). This determination is based entirely on the presence of habitat components; the area has not been surveyed. This habitat is within Critical Habitat Unit CP-10, which includes portions of the Arizona Strip, Kaibab National Forest, and Grand Canyon National Park (see Figure 3.8-5) (USFWS 2004).

The southeast corner of the Kanab Plateau is within Critical Habitat Unit CP-10, which includes portions of the Arizona Strip, Kaibab National Forest, and Grand Canyon National Park (see Figure 3.8-5) (USFWS 2004). All three proposed withdrawal parcels are within the Colorado Plateau Recovery Unit, one of six recovery units recognized in the United States (USFWS 1995a). The Colorado Plateau Recovery Unit coincides with the Colorado Plateau physiographic province and includes most of south-central and southern Utah, plus portions of northern Arizona, northwestern New Mexico, and southwestern Colorado.

YELLOW-BILLED CUCKOO (*COCCYZUS AMERICANUS OCCIDENTALIS*)

There are no yellow-billed cuckoo nesting records from within the proposed withdrawal area, but cuckoos have been recorded in Grand Canyon National Park (Payne et al. 2010) and may occur along Kanab Creek on the Kanab Plateau. The breeding range of the species is currently restricted to southern and central Arizona and the extreme northeast corner of the state (AGFD 2002a; Corman 2005). It has been observed in the Arizona Strip in the cottonwood/willow galleries at the confluence of Beaver Dam Wash and the Virgin River (BLM 2007). In Arizona, the species prefers streamside cottonwood, willow groves, and larger mesquite bosques for migrating and breeding (AGFD 2002a). Yellow-billed cuckoos feed almost entirely on large insects that they glean from tree and shrub foliage. They feed primarily on caterpillars, including tent caterpillars. They also feed frequently on grasshoppers, cicadas, beetles, and katydids, occasionally on lizards, frogs, and eggs of other birds, and rarely on berries and fruits.

BALD EAGLE (*HALIAEETUS LEUCOCEPHALUS*) (DELISTED)

The species has been documented within all three proposed withdrawal area. According to Payne et al. (2010), it is frequently observed over the South Parcel and has been observed roosting near Boggy Tank. Bald eagles arrive in northern Arizona as early as the last week of October and typically leave by the third week of March (Payne et al. 2010). Bald eagles are mostly fish eaters. Bald eagles do nest in northern Arizona but have not been recorded from within the proposed withdrawal area (Brown and Stevens 1992). The bald eagle has been delisted under the ESA, which means that is no longer listed as threatened or endangered under the ESA. However, the BLM and Forest Service still treat this species as a ‘proposed’ species and still afford this species analysis and protection as a listed species.

AMERICAN PEREGRINE FALCON (*FALCO PEREGRINUS ANATUM*) (DELISTED)

Based on examination of the peregrine falcon nest map in the Arizona Heritage Data Management System (AGFD 2002b), the species appears to nest along Kanab Creek on the Kanab Plateau. There also are at least six peregrine falcon breeding territories along Marble Canyon (Payne et al. 2010), as well as breeding records along the Vermilion Cliffs immediately adjacent to the proposed withdrawal area (Figure 3.8-6) (AGFD 2002b). Currently, there are more than 50 nesting pairs in Grand Canyon National Park, from Lees Ferry to Lake Mead, and a monitoring program is in place (Payne et al. 2010). Optimum peregrine habitat is generally considered to be steep, sheer cliffs overlooking woodlands, riparian areas, or other habitats supporting abundant avian prey species (AGFD 2002b). The peregrine falcon has been delisted under the ESA, which means that is no longer listed as threatened or endangered under the ESA. However, this species is treated as a ‘proposed’ species by agencies and is still afforded protection as a listed species.

CALIFORNIA LEAST TERN (*STERNA ANTILLARUM BROWNI*)

There are no occurrences of California least tern within the proposed withdrawal area, and the proposed withdrawal area does not fall within designated critical habitat for this species. The California least tern is primarily a resident of California but may occur in different parts of Arizona where habitat components are adequate for nesting or feeding such as large lakes, recharge basins, or wetland areas (USFWS 2009e). Breeding has been documented in Maricopa County. Transient migrants occur more frequently and have recently been documented in Mohave and Pima counties. This species forms nesting colonies on barren to sparsely vegetated areas and in shallow depressions on open sandy beaches, sandbars, gravel pits, or exposed flats along shorelines of inland rivers, lakes, reservoirs, and drainage systems (USFWS 2009e). The California least tern is diet is primarily a fish-eater, feeding in shallow waters of rivers, streams, and lakes (USFWS 2009e).

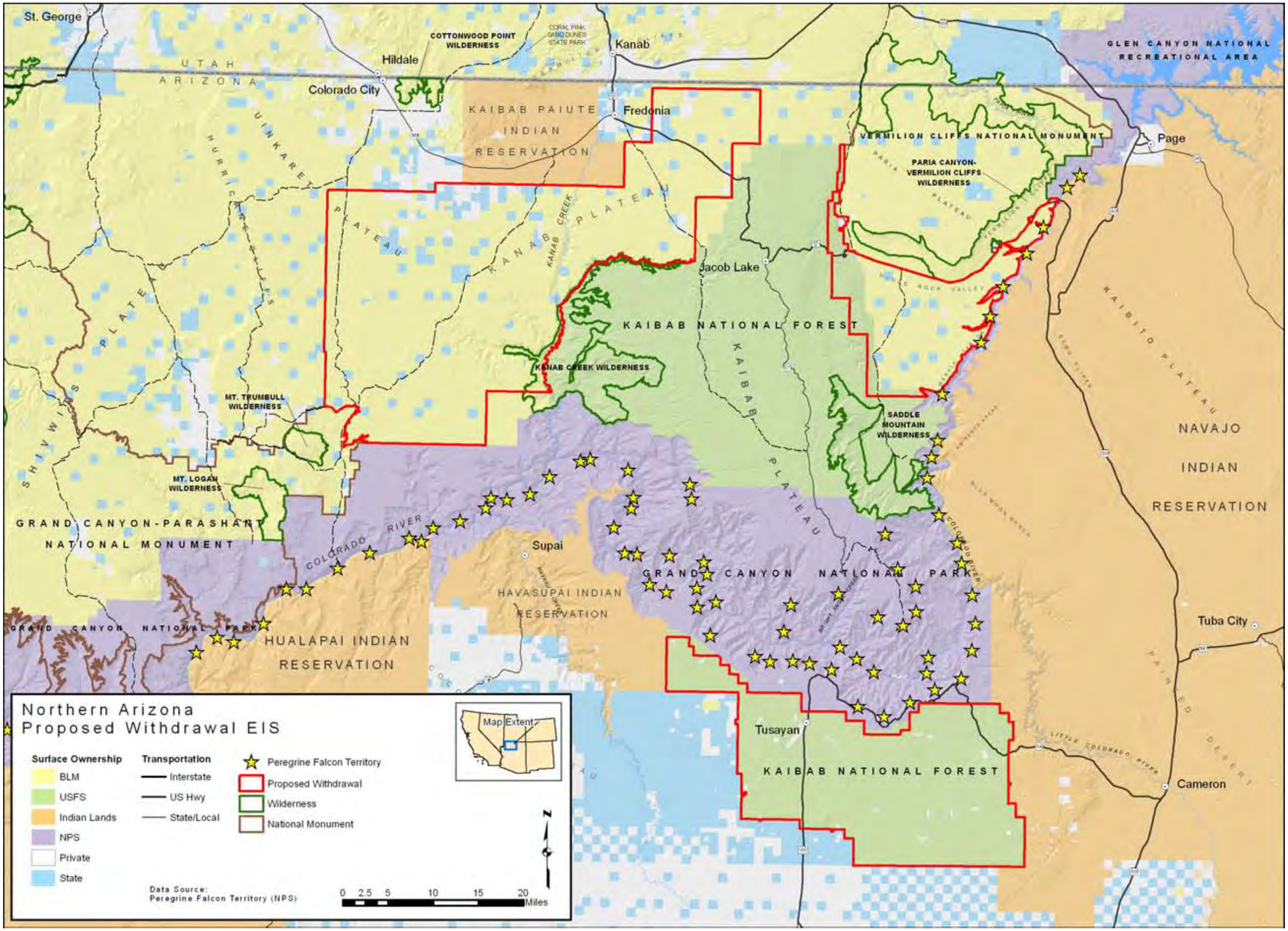


Figure 3.8-6. Peregrine falcon.

CALIFORNIA BROWN PELICAN (*PELECANUS OCCIDENTALIS CALIFORNICUS*) (DELISTED)

There are no occurrences of brown pelican within the proposed withdrawal area. This species is widely distributed in southern coastal areas of the continental United States, Pacific Coast of Mexico, Central America, and the Pacific and Caribbean coasts of South America (USFWS 2009f). Brown pelicans nest in colonies on offshore islands that are free of mammalian predators and human disturbance, are of sufficient elevation to prevent flooding of nests, and are associated with an adequate and consistent food supply. This species uses coastal open water habitat and is considered as accidental occurrences in Arizona that may be influenced by severe storms and to variable weather patterns such as El Niño that affect food supply. The diet of the brown pelican is primarily fish and amphibians as well as crustaceans (USFWS 2009f).

DESERT TORTOISE (*GOPHERUS AGASSIZII*) (MOJAVE POPULATION)

The proposed withdrawal area does not include desert tortoise habitat and does not fall within designated critical habitat for the species. There are no occurrences of desert tortoise within the proposed withdrawal area. In Arizona, tortoises and critical habitat are located north of the Colorado River, approximately 40 miles west of the North Parcel (see Figure 3.8-5). The Arizona Strip is within the Northeast Mojave Recovery Unit and includes two areas of critical habitat for the species: one along the western slope of the Beaver Dam Mountains (Beaver Dam Slope), the other along the northern slope of the Virgin Mountains (Gold Butte-Pakoon) (BLM 2007). Habitat for the species includes sandy 13 loam and rocky soils in valleys, bajadas, and rocky slopes and hills in the Mojave Desert at elevations ranging from 500 to 5,100 feet amsl (BLM 2007). The desert tortoise is an herbivore. Grasses form the bulk of its diet, but it also eats herbs, annual wildflowers, and new growth of cacti, as well as their fruit and flowers.

DESERT TORTOISE (*GOPHERUS AGASSIZII*) (SONORAN POPULATION)

The Sonoran desert tortoise does not occur within the proposed withdrawal area. The distribution in the United States is considered to be east and south of the Colorado River, extending south and east from northwestern Mohave County (near Perce Ferry) in Arizona, and covers roughly the western portion of the state (AGFD 2001c). The distribution in the United States is likely bounded to the northeast and east by habitat changes imposed by the Mogollon Rim. Habitat consists primarily of rocky slopes and bajadas of the Mojave and Sonoran desertscrub vegetation communities (AGFD 2001c). The desert tortoise is an herbivore. Grasses form the bulk of its diet, but it also eats herbs, annual wildflowers, and new growth of cacti, as well as their fruit and flowers (AGFD 2001c).

RELICT LEOPARD FROG (*LITHOBATES* [RANA] *ONCA*)

The species does not occur within the proposed withdrawal area. In Arizona, extant populations apparently are restricted to two general areas: Surprise Canyon in lower Grand Canyon National Park and Sycamore Spring, both in Mohave County (USFWS 2009a). However, according to USFWS (Brian Wooldridge, personal communication December 2009), the frogs in Surprise Canyon originally thought to be this species are actually lowland leopard frogs (*Rana yavapaiensis*). Relict leopard frog was introduced to Sycamore Spring in 2003. It also is present in Nevada at springs near the Overton Arm of Lake Mead and springs in Black Canyon below Hoover Dam (USFWS 2009a). No relict leopard frogs are known from BLM lands on the Arizona Strip (BLM 2007). A historic population was found at a privately owned spring adjacent to the Virgin River at Littlefield, Arizona, but that population has since been extirpated (BLM 2007). Adult frogs inhabit permanent streams, springs, and spring-fed wetlands below approximately 2,000 feet amsl (USFWS 2009a). Relict leopard frog presumably feed on a wide variety of invertebrates (USFWS 2009a).

In August 2009, 17 springs in Grand Canyon National Park considered at risk from uranium extraction activities were sampled for relict leopard frogs and other aquatic organisms by USGS and NPS personnel (Museum of Northern Arizona 2009). Relict leopard frogs were not found during this survey.

NORTHERN LEOPARD FROG (*LITHOBATES* [RANA] *PIPIENS*)

Northern leopard frog occurs within the North Parcel (Kanab Creek) (see Figure 3.8-4). Portions of Kanab Creek support suitable habitat for the species, which were last recorded from that drainage in 1993 (personal communication, M. Sredl, AGFD June 2010). It has also been introduced into three to four stock tanks in the House Rock Valley Wildlife Area within the East Parcel. Extensive surveys beginning in 2003 and continuing through the present have been directed at locating existing populations of northern leopard frogs and documenting population size and extent, habitat characteristics and conditions, and current population trends. In spite of exhaustive surveys of available habitats throughout the length of Grand Canyon from Lees Ferry to Lake Mead, surveys were unable to locate any extant populations of northern leopard frogs (Durst 2010). In August 2009, 17 springs in Grand Canyon National Park were sampled for northern leopard frogs and other aquatic organisms by USGS and NPS personnel (Museum of Northern Arizona 2009). Northern leopard frogs were not found during this survey. During the last comprehensive survey of the Colorado River corridor, which did not include upper Kanab Creek, no northern leopard frogs were found (Payne et al. 2010). During that same survey, lowland leopard frogs were found (see Payne et al. 2010). The species breeds in a variety of aquatic habitats, such as slow-moving or still water along streams and rivers, wetlands, permanent or temporary pools, beaver ponds, and human-constructed habitats such as earthen stock tanks and borrow pits. Northern leopard frogs eat a variety of aquatic and terrestrial invertebrates. Larger frogs eat small leopard frogs, other amphibians, fish, snakes, and other vertebrates, as well.

CHIRICAHUA LEOPARD FROG (*LITHOBATES* [RANA] *CHIRICAHUENSIS)*

This species does not occur within the proposed withdrawal area. This species inhabits mountain regions of central and southeastern Arizona, southwestern New Mexico, south in the Sierra Madre Occidental to Western Jalisco, Mexico, from 1,066–2,408 m (3,500–7,900 feet) amsl (AGFD 2006e). Within Arizona, this species' range is divided into two areas. The first (northern population) extends from montane central Arizona east and south along the Mogollon Rim to montane parts of west-southwestern New Mexico. The second is located in the mountains and valleys south of the Gila River in southeastern Arizona and southwestern New Mexico and extends into Mexico (adjacent Sonora) along the eastern slopes of the Sierra Madre Occidental (AGFD 2006e). The primary habitat type of Chiricahua leopard frog is oak, mixed oak, and pine woodlands. Other habitat types range into areas of chaparral, grassland, and even desert.

Chiricahua leopard frogs are habitat generalists that live and breed in lentic and lotic habitats in natural and man-made systems (AGFD 2006e). The Chiricahua leopard frog presumably feeds on a wide variety of invertebrates as well as some small vertebrates (including juveniles of their own kind) (AGFD 2006e).

NORTHERN MEXICO GARTERSNAKE (*THAMNOPHIS EQUES MEGALOPS*)

This species does not occur within the proposed withdrawal area. Northern Mexico gartersnake ranges from southeastern Arizona and extreme southwestern New Mexico, southward into the highlands of western and southern Mexico, to Oaxaca (AGFD 2001n). Within Arizona, this species occurs in the southeast corner of state from the Santa Cruz Valley east and generally south of the Gila River. Recent valid records (post 1980) occur from the San Rafael and Sonoita grasslands area and from Arivaca. It is also known from the Agua Fria River, Oak Creek, the Verde River, and from several upper Salt/Black

River sites, including smaller tributaries (AGFD 2001n). The gartersnake eats frogs, toads, fish, lizards, and small mammals (AGFD 2001n).

HUMPBACK CHUB (*GILA CYPHA*)

Humpback chub does not occur within the proposed withdrawal area, and there is no critical habitat for the species within the proposed withdrawal area; however, the Colorado River, which is adjacent to the proposed withdrawal area, has been designated critical habitat. Humpback chubs feed predominantly on small aquatic insects, diatoms and filamentous algae. According to Glen Knowles (personal communication, USFWS biologist, December 2009), this species occurs in the lower 12 miles of the Little Colorado River, and from about RMs 30 to 240 in the main stem Colorado River; the vast majority of fish, however, are located in the lower 9 miles of the Little Colorado River and in the reach of the Colorado River around the Little Colorado River, from RMs 56 to 67. Included in the critical habitat designation is the main stem Colorado River from the confluence of the Paria River to Hoover Dam, including Lake Mead, Lake Mohave, and Colorado River below Parker Dam. Critical habitat includes portions of the Colorado, Green, and Yampa rivers in the Upper Basin and the Colorado and Little Colorado rivers in the Lower Basin in Colorado, Utah, and Arizona (USFWS 2002a). Critical habitat relative to the proposed withdrawal area is depicted in Figure 3.8-5. According to Brian Healy (personal communication, USFWS biologist, August 2010), NPS is currently working on several translocation projects within the Grand Canyon. To date, Shinamu Creek has had two translocation efforts, with about 300 fish being released. Feasibility studies are underway to potentially translocate humpback chub to Bright Angel Creek and Havasu Creek, and long-range planning could translocate populations of humpback chub in Kanab Creek in later phases.

RAZORBACK SUCKER (*XYRAUCHEN TEXANUS*)

Razorback sucker does not occur within the proposed withdrawal area, and there is no critical habitat designated on any of the proposed withdrawal parcels. Currently, natural adult populations occur only in Lakes Mohave, Mead, and Havasu (AGFD 2002c). Critical habitat includes parts of the Yampa, Greene, Duchesne, White, Colorado, San Juan, Gila, Salt, and Verde rivers (USFWS 2009b). Included in the designation are Lake Mohave, Lake Mead, and the Colorado River below Parker Dam (see Figure 3.8-5). This species uses a variety of habitat types from main stem channels to slow backwaters of medium-sized and large streams and rivers, sometimes around cover (AGFD 2002c). Recent data indicate that razorback suckers have been found upstream of Lake Mead in the main stem of the Colorado River (personal communication, Pam Sponholtz, USFWS 2010). These records are important because they open up the possibility of razorback suckers' being found throughout the Colorado River, especially during the time frame of this proposed withdrawal. The USFWS considered the Colorado River occupied habitat.

Historical records from the Grand Canyon through 1990, as reported by Minckley et al. (1991), are Bright Angel Creek, 1944 (one fish); Lees Ferry, 1963 (one fish); Paria River, 1978 (one fish); Paria River, 1979 (three fish); Bass Rapid, 1986 (one fish; photographed); Bright Angel Creek, 1987 (three fish); and mouth of the Little Colorado River, 1989 and 1990 (three fish each year).

All recent records of the species are from the Little Colorado River. According to the Grand Canyon Monitoring and Research Center database, which includes records through 2006, there are several records from the Little Colorado from 1989 through 1995. The diet of this species generally is composed of insects and planktonic food sources.

VIRGIN RIVER CHUB (*GILA SEMINUDA*)

The species does not occur within any of the proposed withdrawal parcels, and there is no critical habitat on any of the proposed withdrawal parcels (see Figure 3.8-5). It occurs in the Moapa River in Nevada and the main stem Virgin River in Arizona, Utah, and Nevada from Pah Tempe Springs downstream to the Mesquite Diversion in extreme northwestern Arizona (Mohave County) (USFWS 2009c). Only the Virgin River population is listed. Critical habitat includes the main stem Virgin River and its 100-year floodplain, extending from the confluence of La Verkin Creek, Utah, to Halfway Wash, Nevada (USFWS 2000). Habitat is deeper areas where waters are swift but not turbulent, generally where there are boulders or other cover (USFWS 2009c). The status of this fish is not well known at the present time, but it is likely to still occupy segments of the Virgin River. Virgin River chub are opportunistic feeders, consuming zooplankton, aquatic insect larvae, other invertebrates, debris, and algae.

WOUNDFIN (*PLAGOPTERUS ARGENTISSIMUS*)

Woundfin does not occur within the proposed withdrawal area, and there is no critical habitat in any of the proposed withdrawal parcels (see Figure 3.8-5). Critical habitat is identical to the designation for the Virgin River chub (USFWS 2000). Woundfin has been extirpated from almost all of its historical range, except the main stem Virgin River from Pah Tempe Springs to Lake Mead in northwestern Arizona (Mohave County) (USFWS 2009d). Habitat is shallow, warm, turbid, fast-flowing water (USFWS 2009d). Numbers are thought to be low in the Arizona portion of the Virgin River as a result of competition with introduced species for resources and the absence of suitable habitat features (BLM 2007). Woundfin diets are quite varied and consist mainly of insects, insect larvae, other invertebrates, algae, and detritus.

APACHE TROUT (*ONCORHYNCUS GILAE APACHE*)

The species does not occur within the proposed withdrawal area. The natural range is the headwater streams of the Salt (Black and White rivers), Little Colorado, and Blue rivers in the White Mountains of east-central Arizona (AGFD 2001d). It has been introduced and has become established outside its natural range in the Pinaleño Mountains, Coronado National Forest, and North Kaibab Ranger District of the Kaibab National Forest along North Canyon Creek (AGFD 2001d). In North Canyon Creek, records are all within the Saddle Mountain Wilderness (personal communication, Angela Gatto, Forest Service biologist, December 2009). The Apache trout's diet consists of both terrestrial and aquatic insects.

LITTLE COLORADO SPINEDACE (*LEPIDOMEDA VITTATA*)

The species does not occur within the proposed withdrawal area and is endemic to the Little Colorado River and its north-flowing tributaries, including the Arizona counties of Coconino, Navajo, and Apache (AGFD 2001o). Historical distribution is similar to the current distribution but may have occurred in the Zuni River watershed south of Gallup, New Mexico (AGFD 2001o). This species appears to be quite capable of tolerating relatively harsh environments that undergo dramatic fluctuations in pH, dissolved gases, and water temperature. Predation occurs mainly from rainbow trout (*Oncorhynchus mykiss*) and green sunfish (*Lepomis cyanellus*) (AGFD 2001o). The diet of Little Colorado River spinedace varies seasonally and consists primarily of aquatic and terrestrial insects.

BONYTAIL CHUB (*GILA ELEGANS*)

The species does not occur within the proposed withdrawal area. This species was once widely distributed throughout the Colorado River and its main tributaries, which include the Green River in Utah and Wyoming and the Colorado, Gila, Salt, and Verde rivers in Arizona (AGFD 2001p). Currently found only in isolated populations in the Yampa, Green, and Colorado rivers at the Colorado–Utah border and at the confluence of the Green and Colorado rivers. In the lower basin, found only in Lake Mohave with possible individuals between Parker and Davis dams. Critical habitat was established for bonytail chub in March, 1994 (AGFD 2001p), designating portions of the Colorado, Green, and Yampa rivers in the upper basin and the Colorado River from Hoover to Parker dams (including Lake Mohave and Lake Havasu) (AGFD 2001p). Bonytail chub are opportunistic feeders, eating insects, zooplankton, algae, and higher plant matter.

ROUNDTAIL CHUB (*GILA ROBUSTA*)

This species does not occur within the proposed withdrawal area. Roundtail chubs are known from larger tributaries of the Colorado Basin from Wyoming south to Arizona and New Mexico, as well as the Rio Yaqui south to Rio Piaxtla, northwestern Mexico (AGFD 2002j). Within Arizona, this species currently occurs in two tributaries of the Little Colorado River (Chevelon and East Clear Creeks); several tributaries of the Bill Williams River basin (Boulder, Burro, Conger, Francis, Kirkland, Sycamore, Trout, and Wilder Creeks); the Salt River and four of its tributaries (Ash Creek, Black River, Cherry Creek and Salome Creek); the Verde River and five of its tributaries (Fossil, Oak, Roundtree Canyon, West Clear, and Wet Beaver Creeks); Aravaipa Creek (a tributary of the San Pedro River); and Eagle Creek (a tributary of the Gila River) (AGFD 2002j). Roundtail chub eat terrestrial and aquatic insects, mollusks, other invertebrates, fishes, and algae.

VIRGIN SPINEDACE (*LEPIDOMEDA MOLLISPINIS MOLLISPINIS*)

This species does not occur within the proposed withdrawal area. Virgin spinedace is endemic to the Virgin River and its tributaries in Utah, Nevada, and Arizona (AGFD 2001k). Within Arizona, it is found in Mohave County, lower Beaver Dam Wash to its confluence with the Virgin River at Littlefield, Arizona. Historically present in the Virgin River from the Utah border to Littlefield, primarily in conjunction with clear water inflows of perennial tributaries (AGFD 2001k). Major factors affecting Virgin spinedace are water diversion, impoundment, channelization, degradation of water quality, and introduced species, both fishes and crayfish (AGFD 2001k). A Conservation Agreement between the USFWS, Utah Division of Wildlife Resources, Washington County Water Conservancy District, and others was finalized in 1995. The plan focuses on reducing threats to the Virgin spinedace and enhancing and/or stabilizing instream flow in specific reaches of occupied and unoccupied habitat. Virgin spinedace are opportunistic feeders, eating insects, insect larvae, other invertebrates, and plant matter.

KANAB AMBERSNAIL (*OXYLOMA HAYDENI KANABENSIS*)

Kanab ambersnail does not occur within any of the proposed withdrawal parcels. There are two populations in Arizona: Vasey's Paradise and Elves Chasm, both in Grand Canyon National Park (see Figure 3.8-4). There also are two populations in Utah along Kanab Creek (AGFD 2001e). The snails at Elves Chasm were introduced by AGFD. Vasey's Paradise is a naturally occurring population located approximately 32 miles downstream of Lees Ferry (USFWS 1995b), just south of House Rock Valley. Preliminary estimates indicated a population of about 16,000 individuals at this site (USFWS 1995b). In August 2009, 15 springs (including Vasey's Paradise) in Grand Canyon National Park were sampled for Kanab ambersnails by USGS and NPS personnel (Museum of Northern Arizona 2009). Kanab ambersnail was found at Vasey's Paradise, but no Kanab or other *Oxyloma* ambersnail shells or live individuals were found at any of the other springs visited. The snail also occurs at two wetlands located about 1.3 miles apart near the Arizona border in Kane County, Utah: Three Lakes Canyon and Kanab Creek Canyon (USFWS 1995b). Survey records from approximately 10 years ago indicate that one of the two Kanab Creek populations may be lost, apparently from cattle grazing (AGFD 2001e). Habitat is marshes watered by springs and seeps at the base of sandstone cliffs or limestone at approximately 3,200 feet amsl (AGFD 2001e).

NIOBRARA AMBERSNAIL (*OXYLOMA HAYDENI HAYDENI*)

Niobrara ambersnail does not occur on any of the proposed withdrawal parcels; however, two populations of this species are known from the Colorado River drainage. This species is known to occur in northern Arizona and southern Utah (Kanab Canyon area) (AGFD 2004d). Within Arizona, there is one population that occurs on the South Rim of the Grand Canyon at Indian Gardens; a second population is found at riverside marsh at 9 mile in the Lees Ferry reach. This species is restricted to permanently wet areas fed by a small spring and is associated with *Typha* and other wetland vegetation with damp or saturated cattail litter, common reed litter, watercress, and among sedges growing in saturated soil (AGFD 2004d). Grand Canyon National Park was sampled for Kanab ambersnails and other Oxyloma ambersnail shells or live individuals, and no signs of this species were found at any of the other springs visited.

3.8.2 Bureau of Land Management Sensitive Species

The BLM Sensitive species are listed in Table 3.8-3 and are based on the BLM list dated October 2005 (BLM 2005). Also, effective December 2008, BLM State Directors are required to designate as BLM Sensitive species all federal candidate species. Consequently, Fickeisen plains cactus, a federally designated candidate species not on the 2005 list, was also included as a BLM Sensitive species. Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*), which is neither a federal candidate species nor included on the 2005 list, was also included at the request of the BLM. Beaverdam scurfpea (*Pediomelium castoreum*) and Gierisch globemallow, also listed as federal candidate species, are both tracked as rare plants by the BLM and were also included at the request of the BLM. Information on species trends is included with the individual species accounts when available.

In addition to BLM Sensitive species, Table 3.8-3 also contains species that the Forest Service and NPS also consider Sensitive or MIS, which means some species are listed by multiple agencies. These species are addressed only once and not repeated in Sections 3.8.4 or 3.8.5. Species included on both the Forest Service and BLM species list include Allen’s lappet-browed bat (*Idionycteris phyllotis*), Houserock Valley chisel-toothed kangaroo rat, and western burrowing owl. Species included on both the BLM and NPS Sensitive species lists include Grand Canyon rose (*Rosa stellata* ssp. *abyssa*), Allen’s lappet-browed bat, long-legged myotis (*Myotis volans*), pocketed free-tailed bat, flannelmouth sucker (*Catostomus latipinnis*), and desert sucker (*Catostomus* [Pantosteus] *clarki*). Species previously discussed within the USFWS species list include the bald eagle and American peregrine falcon.

Table 3.8-3. BLM Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Mt. Trumbull beardtongue (*Penstemon distans*)	BLM S	No	No	No
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	USFWS C BLM S (see species account in Section 3.8.1)	Yes	Yes	Possible*
Grand Canyon rose (*Rosa stellata* ssp. *abyssa*)	BLM S NPS SC	Yes	No	Possible*
Three hearts (*Tricardia watsonii*)	BLM S	No	No	No

Table 3.8-3. BLM Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Plants, continued				
Toana milkvetch/Diamond Butte milkvetch (*Astragalus toanus* var. *scidulus*)	BLM S	No	No	No
Cliff milkvetch (*Astragalus cremnophylax* var. *myriorraphus*)	BLM S	Possible	Yes	No
Holmgren milkvetch (*Astragalus holmgreniorum*)	USFWS E BLM S	No	No	No
Marble Canyon milkvetch (*Astragalus cremnohylax* var. *hevronii*)	BLM S	No	Yes	No
Paria Plateau fishhook cactus (*Sclerocactus sileri*)	BLM S	No	Yes	No
September 11 stickleaf (*Mentzelia memorabilis*)	BLM S	No	No	No
Silverleaf sunray (*Enceliopsis argophylla*)	BLM S	No	No	No
Sandhollow/Three-cornered milkvetch (*Astragalus geyeri* var. *triquetrus*)	BLM S	No	No	No
Black rock daisy (*Townsendia smithii*)	BLM S	No	No	No
Crevice penstemon (*Penstemon petiolatus*)	BLM S	No	No	No
Sticky wild buckwheat (*Eriogonum viscidulum*)	BLM S	No	No	No
Gierisch mallow (*Sphaeralcea gierischii*)	USFWS C BLM S[†] (see species account in Section 3.8.1)	No	No	No
Beaverdam scurfpea, Beaverdam breadroot (*Pediomelum castoreum*)	BLM S[†]	No	No	No
Animals				
Allen's lappet-browed bat (*Idionycteris phyllotis*)	BLM S Forest Service S NPS SC	Yes	Yes	Possible
Small-footed myotis (*Myotis ciliolabrum*)	BLM S	Yes	Yes	Yes
Long-eared myotis (*Myotis evotis*)	BLM S	Yes	Possible	Yes
Fringed myotis (*Myotis thysanodes*)	BLM S	Yes	Yes	Yes
Long-legged myotis (*Myotis volans*)	BLM S NPS SC	Yes	Possible	Yes
Big free-tailed bat (*Nyctinomops macrotis*)	BLM S NPS SC	Yes	Yes	Possible
Pocketed free-tailed bat (*Nyctinomops femorosaccus*)	BLM S NPS SC	Possible	Possible	Possible
Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*)	BLM S Forest Service S	No	Yes	No
Western burrowing owl (*Athene cunicularia hypugea*)	BLM S Forest Service S	Yes	Yes	No
Common chuckwalla (*Sauromalus ater*)	BLM S	Possible	Possible	Possible

Table 3.8-3. BLM Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Animals, continued				
Northern sagebrush lizard (*Sceloporus graciosus graciosus*)	BLM S	Possible	Possible	Possible
Banded gila monster (*Heloderma suspectum cinctum*)	BLM S	Possible	No	No
Flannelmouth sucker (*Catostomus latipinnis*)	BLM S NPS SC	No	No	No
Desert sucker (*Catostomus* [Pantosteus] *clarki*)	BLM S NPS SC	No	No	No
Speckled dace (*Rhinichthys osculus*)	BLM S	Possible	No	No
MacNeill's sootywing (*Hesperopsis gracielae*)	BLM S	No	No	No
Hydrobiid spring snails Grand Wash springsnail (*Pyrgulopsis bacchus*) Desert springsnail (*Pyrgulopsis deserta*)	BLM S	No	No	No
Succineid snails (F. Succineidae), Niobrara ambersnail (*Oxyloma haydeni haydeni*)	BLM S	No	No	No

Notes:

BLM
S = Sensitive: those taxa occurring on BLM Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service
S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)
SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

* Based on Forest Service (2009a).

† Added at the request of the BLM.

Plants

MT. TRUMBULL BEARDTONGUE (*PENSTEMON DISTANS*)

Mt. Trumbull beardtongue does not occur within the proposed withdrawal area; however, it is known to occur approximately 20 miles southwest of the Kanab Plateau (see Figure 3.8-1). It is found at the southeastern edge of the Shivwits Plateau in Whitmore, Parashant, and Andrus canyons (AGFD 2001f). The species tends to be widely scattered in isolated populations that seem to be restricted to the relatively cool, moist microhabitats on north- and east-facing slopes of the Kaibab and Toroweap limestone formations (BLM 2007).

Population trends are unknown but apparently stable (AGFD 2001f). The BLM initiated trend studies in 1987 and 1989 at two locations in Grand Canyon-Parashant National Monument (BLM 2007). By 1997, a large plot of 49 plants had increased in number to 80. The smaller count plot started with 21 plants in 1987, decreased to six in 1992, and increased to nine plants in 1997.

GRAND CANYON ROSE (*ROSA STELLATA* SSP. *ABYSSA*)

This species is listed by both the BLM and NPS. The species occurs within the proposed withdrawal area (see Figure 3.8-1). It also occurs along the rim (mainly North Rim, Twin Point) of the Grand Canyon and at the junction of the Little Colorado River and Big Canyon (AGFD 2005c). All known populations are in the Timoweap member of the Moenkopi Formation, on or near canyon rims or the tops of cliffs at the edges of mesas or plateaus, as well as along low ledges at depressions caused by breccia pipes (BLM 2007; Brian 2000). The Kanab Canyon population is decreasing; trends at Twin Point are unknown (AGFD 2005c).

THREE HEARTS (*TRICARDIA WATSONII*)

The species occurs outside the proposed withdrawal area and is located approximately 30 miles southwest and west of the Kanab Plateau (see Figure 3.8-1). It is found near Grand Wash Cliffs Wilderness area and in Parashant Canyon in Grand Canyon National Park in dry, rocky canyons and slopes in desert ranges. Generally, it is found on gravelly slopes and sandy loam flats in Joshua tree (*Yucca brevifolia*) woodland and creosote bush scrub (AGFD 2005d).

Population trends are unknown. One population was found in 1980 in the south half of the Pakoon Basin, near the canyon mouth of Grand Gulch Wash (see BLM 2007). Only three plants were noted at this site in two subsequent monitoring visits. Another four plants have been found in the NPS portion of Grand Canyon–Parashant National Monument (see BLM 2007).

TOANA MILKVETCH/DIAMOND BUTTE MILKVETCH (*ASTRAGALUS TOANUS* VAR. *SCIDULUS*)

The species is found outside the proposed withdrawal area approximately 10 miles west of the Kanab Plateau (see Figure 3.8-1). It is known only from the bases of Diamond Butte and Twin Buttes, where it grows on small outwash fans by small mesas on alluvium overlying the Shnabkaib member of the Moenkopi Formation (BLM 2007).

Population trends are unknown. Less than 12 plants were first discovered in 1999 at two Arizona Strip sites (BLM 2007). These sites have been subsequently monitored, but no plants have been located.

CLIFF MILKVETCH (*ASTRAGALUS CREMNOPHYLAX* VAR. *MYRIORRAPHUS*)

The variety is not known to occur on any of the proposed withdrawal parcels; however, it is endemic to the Buckskin Mountains, Kaibab Plateau, immediately east of the Kanab Plateau (see Figure 3.8-1), where there apparently are scattered populations at as many as 13 sites totaling approximately 750 individuals (Arizona Rare Plant Committee n.d. [2002]). It occurs on rim-rock benches at the canyon edge in crevices and depressions with shallow soils on Kaibab Limestone at approximately 6,200 feet amsl (Arizona Rare Plant Committee n.d.). Population trends apparently are stable (AGFD 2003a). As of spring 1992, there were approximately 700 individuals known from 13 sites (AGFD 2003a; Arizona Rare Plant Committee n.d. [2002]).

MARBLE CANYON MILKVETCH (*ASTRAGALUS CREMNOHYLAX* VAR. *HEVRONII*)

The plant is found on the eastern edge of House Rock Valley (see Figure 3.8-1). It is endemic to the rim of Marble Canyon, where it occurs south of Shinumo Wash, north to Sheep Springs Wash (AGFD 2005e). Marble Canyon milkvetch occurs on rim-rock benches at the canyon edge in crevices and depressions with shallow soils on Kaibab Limestone at approximately 5,420 feet amsl (Arizona Rare

Plant Committee n.d. [2002]). Population trends are unknown (AGFD 2005e). In 1997, six sites with about 265 plants were located.

PARIA PLATEAU FISHHOOK CACTUS (*SCLEROCACTUS SILERI*)

The species occurs in House Rock Valley (East Parcel) and the Paria Plateau (north of the East Parcel) (Arizona Rare Plant Committee n.d. [2002]). Habitat is sandstone to sandy soil of the Moenave, Chinle, and Navajo formations, where it grows on pinyon-juniper mesa tops at 5,000 to 6,300 feet amsl (Arizona Rare Plant Committee n.d. [2002]). Population trends are not well known (AGFD 2003b). This plant is difficult to locate in the field; it appears to be quite rare.

SEPTEMBER 11 STICKLEAF (*MENTZELIA MEMORABILIS*)

The species is found outside the proposed withdrawal area on the adjacent west lands (the Kanab Plateau) (see Figure 3.8-1). It is an Arizona endemic in northern Mohave County, in the Clayhole Wash drainage between Colorado City and Mount Trumbull (AGFD 2006c). September 11 stickleaf grows on dry gypsum-clay outcrops with sparse vegetation between 4,689 and 5,197 feet amsl (AGFD 2006c). Population trends are unknown (AGFD 2006c).

SILVERLEAF SUNRAY (*ENCELIOPSIS ARGOPHYLLA*)

Silverleaf sunray is found outside the proposed withdrawal area on the adjacent west lands (the Kanab Plateau). It is found in Mohave County in the vicinity of Lake Mead, the Grapevine Mesa area, below Hurricane Cliffs, south of Hoover Dam, the Boulder Dam area, the Gyp Hills area, and east of Littlefield (AGFD 2005f). Habitat consists of warm desert shrub communities on dry clay and gypsum slopes and in sandy washes (AGFD 2005f). Population trends are unknown (AGFD 2005f).

SANDHOLLOW/THREE-CORNERED MILKVETCH (*ASTRAGALUS GEYERI* VAR. *TRIQUETRUS*)

The species does not occur within the proposed withdrawal area. The range is confined to extreme northwestern Arizona (see Figure 3.8-1) and southeastern Nevada. In Arizona, it is found in Sand Hollow Wash, Horsethief Canyon, and Beaver Dam Wash in Mohave County (AGFD 2004b). Habitat is limited to washes and small pockets of wind-deposited sand of the creosotebush-scrub series, with sandy soils formed from sedimentary formations (Jurassic-age sandstone) (AGFD 2004b). Population trends are not well known (AGFD 2004b). *A. geyeri* var. *triquetrus* occurs in very low numbers and does not appear every year. It is known from fewer than 25 occurrences in a restricted range near a large human-populated center.

BLACK ROCK DAISY (*TOWNSENDIA SMITHII*)

The species does not occur within any of the proposed withdrawal parcels. The main Arizona Strip population, more than 30 miles west of the Kanab Plateau (see Figure 3.8-1), occurs along the top of Black Rock Mountain in open sagebrush areas, ranging from Maple Reservoir to Trails End Reservoir (a distance of roughly 5 to 6 miles). A smaller population occurs on Wolfhole Mountain, covering a total area of approximately 19 acres (BLM 2007). This species grows on soils derived from Tertiary basalt flows; it is quite scattered in some areas and dense in others. The populations have been located consistently during annual surveys and appear to be stable and unthreatened (BLM 2007). This plant is considered locally common but very narrowly endemic to a small area in Mohave County, Arizona (AGFD 2005g).

CREVICE PENSTEMON (*PENSTEMON PETIOLATUS*)

The species does not occur within any of the proposed withdrawal parcels. It is found in the Virgin and Beaver Dam mountains in Arizona (see Figure 3.8-1) and in adjacent Utah and Nevada (Arizona Rare Plant Committee n.d. [2002]). These populations are more than 40 miles west of the Kanab Plateau. Habitat consists of steep, rocky faces and boulders along the Kaibab Limestone Formation (BLM 2007). Although no trend plots have been established for the plant, known locations are checked annually, and it is generally found there (BLM 2007). This is a rare plant but with few threats because of its inaccessible habitat (Arizona Rare Plant Committee n.d. [2002]). It is considered locally common within its limited distribution.

STICKY WILD BUCKWHEAT (*ERIOGONUM VISCIDULUM*)

The species does not occur within any of the proposed withdrawal parcels. It is found in extreme northwestern Mohave County (see Figure 3.8-1), north of the Virgin River (AGFD 2005h). Habitat includes low dunes, washes, and sandy flats and slopes in saltbush and creosote bush communities in Mohave Desertscrub (AGFD 2005h). Population trends are unknown (AGFD 2005h). There are reports of 29 occurrences in Nevada, with a total estimated population of at least 29,000 individuals.

BEAVERDAM SCURFPEA, BEAVERDAM BREADROOT (*PEDIOMELUM CASTOREUM*)

The species does not occur on any of the proposed withdrawal parcels. It is found in extreme northwestern Mohave County (AGFD 2005m). Habitat includes desert shrub in sand or sandy gravel in open areas and on road cuts (AGFD 2005m). Population trends are unknown (AGFD 2005m).

Animals

ALLEN'S LAPPET-BROWED BAT (*IDIONYCTERIS PHYLLOTIS*)

This species is included on the BLM, Forest Service, and NPS species lists. This insectivorous bat species has been recorded within the Kanab Plateau and House Rock Valley (AGFD 2010a). It is considered likely to occur on the Kaibab National Forest. Population status along the Colorado River corridor is unknown, but individuals have been observed and collected in the river corridor in Grand Canyon National Park (Payne et al. 2010). Most Arizona specimens have been taken from the southern Colorado Plateau, the Mogollon Rim, and adjacent mountain ranges (AGFD 2001g). In Arizona, it has been taken most often in ponderosa pine, pinyon-juniper woodland, and riparian areas with sycamores, cottonwoods, and willows (AGFD 2001g). Population trends are very poorly known (AGFD 2001g).

SMALL-FOOTED MYOTIS (*MYOTIS CILIOLABRUM*)

This insectivorous bat species has been recorded within all of the proposed withdrawal parcels (AGFD 2010a; Forest Service 2008a, 2009c). The Kaibab National Forest record is from the Camp 36 Tank (Forest Service 2009c). The range includes Coconino, Pinal, Mohave, and Cochise counties (AGFD 2003c). It generally inhabits desert, chaparral, western coniferous forest, badland and semiarid habitats, and more mesic habitats in southern part of the range (AGFD 2003c). Population trends are unknown (AGFD 2003c).

LONG-EARED MYOTIS (*MYOTIS EVOTIS*)

This insectivorous bat has been recorded within the North and South parcels (AGFD 2010a; Forest Service 2009c). The record on the Kaibab National Forest is from Mile and a Half Tank (Forest Service 2009c). It is considered likely to occur on East Parcel. In Arizona, the range of this bat is the Kaibab and Mogollon plateaus (AGFD 2003d). According to Hoffmeister (1986), it inhabits ponderosa pine or spruce-fir forests of Arizona (AGFD 2003d).

Although primarily a coniferous forest bat, it may also be found in riparian and desert habitats. This species uses a variety of roosts, including abandoned buildings, cracks in the ground, mine tunnels, crevices in cliff faces, and spaces behind exfoliating tree bark. Caves and mine tunnels are used as hibernacula (AGFD 2003d). Populations are stable, although unique populations inhabiting relatively isolated mountain ranges may be threatened by loss of habitats (AGFD 2003d). It is moderately common in areas of suitable habitat but may be threatened by loss of suitable roost sites throughout its range (AGFD 2003d).

FRINGED MYOTIS (*MYOTIS THYSANODES*)

This insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a; Forest Service 2008c). The Kaibab National Forest records are from Skinner Tank and the Camp 36 Tank (Forest Service 2008c). It is known to occur throughout the state, with the exception of the northeast and southwest corners (AGFD 2003e). It occurs primarily in mid-elevation habitats, ranging from deserts to grasslands to woodlands. Populations appear to be stable in Arizona, although they are rare in other areas (AGFD 2003e).

LONG-LEGGED MYOTIS (*MYOTIS VOLANS*)

This species is included on both the BLM and NPS species lists. According to the distribution map at AGFD (2003f) and information from Forest Service (2008a, 2009c), this insectivorous bat species has been recorded within the North and South parcels. The Kaibab National Forest records are from the PIPO Snag Roost, Camp 36 Tank, and Mile and a Half Tank (Forest Service 2008a, 2009c). It is considered likely to occur on East Parcel. Long-legged myotis is found in forested mountains in Apache, Cochise, Coconino, Gila, Mohave, and Yavapai counties (AGFD 2003f) and has been collected along the Colorado River corridor in Grand Canyon National Park (Payne et al. 2010). Although primarily a coniferous forest bat, it may also be found in riparian and desert habitats (AGFD 2003f). Populations are considered stable in Arizona (AGFD 2003f).

BIG FREE-TAILED BAT (*NYCTINOMOPS MACROTIS*)

This insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a). It is considered likely to occur within the South Parcel. It is widely spread throughout the state but is probably absent from coniferous Mogollon Plateau (AGFD 2003g). It is primarily an inhabitant of rugged, rocky country and riparian areas (AGFD 2003g). Populations appear to be stable, although not common, except sometimes locally (AGFD 2003g).

POCKETED FREE-TAILED BAT (*NYCTINOMOPS FEMOROSACCUS*)

This species is included on both the BLM and NPS species lists. This insectivorous bat species is considered possible within the proposed withdrawal area. It was collected in Grand Canyon National Park for the first time in 2002 near RM 209 (Payne et al. 2010). The range is otherwise limited primarily to the south half of Arizona in Pima, Gila, Mohave, Maricopa, La Paz, Pinal, Graham, Cochise, and Yuma counties (AGFD 2003h).

HOUSEROCK VALLEY CHISEL-TOOTHED KANGAROO RAT (*DIPODOMYS MICROPS LEUCOTIS*)

This species is included on both the BLM and Forest Service species lists. The species is known to occur within the proposed withdrawal area (see Figure 3.8-2). The range is restricted to the House Rock Valley (East Parcel), on the west side of the Colorado River, in Coconino County (AGFD 2001h). Habitat is shrub-dominated Great Basin Desertscrub with relatively high shrub cover and sparse grass cover at 3,500 to 6,500 feet amsl. The preferred soils have a rocky or gravelly component and are deep to moderately deep (AGFD 2001h). The diet of this species is generally dominated by leaves, but it will sometimes eat insects and fungi (AGFD 2001h).

The relative abundance of the species throughout the occupied portion of East Parcel appears to be low and generally patchy; approximately 73,624 acres of habitat are occupied out of a total of about 150,000 acres that are available (AGFD 2001h). It appears that this species is now absent from part of its former range (AGFD 2001h).

WESTERN BURROWING OWL (*ATHENE CUNICULARIA HYPUGEA*)

This species is included on both the BLM and Forest Service sensitive species lists. The owl occurs on both the North and East parcels (AGFD 2001i). There are no known or historic records from the Kaibab National Forest. It occurs locally in open areas, generally year-round, with only a few winter records on the Colorado Plateau in the northeastern part of the state (AGFD 2001i).

Habitat includes open, well-drained grasslands, steppes, deserts, prairies, and agricultural lands, often associated with burrowing mammals. Burrowing owls feed on a wide variety of prey, changing food habits as location and time of year determine availability. Large arthropods, mainly beetles and grasshoppers, form a large portion of their diet. Small mammals, especially mice, rats, gophers, and ground squirrels, are also important food items. Other prey animals include reptiles and amphibians, scorpions, young cottontail rabbits, bats, and birds, such as sparrows and horned larks (AGFD 2001i).

COMMON CHUCKWALLA (*SAUROMALUS ATER*)

Common chuckwalla is considered likely to occur within the proposed withdrawal area. The species is found across southwestern Arizona, along the state’s western border, and up through the Grand Canyon into Glen Canyon at elevations ranging from near sea level along the Colorado River to about 6,000 feet amsl (Brennan 2008). Populations in the upper Grand and Glen canyons are located in Great Basin Desertscrub. This crevice-dweller is found in rocky habitats such as boulder fields, outcroppings on hillsides and slopes, and lava fields. Population trends are unknown but possibly decreasing as a result of pet trade demand (AGFD 2009). The chuckwalla is an herbivore, feeding on wildflowers, fruits and leaves of creosote and, to a lesser extent, on other perennials and annuals (AGFD 2009).

NORTHERN SAGEBRUSH LIZARD (*SCELOPORUS GRACIOSUS GRACIOSUS*)

Northern sagebrush lizard is considered likely to occur within the proposed withdrawal area. In Arizona, much of the range is on the Navajo Nation, including Coconino, Navajo, and Apache counties (AGFD 2000). It is known to occur in Grand Canyon National Park (Payne et al. 2010). This insectivorous lizard species is chiefly a ground-dweller, usually found near bushes, brush heaps, logs, or rocks and occasionally in trees (AGFD 2000). Populations of this lizard appear to be stable (AGFD 2000).

BANDED GILA MONSTER (*HELODERMA SUSPECTUM CINCTUM*)

The species may occur on the Kanab Plateau, but it is unknown whether it occurs on the North Parcel. It is distributed mainly in northwestern Arizona (the Arizona Strip), with immediately adjacent isolated populations in Utah, Nevada, and California (AGFD 2002d). Only populations northwest of the Colorado River are considered BLM Sensitive. In Arizona, it occurs primarily in the Sonoran Desert and extreme western edge of the Mohave Desert, less frequently in desert-grassland, and rarely in oak woodland (AGFD 2002d). It is most common in undulating rocky foothills, bajadas, and canyons to approximately 5,000 feet amsl (AGFD 2002d). Population trends are unknown (AGFD 2002d). This species generally feed on small mammals, lizards, and eggs of birds and reptiles (AGFD 2002d).

FLANNELMOUTH SUCKER (*CATOSTOMUS LATIPINNIS*)

This species is included on both the BLM and NPS species lists. The flannelmouth sucker does not occur within the proposed withdrawal area; however, its range does include the Colorado River and its larger tributaries in Glen and Grand canyons, to include the Virgin River (AGFD 2001j). It is reportedly found in the Paria River at its confluence with the Colorado River (BLM 1987); however, this reference may no longer be accurate. Flannelmouth suckers are omnivorous, benthic foragers (they feed on the bottom) that are primarily restricted to large and moderately large rivers; larvae inhabit shallow, slow-flowing near-shore areas (AGFD 2001j).

DESERT SUCKER (*CATOSTOMUS* [PANTOSTEUS] *CLARKI*)

This species is included on both the BLM and NPS species lists. The species does not occur within the proposed withdrawal area. The range of this sucker in Arizona includes the lower Colorado River downstream of Grand Canyon National Park, generally including the Bill Williams, Salt, Gila, and San Francisco river drainages, along with the Virgin River basin (AGFD 2002e). Habitat consists of the rapids and flowing pools of streams and rivers, primarily over bottoms of gravel-rubble, with sandy silt in the interstices (AGFD 2002e). Young desert suckers feed primarily on the larvae of aquatic insects. Adults feed mostly on aquatic plants and parts of plants present along the stream bottom. Feeding is performed predominantly by scraping plant materials off of rocks and small stones (AGFD 2002e).

SPECKLED DACE (*RHINICHTHYS OSCULUS*)

Speckled dace is not known to occur within the proposed withdrawal area; however, it may occur in Kanab Creek on the Kanab Plateau (adjacent lands). In Arizona, it is found in the Colorado, Bill Williams, and Gila river drainages; it is not present in the slower and warmer portions of Colorado River main stem (AGFD 2002f). It is reportedly found in the Paria River at the confluence with the Colorado River (BLM 1987); however, this reference may no longer be accurate. The species is a bottom dweller, found in rocky riffles, runs, and pools of headwaters, creeks, and small to medium-sized rivers (AGFD 2002f). Populations of this species apparently are stable (AGFD 2002f). Speckled dace are benthic feeders, eating primarily insect larvae and other invertebrates, although algae and fish eggs are also consumed (AGFD 2002f).

MACNEILL'S SOOTYWING (*HESPEROPSIS GRACIELAE*)

MacNeill's sootywing is unlikely to be found within the proposed withdrawal area. The distribution range of the species includes Nevada, Utah, and Arizona. In Arizona, it is found along the Lower Colorado River at Havasu Lake National Wildlife Refuge and Cibola National Wildlife Refuge and along the Virgin, Salt, and Gila rivers (AGFD 2003i). The larval food plant is quailbush (*Atriplex lentiformis*), which does not occur within the proposed withdrawal area. MacNeill's sootywing is declining from loss of its larval food plant because of agriculture and development along the Colorado River (AGFD 2003i).

HYDROBIID SPRING SNAILS: GRAND WASH SPRINGSNAIL (*PYRGULOPSIS BACCHUS*); DESERT SPRINGSNAIL (*PYRGULOPSIS DESERTA*)

Neither of these *Pyrgulopsis* springsnails occurs within the proposed withdrawal area. Both species are associated with springs. The Grand Wash springsnail is known to occur in only three springs in the Grand Wash trough in Mohave County; the species possibly also occurs in the Virgin Mountains in Clark County, Nevada (BLM 2007). Desert springsnail is found in springs along the Virgin River in southwestern Utah and northwestern Arizona (BLM 2007). Population trends and food habits for these two snails are unknown (AGFD 2001l, 2004c).

SUCCINEID SNAILS (FAMILY SUCCINEIDAE): NIOBRARA AMBERSNAIL (*OXYLOMA HAYDENI HAYDENI*)

Niobrara ambersnail does not occur within the proposed withdrawal area. In Arizona, there are two populations along the Colorado River (see Figure 3.8-4): within the Grand Canyon at Indian Gardens (Bright Angel Trail); and a riverside marsh at 9 Mile in the Lees Ferry reach (AGFD 2004d). The latter site is immediately adjacent to the East Parcel. In August 2009, 17 springs in Grand Canyon National Park considered at risk from uranium extraction activities were sampled for ambersnails by USGS and NPS personnel (Museum of Northern Arizona 2009). No *Oxyloma* snails were found during this survey. A third population of Niobrara ambersnails is located in southern Utah in the Kanab Canyon area (AGFD 2004d). The Indian Gardens population is restricted to permanently wet areas fed by a small spring, and the Lees Ferry population is restricted to areas with damp or saturated soil (AGFD 2004d).

Because of the populations' great reliance on wetland habitat, de-watering is a common threat to all *Oxyloma* populations (AGFD 2004d). The population near Lees Ferry is subject to inundation from even moderate flows of the Colorado River (>25,000 cubic feet per second [708 cubic meters per second]), and more than 90% of the entire habitat is inundated at 45,000 cubic feet per second or more (AGFD 2004d). The Indian Gardens population is threatened by trampling from off-trail hikers, large flash floods, and possible habitat loss/degradation as a result of landscape maintenance (AGFD 2004d).

3.8.3 Forest Service Sensitive Species

The Forest Service Sensitive species listed in Table 3.8-4 and addressed below are based on correspondence from Kaibab National Forest biologists and on the Regional Forester's sensitive species list (Forest Service 2010a). Information on species trends is included when available. As noted in Table 3.8-4, several of these species are also listed as sensitive by BLM and as such are addressed in Section 3.8.3, above. Species that are included on both the Forest Service and BLM species list and that have been discussed above include Allen's lappet-browed bat, Houserock Valley chisel-toothed kangaroo rat, and western burrowing owl.

Plants

TUSAYAN FLAMEFLOWER (*PHEMERANTHUS VALIDULUM*)

The species is found within the proposed withdrawal area (see Figure 3.8-1). It has been reported on the TenX and Kotzin inholdings (Forest Service 1999). The overall range includes several discrete locales: Pine Flats and vicinity, Tusayan, Coconino Plateau, Kaibab Plateau, southeast of Williams, the southern boundary of Grand Canyon National Park, near Grand Canyon Caverns, Rattlesnake Tanks near the San

Francisco Mountains in Coconino County, Juniper Mountains, Big Black Mesa, and Black Hills, Yavapai County (AGFD 2002g). Habitat consists of shallow pockets of sandy soil on exposed bedrock ledges and terraces in Madrean pine-oak forest openings at 5,000 to 7,000 feet amsl (Arizona Rare Plant Committee n.d. [2002]). There is no information on population trends (AGFD 2002g). Surveys conducted in the 1990s resulted in the discovery of 130 populations totaling more than 15,000 plants (Forest Service 1999).

Table 3.8-4. Forest Service Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Tusayan flameflower (*Phemeranthus validulum*)	Tracked as rare by Forest Service	No	No	Yes
Arizona leatherflower (*Clematis hirsutissima* var. *hirsutissima*)	Forest Service S	No	No	Yes
Tusayan rabbitbrush (*Chrysothamnus molestus*)	Forest Service S	No	No	Yes
Morton wild buckwheat (*Eriogonum mortonianum*)	Forest Service S	No	No	No
Animals				
Bald eagle (*Haliaeetus leucocephalus*)	USFWS Delisted Forest Service S	Yes	Yes	Yes
American peregrine falcon (*Falco peregrinus anatum*)	USFWS Delisted Forest Service S	Yes	Possible	Possible
Greater western mastiff bat (*Eumops perotis californicus*)	Forest Service S NPS SC	Yes	Yes	Possible
Western red bat (*Lasiurus blossevillii*)	Forest Service S	Possible	Possible	Possible
Spotted bat (*Euderma maculatum*)	Forest Service S NPS SC	Yes	Yes	Yes
Allen's lappet-browed bat (*Idionycteris phyllotis*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Yes
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	Forest Service S NPS SC	Yes	Yes	Yes
Desert bighorn sheep (*Ovis canadensis nelsoni*)	Forest Service S	Yes	Yes	No
Houserock Valley chisel-toothed kangaroo rat (*Dipodomys microps leucotis*)	BLM S Forest Service S (see species account in Section 3.8.2)	No	Yes	No
Merriam's shrew (*Sorex merriami*)	Forest Service S	No	Possible	Yes
Mogollon vole (*Microtus mogollonensis*)	Forest Service S	No	No	Yes
Northern goshawk (*Accipiter gentilis*)	Forest Service S Forest Service MIS	Possible	Possible	Yes
Western burrowing owl (*Athene cunicularia hypugea*)	BLM S Forest Service S (see species account in Section 3.8.2)	Yes	Yes	No

Table 3.8-4. Forest Service Sensitive Species and Their Potential for Occurrence in the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Animals, continued				
Lowland leopard frog *(Lithobates* [Rana] *yavapaiensis*	12 month status review BLM S Forest Service S	Possible	No	No
Northern Leopard Frog (Lithobates [Rana] pipiens)	Forest Service S (see species account in Section 3.8.2)	Possible	No	No
Grand Canyon rattlesnake (*Crotalus oreganus abyssus*)	Forest Service S	Possible	No	No

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service

MIS = Management Indicator Species: Species managed by the Forest Service because they 1) are thought to be the easiest species for determining population trends; 2) best lend themselves to interpretations of population change relative to habitat condition; and 3) best lend themselves to interpretations of species mix relative to habitat conditions.

S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)

SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

ARIZONA LEATHERFLOWER (*CLEMATIS HIRSUTISSIMA* VAR. *HIRSUTISSIMA*)

Arizona leatherflower is found within the proposed withdrawal area (see Figure 3.8-1). In Arizona, it is known from the Flagstaff area along Rio de Flag and lower Lake Mary, Volunteer Canyon in the Tusayan, and the Chuska Mountains (Arizona Rare Plant Committee n.d.). It occurs in moist mountain meadows, prairies, and open woods and thickets, usually in limestone soils of ponderosa pine and mixed-conifer forests at elevations ranging from 6,800 to 9,000 feet amsl (Arizona Rare Plant Committee n.d.).

TUSAYAN RABBITBRUSH (*CHRYSOTHAMNUS MOLESTUS*)

Tusayan rabbitbrush occurs within the proposed withdrawal area (see Figure 3.8-1). In Arizona, it is generally found in the southern part of the South Parcel (Forest Service 1999). The overall range of the species includes Coconino County from the South Rim of Grand Canyon National Park to the Flagstaff area (AGFD 2005i). Two disjunct populations are present on the Navajo Nation (Hopi Buttes and west of Gray Mountain) (AGFD 2005i). It is typically found in open pinyon-juniper grasslands on slopes and flats (where periodic fires naturally occur at an interval of every 15–30 years) from 5,710 to 6,880 feet amsl (AGFD 2005i). Population trends are unknown (AGFD 2005i). It apparently is extant at 21 locations in Coconino County, Arizona; few to none of these locations are protected (see AGFD 2005i).

MORTON WILD BUCKWHEAT (*ERIOGONUM MORTONIANUM*)

The species is not known to occur within the proposed withdrawal area. It is found about 4 to 6 miles southwest of Fredonia along SR 389in, Mohave County (AGFD 2001a). It is also found approximately 9 miles east-northeast of Pipe Springs in Utah. Habitat is usually along small drainages in red clay hills of very shallow gypsiferous soils on sandstone and shale uplands (AGFD 2001a). Only one population, with approximately 750 plants, is known in Arizona (AGFD 2001a). The population appears to be stable, with several size and age classes represented. A positive 90-day finding was published in the *Federal Register*

(74[240]:66866) for the Morton wild buckwheat, and a 12-month status review to determine whether or not to federally list the species will be published in the future.

Animals

GREATER WESTERN MASTIFF BAT (*EUMOPS PEROTIS CALIFORNICUS*)

The insectivorous bat species is known to occur on adjacent lands to the proposed withdrawal area (AGFD 2010a). It is considered likely to occur on the South Parcel. It has been recorded in Grand Canyon National Park (Payne et al. 2010); sonograms recorded at Point Sublime on the North Rim of the Grand Canyon were verified by D. Pearson (AGFD 2002h). In Arizona, where it is considered a year-round resident, the species been found in all Arizona counties except Yavapai, Navajo, Apache, and Santa Cruz (AGFD 2002h). Habitat includes lower and upper Sonoran Desertscrub vegetation zones near cliffs, where it prefers rugged, rocky canyons with abundant crevices (AGFD 2002h). Population trends are poorly known (AGFD 2002h).

WESTERN RED BAT (*LASIURUS BLOSSEVILLII*)

The insectivorous bat species is considered likely to occur within the proposed withdrawal area. It resides in Arizona from April through September, primarily in riparian and other woodland habitats where roosting sites are located in the foliage of trees and shrubs (AGFD 2003j). The species has been documented in Grand Canyon National Park, where it is found throughout the river corridor and has been observed and collected at various locations from Bright Angel Creek to Diamond Creek (Payne et al. 2010). Population trends are unknown in Arizona (AGFD 2003j).

SPOTTED BAT (*EUDERMA MACULATUM*)

The insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a; Forest Service 2008a, 2009c). The Kaibab National Forest records are from the Camp 36 Tank (Forest Service 2008a, 2009c). It has been recorded from the Kaibab Plateau, at a watershed southeast of Seligman, at a known roost near Marble Canyon (AGFD 2003k), and in Grand Canyon National Park (Payne et al. 2010). There appears to be a substantial population in the Fort Pierce Wash area on the Utah–Arizona border (AGFD 2003k). In Arizona, it is mostly collected in dry, rough desertscrub, with a few captured or heard in ponderosa pine forest (AGFD 2003k).

Population abundance and densities are very poorly known, but spotted bat is now known to occupy a wider total range and to be more common than initially thought (AGFD 2003k). The Fort Pierce Wash area of southwestern Utah and northwestern Arizona is one of five areas in the western United States where it has been taken in some numbers or fairly regularly (AGFD 2003k).

PALE TOWNSEND'S BIG-EARED BAT (*CORYNORHINUS TOWNSENDII PALLESCENS*)

The insectivorous bat species is known to occur within the proposed withdrawal area (AGFD 2010a; Forest Service 1999, 2009c). Maternity colonies are located in the East and South parcels (AGFD 2010a). In the South Parcel, the species was identified during surveys of caves (Forest Service 2008b) and abandoned mine features (Forest Service 2008c). It is considered widespread in Arizona and has been found in Cochise, Coconino, Gila, Graham, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, and Yuma counties (AGFD 2003l). There is a maternity colony at Stanton's Cave in Grand Canyon National Park (Payne et al. 2010). Habitat includes desertscrub, oak woodlands, pinyon-juniper, and conifer forest types throughout the state in summer (AGFD 2003l).

DESERT BIGHORN SHEEP (*OVIS CANADENSIS NELSONI*)

Desert bighorn sheep occur within the proposed withdrawal area (Figure 3.8-7). There are two major habitat areas in the vicinity of the proposed withdrawal area: Kanab Creek and the Paria Canyon–Vermilion Cliffs Wilderness (BLM 2007). Desert bighorn sheep occur along the entire drainage of the Colorado River within Grand Canyon. This species preferred habitat is rough, rocky, sparsely vegetated land, characterized by steep slopes, canyons, and washes (Payne et al. 2010).

With the exception of occasional sightings, bighorn sheep were believed to have been eliminated from the above-listed major habitat areas around the turn of the century. In a cooperative effort between the BLM and AGFD beginning in 1979, it was successfully reintroduced, and populations in these areas now appear stable (BLM 2007). For example, bighorn sheep transplanted to the Paria Canyon–Vermilion Cliffs area (immediately north of House Rock Valley) beginning in 1984 have exhibited one of the best reproductive success rates of any bighorn transplant in Arizona, primarily because of desirable habitat conditions (BLM 2007).

MERRIAM'S SHREW (*SOREX MERRIAMI*)

Merriam's shrew is likely to occur within the proposed withdrawal area (Hoffmeister 1986).
The distribution range in Arizona includes the Coconino Plateau, the Mogollon Plateau in the vicinity of Williams and Flagstaff, and Rose Peak in the White Mountains (Hoffmeister 1986). In Arizona, it inhabits cool, grassy locations near coniferous forests (Hoffmeister 1986). Merriam's shrew is widespread, although uncommon, and the population does not appear to be in decline (International Union for Conservation of Nature Red List 2010). Merriam's shrews are insectivores, eating insects, insect larvae (such as caterpillars), worms, and other small invertebrates (Utah Division of Wildlife Resources 2010f).

MOGOLLON VOLE (*MICROTUS MOGOLLONENSIS*)

The species occurs within the proposed withdrawal area (Frey and LaRue 1993). The distribution range is primarily Arizona and New Mexico, with peripheral populations in Utah, Colorado, and Texas. It is confined mainly to montane areas, where it prefers grassy habitats in ponderosa pine and mixed-conifer forests (Frey and LaRue 1993). Mogollon voles are herbivores that eat mainly green vegetation (Utah Division of Wildlife Resources 2010g).

Population trends are unknown (AGFD 2003m), primarily as a result of taxonomic confusion. Recent genetic studies place *M. mexicanus hualpaiensis*, which was listed by the USFWS as endangered in 1987, in *M. mogollonensis*. *M. mogollonensis* is now believed to consist of three subspecies: *hualpaiensis*, *mogollonensis*, and *navaho* (AGFD 2003m).

NORTHERN GOSHAWK (*ACCIPITER GENTILIS*)

Northern goshawk is known to occur within the proposed withdrawal area (Figure 3.8-8).The Kaibab Plateau exhibits one of the highest breeding densities known (AGFD 2003n). In Arizona, the species nests most commonly in ponderosa pine forests along the Mogollon Rim and on the Kaibab Plateau and in ponderosa pine forests in the southeastern mountains (AGFD 2003n). Beier (1997) found that adult goshawks in Arizona wintered in ponderosa pine forest and pinyon-juniper woodlands during some winters. In general, females remained in ponderosa pine in the general vicinity of their nest, while most male goshawks moved 5 to 10 miles from the nesting area and generally into the closest pinyon-juniper woodlands.

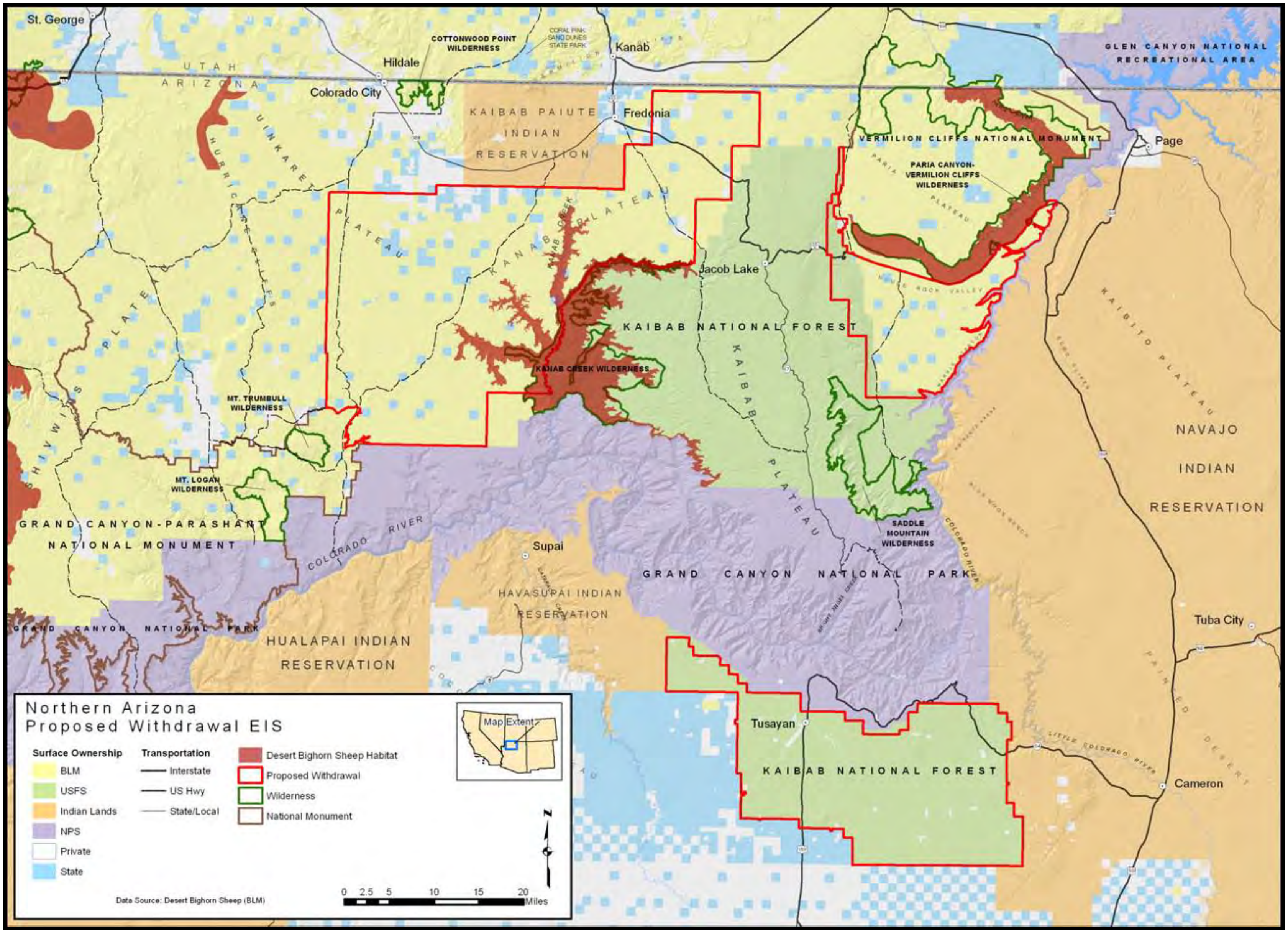


Figure 3.8-7. Desert bighorn sheep.

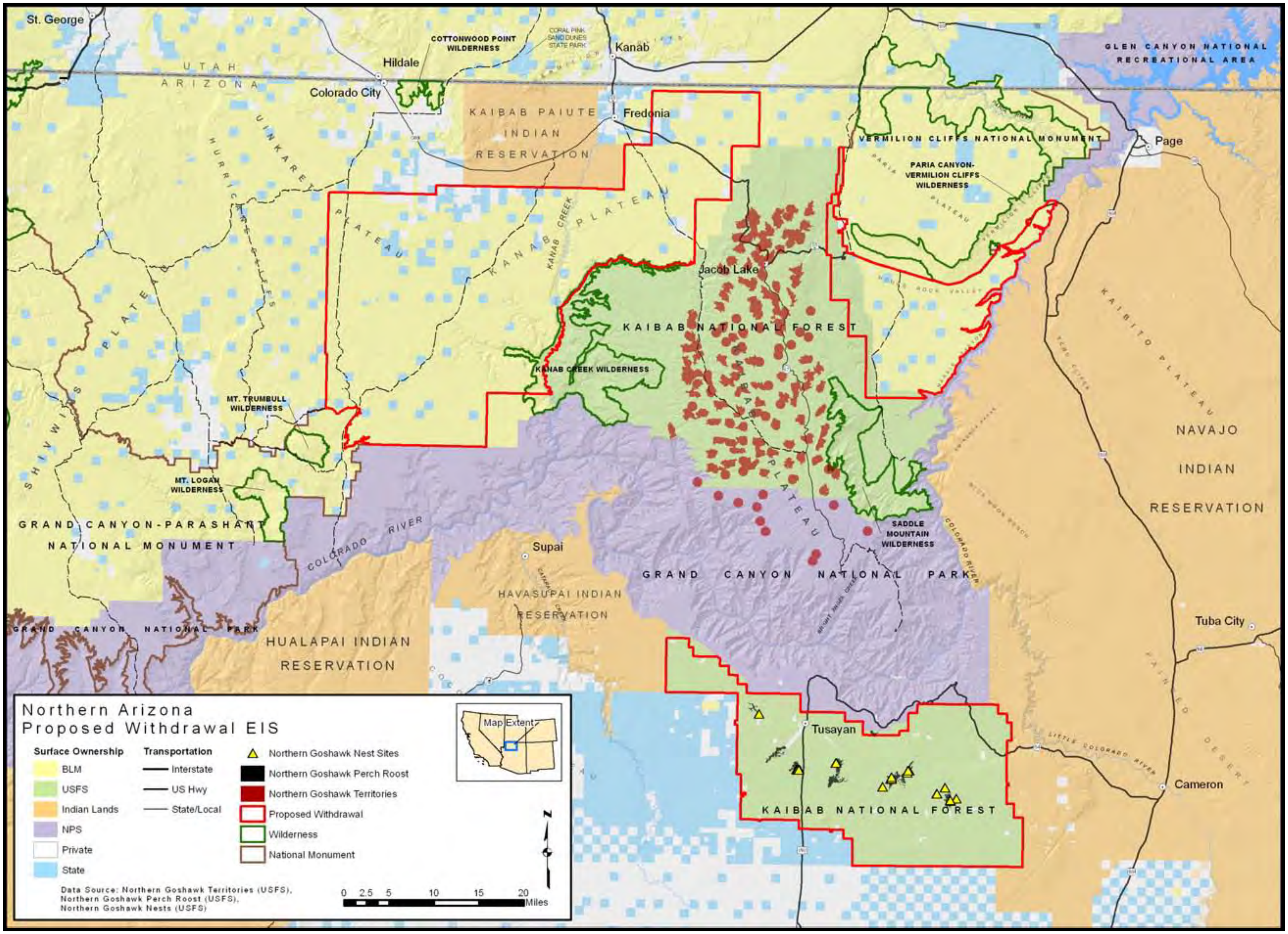


Figure 3.8-8. Northern Goshawk.

Human disturbance is not considered a potential limiting factor (Reynolds et al. 2006). A number of the known goshawk nest sites on the Tusayan and Williams ranger districts of the Kaibab National Forest are located close to Level 2 forest roads, which are characterized by relatively low traffic volumes and speeds. Logging trucks passing within approximately 1,600 feet of two active nests on the Kaibab Plateau did not cause discernible behavioral responses from the individuals at the nests (Forest Service 2009d).

Little historical information on goshawk densities exists, but populations appear to have undergone dramatic declines over the past 50 years (AGFD 2003n). On the Kaibab National Forest, the species is assumed by the Forest Service to be declining (Forest Service 2008d). All ponderosa pine and ponderosa pine–Gambel oak habitat on the forest was surveyed by Forest Service personnel, following Forest Service regional northern goshawk protocol. A total of 107 nesting territories was identified on a 684-square-mile study area on the Kaibab Plateau from 1991 to 1996 (AGFD 2003n). Causes being investigated for the decline include a change in forest composition and structure resulting from intensive forest management between the 1960s and early 1990s, combined with catastrophic fire and wind throw and natural environmental variation in prey abundance (Bratland et al. 2008).

GRAND CANYON RATTLESNAKE (*CROTALUS OREGANUS ABYSSUS*)

The Grand Canyon rattlesnake possibly occurs within the proposed withdrawal area (Stebbins 1985). This snake is a subspecies of the western rattlesnake and is found in extreme northwestern Arizona. It occurs in a variety of biotic communities, inhabits steep, rocky canyons, rolling hills, high plains, and plateaus of the upper Grand, Marble, Glen, and associated side canyons, as well as on the Arizona Strip, and eats small mammals.

3.8.4 National Park Service Species of Concern

The NPS Species of Concern listed in Table 3.8-5 and addressed below are those species that occur in close proximity to the proposed withdrawal area or that may be affected by one of the alternatives. This list is based on correspondence with Grand Canyon National Park biologists and uses the species given in Payne et al. (2010). Information on species trends is included when available. NPS Species of Concern are former USFWS Category 1, 2, and 3 species (USFWS no longer maintains a list of these species). Species included on both the BLM and NPS Sensitive species lists are Grand Canyon rose, Allen’s lappet-browed bat, long-legged myotis, pocketed free-tailed bat, flannelmouth sucker, and desert sucker. As noted in Table 3.8-5, several of these species are also listed as sensitive by the BLM and/or the Forest Service and as such are discussed in either Section 3.8.3 or 3.8.4.

Table 3.8-5. NPS Sensitive Species and Their Potential for Occurrence on the Proposed Withdrawal Area

Species	Status	North Parcel	East Parcel	South Parcel
Plants				
Grand Canyon rose (*Rosa stellata* ssp. *abyssa*)	BLM S NPS SC (see species account in Sectopm 3.8.2)	Yes	No	Possible*
Grand Canyon beavertail cactus (*Opuntia basilaris* var. *longiareolata*)	NPS SC	No	No	No
Kaibab agave (*Agave utahensis* ssp. *kaibabensis*)	NPS SC	No	No	No
McDougall’s yellowtops (*Flaveria mcdougallii*)	NPS SC	No	No	No
Grand Canyon cave-dwelling primrose (*Primula specuicola*)	NPS SC	No	No	No

Table 3.8-5. NPS Sensitive Species and Their Potential for Occurrence on the Proposed Withdrawal Area (Continued)

Species	Status	North Parcel	East Parcel	South Parcel
Plants, continued				
Kaibab suncup (Grand Canyon Evening-primrose) (*Camissonia specuicola* ssp. *hesperia*)	NPS SC	No	No	No
Animals				
Grand Canyon cave pseudoscorpion (*Archeolarca cavicola*)	NPS SC	No	No	No
Mexican long-tongued bat (*Choeronycteris mexicana*)	NPS SC	Possible	Possible	Possible
Southwestern myotis (*Myotis auriculus*)	NPS SC	No	No	No
Southwestern river otter (*Lontra canadensis sonora*)	NPS SC	No	No	No
Allen's lappet-browed bat (*Idionycteris phyllotis*)	BLM S Forest Service S NPS SC (see species account in Section 3.8.2)	Yes	Possible	Yes
Long-legged myotis (*Myotis volans*)	BLM S NPS SC (see species account in Section 3.8.2)	Yes	Possible	Yes
Pocketed free-tailed bat (*Nyctinomops femorosaccus*)	BLM S NPS SC (see species account in Section 3.8.2)	Possible	Possible	Possible
Desert Tortoise (*Gopherus agassizii*)	USFWS 12-month review NPS SC (see species account in Section 3.8.2)	No	No	No
Greater western mastiff bat (*Eumops perotis californicus*)	Forest Service S NPS SC (see species account in Section 3.8.3)	Yes	Possible	Possible
Spotted bat (*Euderma maculatum*)	Forest Service S NPS SC (see species account in Section 3.8.3)	Yes	Yes	Yes
Big free-tailed bat (*Nyctinomops ferorosaccus*)	BLM S NPS SC (see species account in Section 3.8.2)	Yes	Yes	Possible
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	Forest Service S NPS SC (see species account in Section 3.8.4)	Yes	Yes	Yes
Flannelmouth sucker (*Catostomus latipinnis*)	BLM S NPS SC (see species account in Section 3.8.2)	No	No	No
Desert sucker (*Catostomus* [Pantosteus] *clarki*)	BLM S NPS SC (see species account in Section 3.8.2)	No	No	No

Notes:

BLM

S = Sensitive: those taxa occurring on BLM Field Office Lands in Arizona that are considered sensitive by the Arizona State Office.

Forest Service

S = Sensitive: those taxa occurring on National Forests in Arizona that are considered sensitive by the Regional Forester.

NPS (Grand Canyon National Park)

SC = Species of Concern. There is some information showing vulnerability or threat, but not enough to support listing under the ESA. These species are former USFWS Category 1, 2, and 3 species (*Note: the Southwest Region of the USFWS no longer maintains a list of Category 1, 2, or 3 species*).

Plants

GRAND CANYON BEAVERTAIL CACTUS (*OPUNTIA BASILARIS* VAR. *LONGIAREOLATA*)

This cactus variety is not known to occur within the proposed withdrawal area. The range in Arizona is apparently confined to Granite Rapids, Grand Canyon National Park, where it is found on rocky soils at the bases of talus slopes at about 2,000 feet amsl (Benson 1982; Brian 2000). According to Benson (1982), the validity of this variety is dubious. The elongate areoles that the specific epithet implies are not at all characteristic for *Opuntia basilaris* var. *longiareolata* and are sometimes found on plants of other varieties (*Flora of North America* 2010).

KAIBAB AGAVE (*AGAVE UTAHENSIS* SSP. *KAIBABENSIS*)

Kaibab agave is not known to occur within the proposed withdrawal area. It is endemic to Coconino and Mohave counties, Arizona, including the Kaibab Plateau south to the South Rim and along the cliffs above the Little Colorado River (AGFD 2005j). In Grand Canyon National Park, it is known from eastern Grand Canyon to the Kanab Plateau. Small populations occur in Virgin Canyon above the Virgin Gorge and in Lime Kiln Canyon, Mohave County (AGFD 2005j). Habitat is open ledges, rims, and level to moderately sloping ledges of limestone and sandstone-derived soils (Brian 2000) in the Mohave and Great Basin Desertscrub and Great Basin Conifer Woodland. It has been collected on the Esplanade Formation and on Coconino Sandstone just above the Supai Formation (AGFD 2005j). Population trends are unknown (AGFD 2005j).

MCDOUGALL'S YELLOWTOPS (*FLAVERIA MCDOUGALLII*)

The species is not known to occur within the proposed withdrawal area. It is known from a limited number of populations along the tributaries and main Colorado River corridor of western Grand Canyon National Park, from Matkatimiba Canyon to Lava Falls Rapid, in Coconino and Mohave counties (AGFD 2005j; Arizona Rare Plant Committee n.d.). It grows in hanging gardens or terrace ledges in perennial alkaline or saline seeps, in Muav Limestone and at the Muav Limestone Bright Angel Shale interface from 1,700 to 2,000 feet amsl (AGFD 2005j). The species is considered locally abundant within its limited habitat (NatureServe 2005).

GRAND CANYON CAVE-DWELLING PRIMROSE (*PRIMULA SPECUICOLA*)

The species is not known to occur within the proposed withdrawal area. In Arizona, it is endemic to the canyons of the Colorado River in Coconino and Mohave counties, including Grand Canyon National Park (AGFD 2004e). It grows in moist sites from hanging gardens or alcoves in canyons with limestone cliffs from 3,500 to 5,200 feet amsl in Utah and from 1,250 to 7,600 feet amsl in Arizona (AGFD 2004e). Populations appear to be stable (AGFD 2004e). In 1979, there were 10 estimated populations, with few to several hundred individuals per population (see AGFD 2004e).

KAIBAB SUNCUP (GRAND CANYON EVENING-PRIMROSE) (*CAMISSONIA SPECUICOLA* SSP. *HESPERIA*)

The species is not known to occur within the proposed withdrawal area. There are two disjunct populations along the Colorado River in Arizona, in Havasu and Hualapai canyons, Coconino County, and from Separation Canyon to Spencer Canyon, Mohave County (AGFD 2004f; Brian 2000). It is found scattered on open slopes and in rock crevices, washes, and dry streambeds, often on limestone at 1,240 to 4,500 feet amsl (AGFD 2004f). Population trends are unknown (AGFD 2004f).

Animals

GRAND CANYON CAVE PSEUDOSCORPION (*ARCHEOLARCA CAVICOLA*)

The species is not known to occur within the proposed withdrawal area. The only known location is along the Colorado River at Cave of the Domes, Grand Canyon National Park, Arizona (AGFD 2003o), about 5 miles north of the Kaibab National Forest. However, Payne et al. (2010) reference several specimens confirmed in two caves in the Lower Gorge. It is found in subterranean cave habitat with bats and/or rodents (AGFD 2003o). Population trends are unknown (AGFD 2003o).

MEXICAN LONG-TONGUED BAT (*CHOERONYCTERIS MEXICANA*)

The species may occur on lands adjacent to the proposed withdrawal area. The AGFD documented one record along the Colorado River adjacent to East Parcel (AGFD 2006d). At Grand Canyon National Park, this species has also been documented living in caves and mines (Payne et al. 2010). The species prefers mesic areas in canyons of mixed oak-conifer forests in mountains rising from the desert (AGFD 2006d). Population trends are unknown (AGFD 2006d). This species of bat feed on fruits, pollen, nectar, and probably insects.

SOUTHWESTERN MYOTIS (*MYOTIS AURICULUS*)

The insectivorous bat species is not known to occur within the proposed withdrawal area. According to Payne et al. (2010), this species has been captured once along the Colorado River in Grand Canyon National Park. It is found primarily in Gila, Maricopa, and Cochise counties (AGFD 2003p). Although typically found in ponderosa pine habitat and other semi-arid woodland habitats, it is also sometimes captured in desert grasslands (AGFD 2003p). Populations appear to be stable, although few data exist throughout the species' range (AGFD 2003p). It may be expanding its range northward in the United States.

SOUTHWESTERN RIVER OTTER (*LONTRA CANADENSIS SONORA*)

The native subspecies of river otter is not known to occur within the proposed withdrawal area. It is probably extirpated from its former range along the Colorado River (Payne et al. 2010). Although there are occasional unconfirmed sightings of otters along the Colorado River below Lake Mead, it is likely that these are a nonnative subspecies introduced into the river drainage by AGFD between 1978 and 1991 (Payne et al. 2010). A river otter subspecies from Louisiana, *L. c. lataxina,* was successfully introduced into the Verde River drainage in central Arizona during 1981–1983 and may eventually cause genetic swamping of any native individuals, if any still exist (AGFD 2002i).

Although apparently never abundant, the southwestern river otter population has declined and is now considered very rare by AGFD (AGFD 2002i). Evidence cited above also suggests the possibility of inbreeding between native, if any still exist, and introduced otters.

3.8.5 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, 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. Other habitat enhancement projects implemented include prescribed burns, seeding, and chemical or mechanical treatments of poor-quality habitat areas. Wildlife habitat monitoring studies are being conducted to assess the results of management toward meeting wildlife objectives. In cooperation with the USFWS and AGFD, several species have been reintroduced to former ranges, and existing populations have been augmented. These include pronghorn, desert bighorn sheep, mule deer, and Merriam's turkey, as well as northern leopard frog and Apache trout.

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 include Niobrara ambersnail, Kanab ambersnail, northern leopard frog, relict leopard frog, Sonoran desert tortoise, flannelmouth sucker, humpback chub, razorback sucker, speckled dace, olive-sided flycatcher (*Contopus borealis*), sage thrasher, western yellow-billed cuckoo, northern goshawk, American peregrine falcon, western burrowing owl, Mexican spotted owl, southwestern willow flycatcher, 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 (*Lasiurus xanthinus*), 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 (*Catostomus discobolus*), which occurs in Kanab Creek immediately south of the Kanab Plateau, and a variety of avian species found at higher elevations in habitats (i.e., mixed conifer, spruce-fir, aspen) on the Kaibab Plateau 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 (*Picoides tridactylus*), western purple martin (*Progne subis*), red-naped sapsucker (*Sphyrapicus nuchalis*), Lewis's woodpecker (*Melanerpes lewis*), Lincoln's sparrow (*Melospiza lincolnii*), MacGillivray's warbler (*Oporornis tolmiei*), downy woodpecker (*Picoides pubescens*), green-tailed towhee (*Pipilo chlorurus*), ruby-crowned kinglet (*Regulus satrapa*), and golden-crowned kinglet (*R. calendula*).

Bluehead sucker (*Catostomus discobolus*)

The bluehead sucker is found in high gradient streams of western North America (AGFD 2003q). The bluehead sucker is a benthic (bottom dwelling) species with a mouth modified to scrape algae (the primary food of the bluehead sucker) from the surface of rocks. Members of the species spawn in streams during the spring and summer. Fast-flowing water in high-gradient reaches of mountain rivers has been identified as important habitat for bluehead sucker.

In Arizona, this species is found in the Colorado River main stem and Grand Canyon tributaries, including Little Colorado River, Clear Creek, Bright Angel Creek, Shinumo Creek, Kanab Creek, and Havasu Creeks; rare below Diamond Head. This species may also be found in a few areas on the Navajo Reservation and in the San Juan Drainage (AGFD 2003q). This species is located within the proposed withdrawal area (Kanab Creek).

American three-toed woodpecker (*Picoides tridactylus*)

It is unknown whether the American three-toed woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. American three-toed woodpeckers are generally associated with spruce forests, although their occurrence in other types of coniferous forest varies geographically (Short 1974). American three-toed woodpeckers occur as far north as Alaska and extend through the boreal forests of Canada south into the lower 48 states. American three-toed woodpeckers flake off bark to forage on bark beetles (Scolytidae) and are typically found in old growth forests and/or disturbed areas that have high densities of bark beetle larvae (Short 1974). While any disturbance that produces a large number of dead/decaying trees may be important for this species (i.e., insect outbreaks, flooding, disease), multiple studies have noted the importance of burns for American three-toed woodpeckers (Short 1974).

Western purple martin (*Progne subis*)

It is unknown whether the western purple martin is located within the proposed withdrawal area, but it is a species that is possible in the region. The purple martin can be found throughout North America in summer and winters in South America (Animal Diversity Web 2010). The original habitat of this species was probably forest edge and riparian habitats, but many populations now inhabit cities and towns. The habitat of this species is coniferous forests near water sources. The diet of this species is flying insects (Animal Diversity Web 2010).

Red-naped sapsucker (*Sphyrapicus nuchalis*)

It is unknown whether the red-naped sapsucker is located within the proposed withdrawal area, but it is a species that is possible in the region. The red-naped sapsucker is a woodpecker of lower elevations in the Rocky Mountains (NatureServe 2005). It prefers to make sap wells in willow trees but will use a variety of tree species. Their habitat includes mixed forests in the Rocky Mountains and Great Basin areas of North America. They nest in cavities of dead trees.

Lewis's woodpecker (*Melanerpes lewis*)

It is unknown whether the Lewis's woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. This species is associated with mature montane and riparian forests from interior southern Canada to Arizona and New Mexico and from coastal California east to Colorado (Cornell Laboratory Ornithology 2010a).

Three principal habitats are open ponderosa pine forest, open riparian woodland dominated by cottonwood, and logged or burned pine forest; however, breeding birds are also found in oak woodland, nut and fruit orchards, pinyon pine-juniper woodland, a variety of pine and fir forests, and agricultural areas, including farm and ranchland. Important aspects of breeding habitat include an open canopy, a brushy understory offering ground cover and abundant insects, dead or downed woody material, available perches, and abundant insects (Cornell Laboratory of Ornithology 2010a).

Lincoln's sparrow (*Melospiza lincolnii*)

It is unknown whether the Lincoln's sparrow is located within the proposed withdrawal area, but it is a species that is possible in the region. Lincoln's sparrow occurs from northern Canada south through the Rocky Mountains and the Pacific coastal ranges to southern California, Arizona, and New Mexico (Utah Division of Wildlife Resources 2010a). During winter, it is found in the south-central and southwestern United States, south to Honduras. Habitats used by Lincoln's sparrow during the breeding season include wet meadows, bogs, and riparian thickets, especially where these habitats include willows and where shrub cover is dense; during migration and in winter, this species uses a much broader array of habitats, ranging from weedy pastures to tropical forests. This species feeds mainly on terrestrial invertebrates (arthropods) and small seeds.

MacGillivray's warbler (*Oporornis tolmiei*)

It is unknown if the MacGillivray's warbler is located within the proposed withdrawal area, but it is a species that is possible in the region. MacGillivray's warblers are migratory birds that spend their summers in temperate forests located in the western United States and in boreal forests of west Canada (Cornell Laboratory of Ornithology 2010b). In autumn, these birds will migrate back to Central America, where they will stay in temperate shrublands for the winter. This species primarily feeds on insects but will also take spiders and occasionally worms. They also are known to feed at sapsucker drill wells.

Downy woodpecker (*Picoides pubescens*)

It is unknown whether the downy woodpecker is located within the proposed withdrawal area, but it is a species that is possible in the region. The downy woodpecker is a common year-round resident in forests, riparian woodlands, parks, and suburbs throughout Canada and most of the United States (Utah Division of Wildlife Resources 2010b). The diet of the downy woodpecker consists primarily of insects, but fruits, seeds, and sap are also consumed. Individuals either glean food items directly off of a tree, or drill into tree bark.

Green-tailed towhee (*Pipilo chlorurus*)

It is unknown whether the green-tailed towhee is located within the proposed withdrawal area, but it is a species that is possible in the region. The green-tailed towhee is a large secretive sparrow that uses different habitats throughout its range (Utah Division of Wildlife Resources 2010c). At low elevations, it is found in diverse shrub communities or in pinyon-juniper forests. At higher elevations, it is frequently found in disturbed forests and along forest edges. Green-tailed towhees forage for food under dense cover either on the ground or in low vegetation. They scratch the ground to expose small seeds and insects, which they then pluck off the ground. Less often, they will take insects or fruits directly off vegetation.

Ruby-crowned kinglet (*Regulus satrapa*)

It is unknown whether the ruby-crowned kinglet is located within the proposed withdrawal area, but it is a species that is possible in the region. The ruby-crowned kinglet is a small songbird that breeds in boreal, subalpine, and mixed coniferous forests in Canada and in both the northeastern and western United States (Utah Division of Wildlife Resources 2010d). This bird winters in coniferous and deciduous forests across the United States and into northeastern Mexico. The diet of the ruby-crowned kinglet consists primarily of insects that are either gleaned from leaves and limbs, or chased down and captured.

Golden-crowned kinglet (*R. calendula*)

It is unknown whether the golden-crowned kinglet is located within the proposed withdrawal area, but it is a species that is possible in the region. The golden-crowned kinglet is a small songbird that breeds in boreal, subalpine, and mixed coniferous forests in Canada and in both the northeastern and western United States (Utah Division of Wildlife Resources 2010e). This bird winters in coniferous and deciduous forests across the United States and into northeastern Mexico. The diet of the ruby-crowned kinglet consists primarily of insects that are either gleaned from leaves and limbs or chased down and captured.

3.8.6 Resource Condition Indicators

Table 3.8-6. Special Status Species Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Special status species habitat	Issues associated with special status species habitat include fragmentation of habitat by roads, noise from exploration or development activities that disrupts species, species disturbed by visual intrusions such as moving vehicles or equipment, and loss of habitat from surface disturbance or introduction of invasive species.	*Indicator*: Acres and type of habitat lost and duration of loss. *Indicator*: Changes in migratory or foraging behavior. *Indicator*: Avoidance or adaptation of species to noise source/visual intrusion. *Indicator*: Acres of habitat loss as a result of establishment of invasive species caused by mineral exploration or development activities.
Special status species populations	Potential loss of critical special status species winter range. Potential for activity to occur in critical calving or fawning areas, disruption of nesting habitat, etc.	*Indicator*: Maximum fraction of critical winter range or calving, fawning, or nesting areas subject to disturbance at a given time.
Special status species mortality	The increase in vehicle traffic associated with increased uranium exploration and development has the potential to cause increased vehicle/wildlife accidents and associated wildlife mortality.	*Indicator*: Estimated number of vehicle/wildlife collisions associated with exploration or production activity.

3.9 VISUAL RESOURCES

3.9.1 Introduction

Visual resources are the visible physical features on a landscape and may include land, water, vegetation, animals, structures, and other features. The combination of these physical features creates scenery and provides an overall landscape character. This character is formed by the variety and intensity of the landscape features and the four basic elements of form, line, color, and texture. These factors give an area a unique quality that distinguishes it from its immediate surroundings. Usually, the more variety of these elements a landscape has, the more interesting or scenic the landscape becomes if the elements coexist harmoniously. Scenic quality is the relative value of a landscape from a visual perception point of view.

The region where the proposed withdrawal area is located in Coconino and Mohave counties, Arizona (see Figure 1.1-1), is internationally recognized for its diverse landscapes and scenic qualities and offers many developed and dispersed backcountry recreation opportunities for sightseeing, wildlife viewing, and on-road touring. It attracts large numbers of tourists, varying from local residents to visitors from around the world, who come to the area to enjoy the area's dramatic scenic qualities. Distinct and notable scenic features in the region include the Grand Canyon, Vermilion Cliffs, Kaibab Plateau, Coconino Plateau, Mount (Mt.) Trumbull, and others. The analysis area for visual resources includes lands where potential changes to the landscape may be discerned.

3.9.2 Landscape Character

The proposed withdrawal area is in the southwestern portion of the Colorado Plateau. Scenery throughout the proposed withdrawal area is made up of a diverse variety of physical elements. The landscape is generally characterized by colorful sedimentary rock formations, steep-walled canyons, wooded plateaus, broad plains, dark gray cinder cones, fields of rugged volcanic rock, and major fault scarps. Because of the remote and undeveloped nature of much of the proposed withdrawal area, visitors to the area are rewarded with unrestricted views of forested ridges, steep, colorful canyons, and vast, open plains.

Human modifications occur throughout the proposed withdrawal area and contribute to the overall landscape character. These modifications consist primarily of roads and ranching developments and include some transmission lines, mining development, and trails.

3.9.3 Federal Visual Resource Management Systems

The BLM, Forest Service, and NPS all use a visual resource inventory and contrast analysis process to analyze impacts to visual resources. However, each agency applies its own system to establish Visual Resource Management (VRM) objectives or scenic integrity levels. Typically, a visual resource inventory process involves rating the visual appeal of a tract of land, measuring 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.

Visual analysis involves determining whether the potential visual impacts from proposed activities or developments would meet the management objectives established for the area. A visual contrast rating process is used for this analysis, which involves comparing the proposed withdrawal features with the major features in the existing landscape using the basic design elements of form, line, color, and texture.

The following sections detail the BLM, Forest Service, and NPS VRM systems.

Bureau of Land Management

The BLM (South and East parcels) uses the VRM system to manage visual resources on public lands (BLM 1986a, 1986b). Most of these two parcels are managed under the direction contained within the Arizona Strip Field Office RMP (BLM 2008b). The primary objective of VRM for the North and East parcels is to maintain the existing visual quality of BLM-administered lands and to protect unique and fragile visual resources. The VRM system uses four classes to describe the different degrees of modification allowed to the basic elements of the landscape (i.e., line, form, color, and texture).
The VRM classes and their objectives are described in Table 3.9-1.

Table 3.9-1. Visual Resource Management Class Descriptions

VRM Class	Description
I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and should not attract attention.
II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
IV	The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements of the landscape.

Forest Service

On most National Forest System lands, the Forest Service uses a Scenery Management System (SMS), which replaces the Forest Service's former Visual Management System (Forest Service 1974) for management of visual resources. *Landscape Aesthetics: A Handbook for Scenery Management*, Agricultural Handbook 701 (Forest Service 1995), defines a system for inventory and analysis of the aesthetic values of National Forest System lands. Both the Forest Service and BLM systems rely on visual inventory and scenic quality classes to manage visual resources.

The Kaibab National Forest currently uses both the SMS and the Visual Management System. The South Parcel is managed under the newer SMS, and the small areas of the Kaibab National Forest within the North and East parcels are managed under the older Visual Management System. The *Environmental Assessment for Amendment of the Kaibab National Forest Management Plan—Recreation and Scenery Management* (Kaibab EA) (Forest Service 2004) determined that the Kaibab National Forest's Visual Management System inventory and mapping was inadequate. This was the result of insufficient visual quality mapping for the Kaibab LRMP/ROD (Forest Service 1988) in which forest managers assigned Visual Quality Objectives (VQOs) to areas of known visual concern (major travel ways, high-use Forest Roads, scenic areas, and recreation sites) but did not map the remaining areas. The Kaibab EA was used to inventory and update VRM on the Kaibab National Forest to the SMS system, but this was only completed for the Tusayan Ranger District (the South Parcel of the proposed withdrawal area). The Kaibab LRMP/ROD was amended to adopt more comprehensive mapping, standards, and the Recreation Opportunity Spectrum (ROS)-SMS Guidebook, but only for the South Parcel. Both Forest Service VRM systems are described below.

VISUAL MANAGEMENT SYSTEM

VQOs are used for VRM of some Forest Service landscapes, depending on the status of the applicable Forest Plan. VQOs establish the acceptable degree of alteration of the characteristic landscape (Table 3.9-2). Each VQO describes a different degree of acceptable alteration of the natural landscape. The degree of alteration is measured in terms of visual contrast with the surrounding landscape generated by introduced changes in form, line, color, or texture. The Kaibab National Forest uses the Visual Management System on their lands within the North and East parcels.

Table 3.9-2. Forest Service Visual Quality Objective Descriptions

VQO Category	Definition
Preservation	Allows ecological change only and management activities that are not noticeable to observers.
Retention	Allows management activities that are not evident to the casual forest visitor.
Partial Retention	Allows management activities that may be evident to the observer but must remain subordinate to the characteristic landscape.
Modification	Allows management activities that may dominate the characteristic landscape but that must, at the same time, use naturally established form, line, color, and texture.

SCENERY MANAGEMENT SYSTEM

The new system used by the Forest Service, the SMS, includes a scenery inventory system similar to the BLM system that assigns Scenic Integrity Objectives (SIOs) to landscapes. The SIO determines the degree of acceptable change or alteration to the visual landscape. The Kaibab National Forest uses the SMS on the Tusayan Ranger District (South Parcel) to guide management activities in terms of visual resources. Table 3.9-3 describes the SIOs.

Table 3.9-3. Forest Service Scenery Management System Scenic Integrity Objectives

SIO	Landscape Theme
Very High	The landscape is intact, with only minute, if any, deviations. The existing character and sense of place should be expressed at the highest level. Human influence from historic use or management should appear completely natural to the majority of viewers.
High	The landscape appears unaltered and intact. Deviations may be present but should repeat the line, form, color, and textures of the existing landscape character so completely, and at such a scale, that they are not evident.
Moderate	The landscape appears slightly altered. Noticeable changes should remain visually subordinate to the landscape character being viewed.
Low	The landscape appears moderately altered. Deviations and changes to the landscape may begin to dominate the landscape character. These changes should borrow valued landscape attributes such as size, shape, edge effects, patterns of natural openings, vegetative type changes, or architectural styles that are outside the altered landscape.

Source: Forest Service (1995).

National Park Service

The proposed withdrawal area does not include lands within Grand Canyon National Park. However, because of the Park's central location and geographic proximity to the three proposed withdrawal parcels the NPS mandate to conserve visual resources is part of the analysis.

NPS does not apply a classification system to managing scenic quality within national parks. As mandated under the Organic Act [16 USC 1], all visual resources and scenic quality within national parks are to be conserved and managed in an unimpaired condition for the enjoyment of future generations. Potential impairment of the resource is determined using context, intensity, duration, and timing to gauge the level of impacts of proposed projects within the National Park System. Through the NEPA process, threshold values have been developed to assist the evaluator in determining whether a project's activities would constitute an impairment of visual resources. Grand Canyon National Park is managed under a General Management Plan (NPS 1995).

The Organic Act [16 USC 1] also addresses that potential impairment of park resources may result from sources or activities outside the park. The NPS will conduct cooperative conservation to work with others to anticipate, avoid, and resolve potential conflicts and protect park resources.

3.9.4 Visual Resource Descriptions

The following sections describe the existing landscape of each parcel. This is done in terms of the basic elements of the characteristic landforms, vegetation, and human modifications found throughout each parcel. Observation points that are representative of the characteristic landscape within each parcel are identified, and the geographic context of those points is described. Because visual details are diminished the farther the observer is removed, landscapes are subdivided into three distance zones based on relative visibility from travel routes or observation points. The three zones are foreground–middle ground, background, and seldom seen. The foreground–middle ground zone includes views that are less than 3 to 5 miles away. Views beyond the foreground–middle ground zone but less than 15 miles away are usually called background zone. Views not seen as foreground–middle ground or background (i.e., hidden from view) are in the seldom-seen zone. VRM objectives have been assigned by BLM and Forest Service to all lands within the three parcels, and a detailed breakdown of those objectives is provided.

These elements—characteristic landscape, geographic context, and agency VRM objectives—will be the basis for assessing visual impacts through contrast analysis and distance zones in Chapter 4.

North Parcel

The North Parcel is located north of the Grand Canyon and includes portions of the Kanab and the Uinkaret plateaus (Figure 3.9-1). Elevations of the North Parcel vary between 4,000 feet amsl along Kanab Creek to approximately 6,500 feet amsl at Hancock Knoll. As documented in the Arizona Strip ROD/RMP (BLM 2008b), the BLM designated the Kanab Creek Wilderness VRM Class I; the Kanab Creek, Moonshine Ridge, and Johnson Spring ACECs, the plateau between Nates and Robinson canyons (south of Hack Canyon), and the Old Spanish National Historic Trail as VRM Class II; an east-west utility corridor as VRM Class IV; and the remainder of the parcel as VRM Class III. Modifications to the characteristic landscape of the North Parcel consist of exploration and development, the utility corridor, and a network of dirt roads to provide access for recreation opportunities, mining operations, livestock grazing, fire suppression, and other land management activities. Table 3.9-4 describes the acres per visual resource classification within the North Parcel, and Figure 3.9-1 depicts the visual resource designations. This parcel also includes a small section of Forest Service land on the east side, along Kanab Creek. This contains the VQO designation of preservation along the lower portion of Kanab Creek and modification on the upper segment.

Table 3.9-4. North Parcel Visual Resource Class Acreage for BLM and Forest Service Land

	Acres
BLM VRM Class	
Class I	4,156
Class II	63,216
Class III	505,449
Class IV	23,422
Forest Service VQO	
Preservation	3,069
Retention	0
Partial Retention	0
Modification	4,989

For the purposes of this analysis, several observation areas were established within the North Parcel. These observation areas include views along major travel corridors (U.S. 89A, SR 389), Toroweap Road (dirt road), and Big Springs Road (dirt road), as well as several trailheads within and adjacent to the North Parcel (see Figure 3.9-1).

U.S. 89A CORRIDOR

U.S. 89A traverses the eastern portion of the North Parcel from east to west (see Figure 3.9-1). The dominant landscape view is of the vast, open, and undeveloped plains of the gently rolling Kanab Plateau. Views south of U.S. 89A include foreground–middle ground views of Kanab Plateau and possible glimpses of Kanab Creek Canyon, parts of which are within the Kanab Creek Wilderness. Foreground and middle ground views west of U.S. 89A include views of Yellowstone Mesa, while views north of U.S. 89A include views of the Shinarump Cliffs. A primary feature is the vertical rise of the Kaibab Plateau to the west.

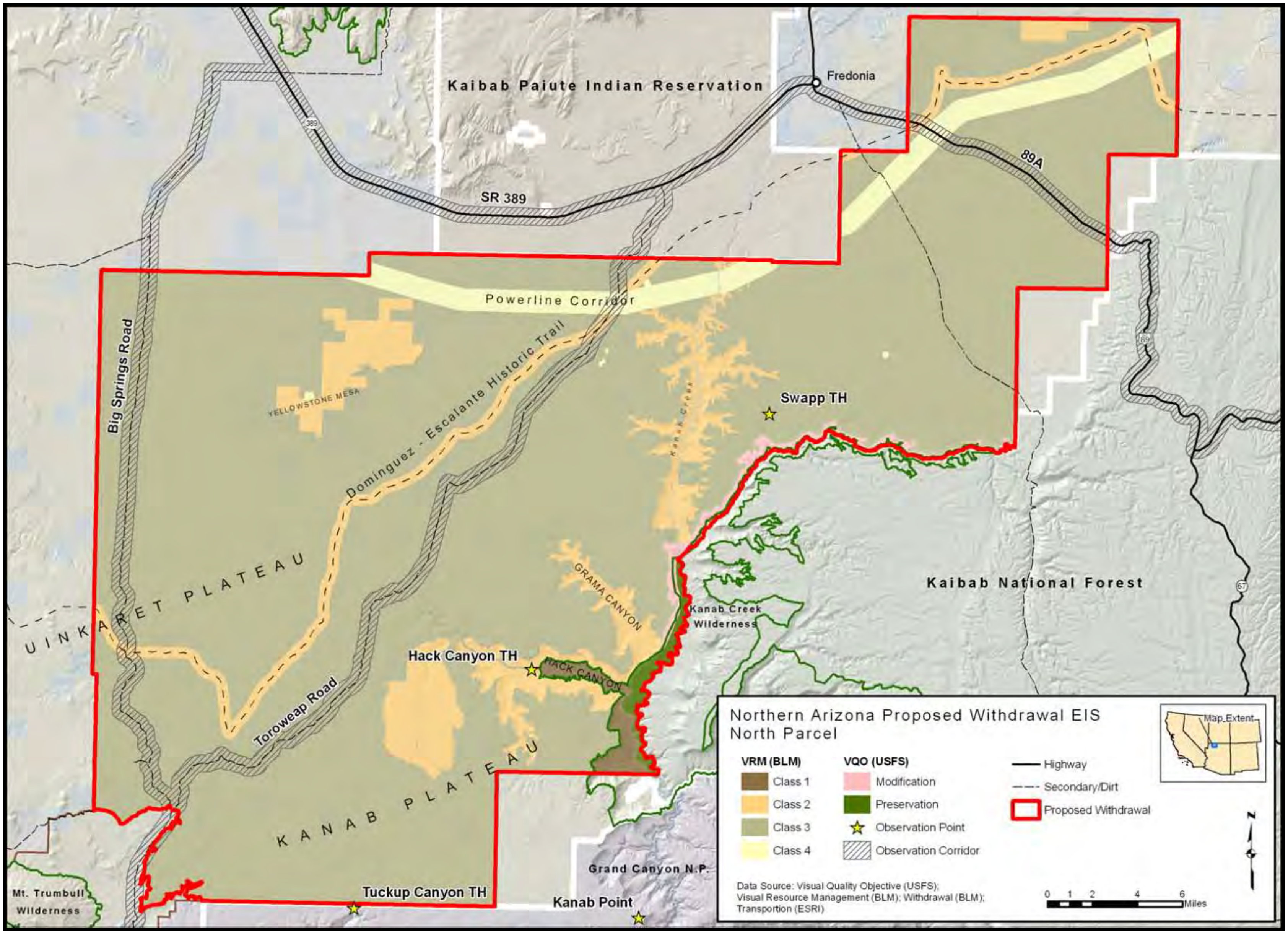


Figure 3.9-1. Visual resource management classes of the North Parcel.

SWAPP TRAILHEAD

Swapp Trailhead is located east of Kanab Creek and north of Snake Gulch, with access along BLM Road 22 from U.S. 89A (see Figure 3.9-1). Foreground and middle ground views to the east and south from Swapp Trailhead include the rising Kaibab Plateau and Kaibab National Forest and views across Snake Gulch into the Kanab Plateau to the east. Background views to the west look across Kanab Creek toward Yellowstone Mesa and Antelope Valley.

HACK CANYON TRAILHEAD

Hack Canyon Trailhead is located within the North Parcel, just west of the Kanab Creek Wilderness boundary in Hack Canyon (see Figure 3.9-1). Hack Canyon Trailhead is accessed from SR 389 and Toroweap Road. Foreground and middle ground views to the east of this trailhead include views into Kanab Creek Wilderness and the Kaibab Plateau.

TOROWEAP ROAD CORRIDOR WITHIN ANTELOPE VALLEY

Toroweap Road is one of two major roads within the North Parcel and is accessed from SR 389 west of Fredonia, Arizona (see Figure 3.9-1). In general, Toroweap Road cuts across the North Parcel in a southwesterly direction through the Kanab Plateau and Antelope Valley. Views from Toroweap Road, while within Antelope Valley, include foreground and middle ground views of rolling plains; background views of Findlay Knolls, Heaton Knolls, and Hancock Knoll. Middle ground views west from Toroweap Road include views of Antelope Valley. Middle ground views north from Toroweap Road include views of Yellowstone Mesa and more background views of the Vermilion Cliffs.

CLAYHOLE ROAD CORRIDOR

Clayhole Road/BLM Road 5 is located along the western boundary of the North Parcel, and like Toroweap Road, it provides access for several recreation sites within Grand Canyon National Park (see Figure 3.9-1). Typical views near the road include a flat landscape with distant view of mesas and the Canaan and Cottonwood mountains to the north. The southern portion of the road has distant views of a few small cinder cones. Views east of Clayhole Road include foreground and middle ground views of Yellowstone Mesa and Antelope Valley. Foreground and middle ground views south include Toroweap Valley and background views of distant plains.

SR 389 CORRIDOR

SR 389 is located outside the North Parcel and offers casual travelers background views of various locations within the North Parcel (see Figure 3.9-1). Views are dominated by vast, open, undeveloped plains of the Kanab Plateau, which contain sagebrush and grass vegetation. The dominant visual elements include views south of the Uinkaret Plateau, Yellowstone Mesa, Antelope Valley, and Kanab Plateau. Located approximately 3 miles south of SR 389 is an east-west utility corridor within the North Parcel, which is visible in the foreground and middle ground views from SR 389.

East Parcel

The East Parcel is located south of the Paria Plateau and Vermilion Cliffs National Monument and west of the Colorado River (Figure 3.9-2). The East Parcel varies between 4,400 and 5,600 feet amsl, and vegetation is dominated by grassland species, and sparse juniper trees and shrubs. U.S. 89A is generally the northern boundary of the East Parcel. BLM Road 8910 (Buffalo Ranch Road) and a network of dirt roads provide access to the Rider Canyon and North Canyon trailheads, livestock grazing facilities, and other land management activities. The casual observer has view of the East Parcel from along U.S. 89A. This paved road follows near the base of the Vermilion Cliffs.

Table 3.9-5 lists the number of acres per visual resource classification within the East Parcel. Figure 3.9-2 depicts the visual resource classifications within the East Parcel. The north half of House Rock Valley is designated Class II because of broad vistas from U.S. 89A and the Vermilion Cliffs area. The Marble Canyon ACEC is also designated Class II. The southern portion of the East Parcel is designated VRM Class III. The Paria Canyon–Vermilion Cliffs Wilderness, adjacent to this parcel, is designated Class I. A segment of Forest Service land is included within the western edge of the parcel. This is designated a VQO modification, except for a small partial retention corridor along U.S. 89A.

U.S. 89 CORRIDOR

U.S. 89 is located on the Navajo Nation and east of the East Parcel (see Figure 3.9-2). U.S. 89 provides casual observers foreground and background views of the East Parcel and varies in distance from just a few miles away to more than 20 miles away. Background views include the canyon walls of the Colorado River and views of House Rock Valley.

Table 3.9-5. East Parcel Visual Resource Class Acreage for BLM and Forest Service Land

	Acres
BLM VRM Class	
Class I	0
Class II	63,296
Class III	50,316
Class IV	86
Forest Service VQO	
Preservation	0
Retention	0
Partial Retention	818
Modification	30,494

U.S. 89A–SOAP CREEK TRAILHEAD

Two observation points along U.S. 89A were established within the East Parcel and include House Rock Valley Overlook and Soap Creek Trailhead (see Figure 3.9-2). Soap Creek Trailhead is located east of U.S. 89A, a few miles southwest the Marble Canyon Bridge crossing over the Colorado River. Foreground and background views east include views of Echo Ridge and Marble Canyon. Background views west from this observation point include views of House Rock Valley and U.S. 89A. Foreground views of Vermilion Cliffs are possible north of this observation point.

U.S. 89A–HOUSE ROCK VALLEY OVERLOOK

House Rock Valley Overlook is located along of U.S. 89A on the Kaibab National Forest (see Figure 3.9-2). This is a popular overlook that experiences high visitation from regional travelers. It provides unbroken views of the House Rock Valley area, which is surrounded by the Vermilion Cliffs to the north and Marble Canyon to the east. More distant views include the Kaibab Plateau and Kaibab National Forest.

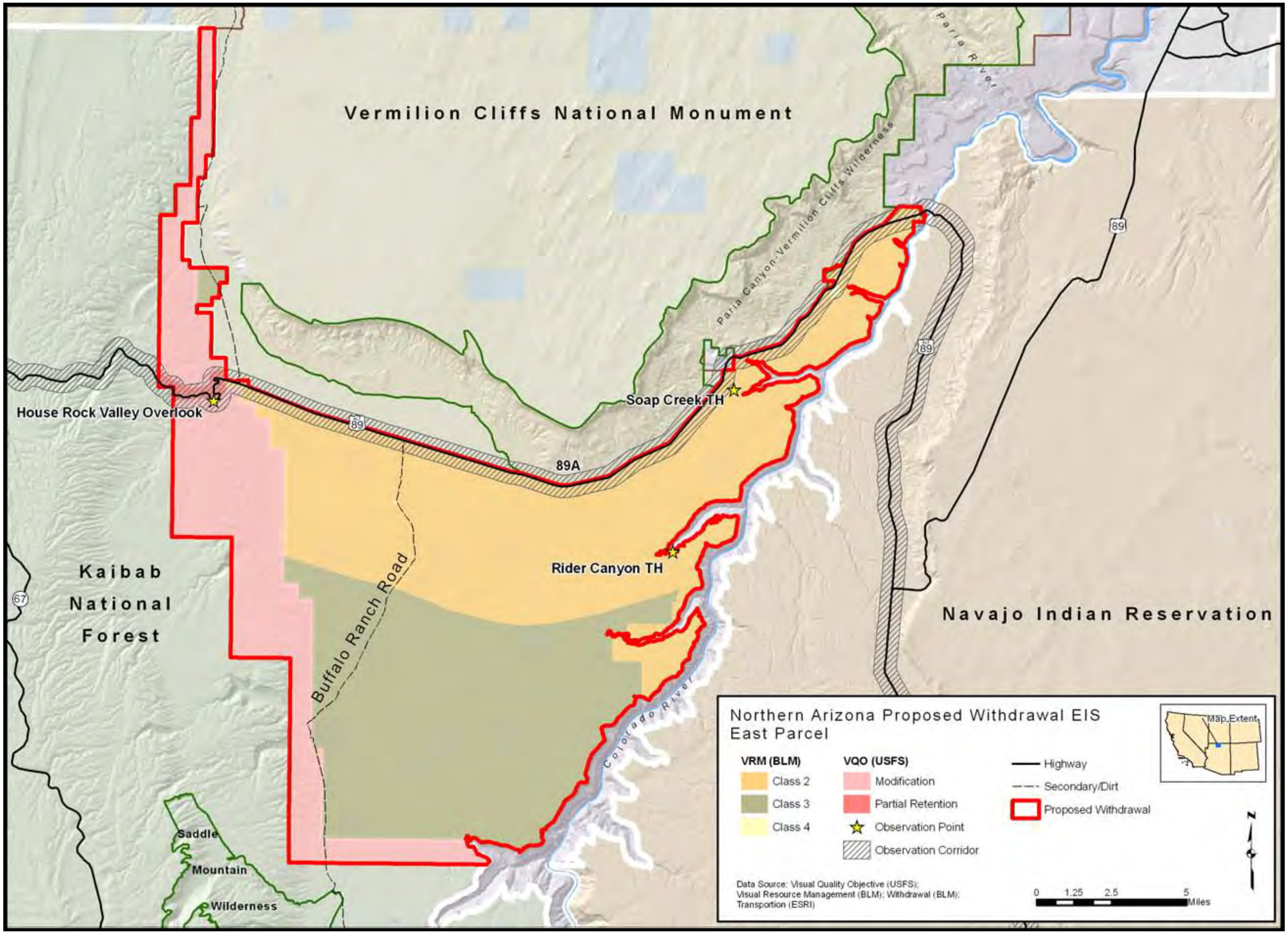


Figure 3.9-2. Visual resource management classes of the East Parcel.

RIDER CANYON TRAILHEAD

Rider Canyon Trailhead is located within the East Parcel and is accessed by BLM Road 8910 south of SR 389 (see Figure 3.9-2). Views east of this observation point include foreground views of Rider Canyon. Background views toward Echo Cliffs on the Navajo Nation are also possible. Middle ground views south of this observation point include House Rock Valley. West of this observation point are background views of House Rock Valley, Kaibab Plateau, and Kaibab National Forest. North of this observation point are middle ground views of the Vermilion Cliffs.

South Parcel

The South Parcel is located south of the Grand Canyon and is managed by the Forest Service. The South Parcel slopes from northeast to southwest, and elevations vary from approximately 5,800 to 7,000 feet amsl. Vegetation within the eastern portion of the South Parcel is dominated by grasslands interspersed with scattered juniper and shrubs, while vegetation in the western and northern portions of the parcel is predominantly tall ponderosa pine forests. Red Butte is one of the few features of vertical relief on the South Parcel; it rises in the southern portion of the parcel. The Coconino Rim, in the northeastern portion of the parcel, rises up from the Colorado River and also presents a distinct view. Dramatic views of the Grand Canyon occur at various points in the parcel.

The South Parcel is intersected by several paved routes and Forest Service roads. U.S. 180/SR 64 is a north-south transportation corridor in the western portion of the South Parcel. Forest Service Road 302 runs predominantly from east to west in the middle of the South Parcel, and SR 64 is located in the northeastern portion of the South Parcel.

Table 3.9-6 presents acres of SIOs for the South Parcel, as illustrated in Figure 3.9-3. Areas classified as “high” include Red Butte and the Coconino Rim area. Most of the parcel is designated “moderate,” with a few isolated pockets of “low.”

Table 3.9-6. South Parcel Visual Resource Class Acreage

SIO	Acres
Very High	0
High	25,511
Moderate	283,182
Low	15,648

RED BUTTE–SR 64 OBSERVATION POINT

The Forest Service has established one official visual quality observation point within the South Parcel. Red Butte SIO-2 encompasses a 3,545-acre area and is located east of SR 64 in the southwestern portion of the South Parcel (see Figure 3.9-3). Red Butte is accessed by Forest Service Road 305. The casual traveler within the South Parcel would have viewing opportunities along SR 64 and from several existing Forest Service dirt roads. Views of the casual observer traveling along SR 64 in the southwestern portion of the South Parcel would include foreground and middle ground views of rolling terrain with grassland and junipers, with the highest feature (Red Butte) visible. The top of Red Butte is accessible by a hiking trail and provides hikers with broad regional views that include the San Francisco Peaks and north to the Grand Canyon and Mt. Trumbull.

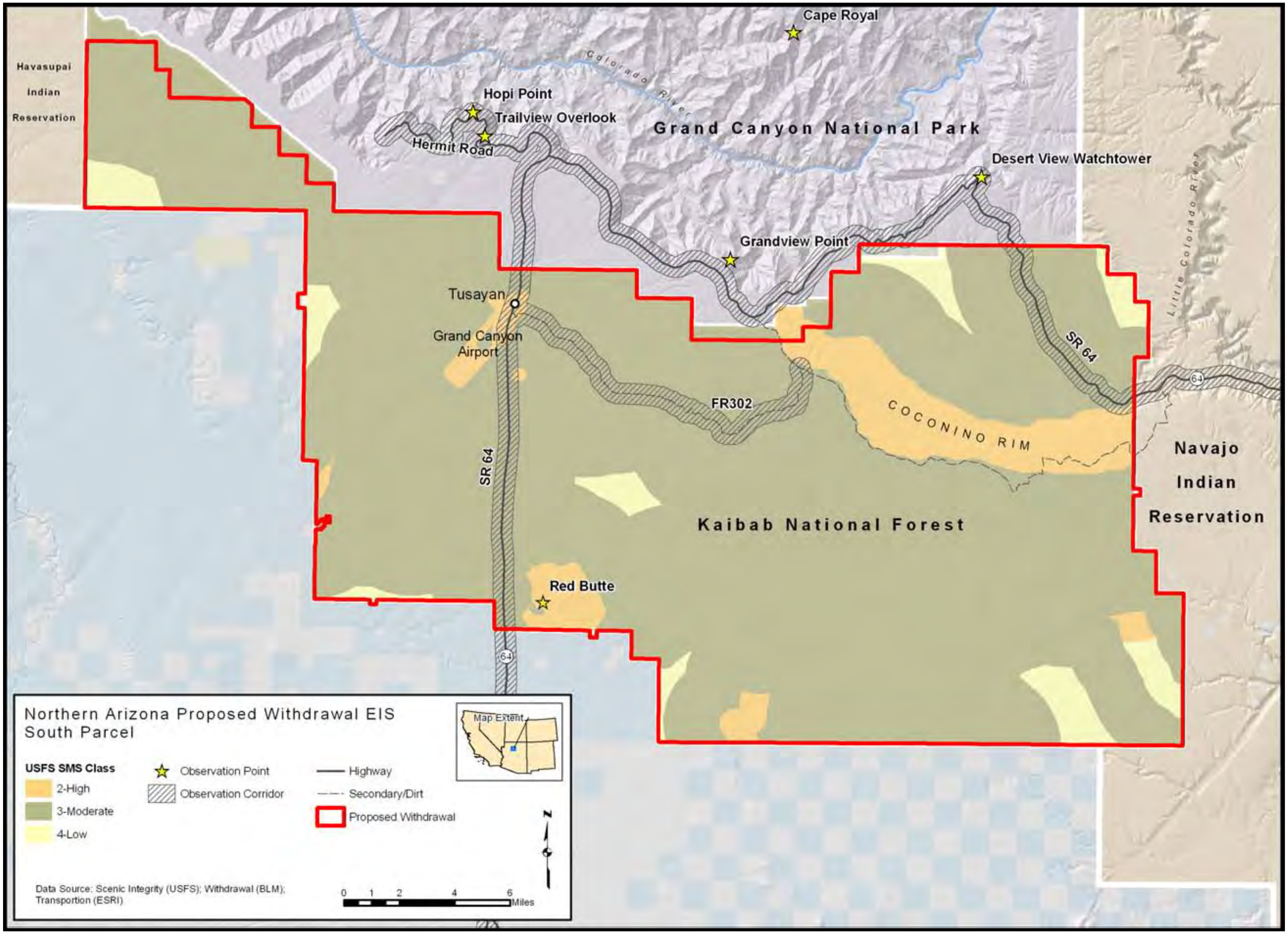


Figure 3.9-3. Scenery Management System classes of the South Parcel.

TUSAYAN–STATE ROUTE 64 CORRIDOR

Views along SR 64 in the northwestern portion of the South Parcel would be mostly limited to the foreground views and existing right-of-way because of the abundance of ponderosa pine trees. SR 64 and the Grand Canyon Railroad are major transportation features in the western portion of the South Parcel (see Figure 3.9-3). The Grand Canyon Airport, an established Forest Service campground (Ten-X), and the town of Tusayan are also located in the northwestern portion of the South Parcel.

EASTERN STATE ROUTE 64 CORRIDOR

The casual observer traveling along SR 64 in the eastern portion of the South Parcel would have foreground views of rolling terrain with sparse vegetation (see Figure 3.9-3). The casual observer would also have background views west of the northeastern slopes of the Coconino Rim and background views east toward the Little Colorado River. The casual observer travelling within Grand Canyon National Park has some views into the South Parcel from the SR 64 corridor. These include background views of Red Butte and minimal foreground views.

FOREST SERVICE ROAD 302 CORRIDOR

The South Parcel also contains a network of dirt roads that serve recreation, grazing, and fire maintenance activities. Forest Service Road 302 is an east-west road that is approximately in the middle of the South Parcel and has a network of dirt roads branching from it (see Figure 3.9-3). Views from select locations along these dirt roads would vary but in general are limited to foreground views because of the natural topography of rolling hills, ridges, and drainages. One east-west utility line (power) easement is located in the southern portion of the South Parcel.

Grand Canyon National Park

There are several viewpoints and visual corridors within Grand Canyon National Park that are in the vicinity of the proposed withdrawal area or provide potential views into the withdrawal area. These areas are described below and illustrated in Figure 3.9-3.

KANAB POINT

Kanab Point is part of Grand Canyon National Park and is accessed through the North Parcel from SR 389 and Toroweap Road (see Figure 3.9-1). Foreground and middle ground views to the east and south of this point include views of the Colorado River Canyon and Kanab Creek Wilderness. Foreground and middle ground views to the north include the Kanab Creek Wilderness.

TUCKUP CANYON TRAILHEAD

Tuckup Canyon Trailhead is located within Grand Canyon National Park and accessed from SR 389 via Toroweap Road (see Figure 3.9-1). Foreground and middle ground views to the east and south of this trailhead include views of the canyons of the Colorado River and tributaries. West of Tuckup Canyon Trailhead are background views of Mount Logan and Mount Trumbull. North of the Tuckup Canyon Trailhead are foreground and middle ground views toward Hancock Knoll.

BRIGHT ANGEL POINT

Bright Angel Point is a paved pedestrian overlook on the North Rim near the North Rim Lodge and is accessed via SR 67. Bright Angel Point overlooks the Grand Canyon with a vista that extends from the southeast to the southwest. Foreground views extend from Angel’s Gate and Coronado Butte to the southeast and continue west to the area of Osa Butte and Powell Memorial. The point overlooks the Bright Angel Fault, and Grand Canyon Village is visible across the canyon. Because of the higher elevation of the North Rim relative to the South Rim, background views extend far to the include the San Francisco Peaks, Red Butte, SR 64 to Grand Canyon Village and Bill Williams Mountain.

POINT IMPERIAL

Point Imperial, located on the North Rim in Grand Canyon National Park, is accessed by the Point Imperial Road. It is the highest point on the North Rim, at 8,803 amsl. It overlooks the Painted Desert and the east end of Grand Canyon.

CAPE ROYAL

Cape Royal is a panoramic viewpoint located within Grand Canyon National Park on the North Rim. Cape Royal is accessed via SR 67 and the Cape Royal Road. Cape Royal’s high vantage point provides extensive foreground views of the Grand Canyon region extending from the northeast to the northwest. Foreground views include Wotan’s Throne and the Palisades of the Desert, Vishnu Temple, Coronado Butte, and Bright Angel Canyon in Grand Canyon. Background views include the Little Colorado River Valley, Desert View, the San Francisco Peaks, Red Butte and Point Sublime. To the North is the Walhalla Plateau in Grand Canyon National Park.

CAPE FINAL

Cape Final is accessed via a short trail hike from Cape Royal Road. Cape Final offers foreground views to the north into Marble Canyon in Grand Canyon and the Marble Platform. Background views include the Vermilion Cliffs, Echo Cliffs, and Navajo Mountain. It provides views to the east of Cape Solitude and the Little Colorado River valley. Views to the south include foreground views of Grand Canyon, middle ground views of Desert View, and background views of Mount Humphreys. Cape Royal and the Walhalla Plateau in Grand Canyon are visible west of Cape Final.

SOWATS POINT

Sowats Point is located on Forest Service land overlooking Jumpup and Kanab canyons. Middle ground views to the west include the Kanab Plateau and Jumpup Point. Background views to the west include Mt. Trumbull and Mt. Logan. Views to the south include Fishtail Mesa in Grand Canyon National Park. Views to the north extend into upper Jumpup Canyon.

HOPI POINT

Hopi Point is located in the south rim area of Grand Canyon National Park west of Grand Canyon Village along the Hermits Rest Road. It provides views of the Grand Canyon and the North Rim, along with some views of the Colorado River to the west.

TRAILVIEW OVERLOOK

Trailview Overlook is accessed by Hermit Road This viewpoint provides views of the Bright Angel Trail, Bright Angel Creek, and Plateau Point. Background views to the south include the Kaibab Plateau, Red Butte, the San Francisco Peaks, and Bill Williams Mountain.

GRANDVIEW POINT

Grandview Point is located in the South Rim area of Grand Canyon National Park along Desert View Drive. This popular viewpoint offers panoramic views of Grand Canyon from east to west, including several bends of the Colorado River to the east.

DESERT VIEW WATCHTOWER

Desert View Watchtower is located at the east end South Rim area of Grand Canyon National Park along Desert View Drive. The viewing tower, at 70 feet high, is the highest point on the South Rim. The tower provides panoramic views of the region, including the Grand Canyon, the Painted Desert to the east, and the San Francisco Peaks to the south. Foreground views of Grand Canyon extend from north to west. To the east, foreground views include Cedar Mesa and the Navajo Reservation. Background views to the north and east extend to the Marble Platform, Navajo Mountain, Echo Cliffs, and Little Colorado River Canyon.

HERMIT ROAD CORRIDOR

Hermit Road is a scenic route along the west end of Grand Canyon Village on the South Rim that follows the rim for 7 miles out to Hermits Rest. This road is accessed by park shuttle bus, foot, and bicycle most of the year, with private vehicles allowed only during winter months. The road provides access to several viewpoints and offers views of the Grand Canyon to the north and the Kaibab Plateau to the south.

HAVASUPAI POINT

Havasupai Point is located on the South Rim of Grand Canyon National Park approximately 30 miles from Grand Canyon Village and is primarily accessed by Forest Road 328 and Havasupai Point Road in Grand Canyon National Park. Havasupai Point offers views of Grand Canyon from east to west. Point Sublime and Powell Plateau on the North Rim are both visible from Havasupai Point.

3.9.5 Night Sky

The nighttime visual resources (e.g., “dark night skies”) of northern Arizona and southern Utah are nationally significant and represent one of the best opportunities for the American public to experience such a sight (BLM 2008b). These dark night skies are an important characteristic of the remote setting and contribute to the nighttime visual landscape of the area. All parcels in the proposed withdrawal area provide outstanding opportunities for visitors to experience significant views of stars and other objects in the night sky.

Light pollution is caused by outdoor lights that are upwards or sideways. Any light that escapes upward, unless blocked by an object, will scatter throughout the atmosphere and brighten the night sky. Air pollution particles also increase the scattering of light at night, just as they impact visibility during the daytime.

The NPS has developed a system for measuring sky brightness to quantify the source and severity of light pollution and is monitoring parks in the region of the proposed withdrawal area. The nearest monitoring site is in Grand Canyon–Parashant National Monument, which is directly east of the North Parcel. The most recent data were collected at McDonald Flat on February 24, 2006, as detailed in the *Night Sky Quality Monitoring Report* (NPS 2006a). The report states,

> Seeing good, transparency very good, daytime visibility about 80 miles. Very dark at zenith, very little airglow tonight. Detail in Milky Way extensive, galactic light extends east to Beehive

> cluster in Cancer and nearly to Polaris in Ursa Minor. Gegenschein easy, zodiacal band visible from Saturn through gegenschein east into the airglow. Light dome of Las Vegas casts a shadow, irritates night vision, definitely brightest thing in the sky. Noticeable decrease in size and brightness as night progresses. Other light domes minimal intrusion on an otherwise pristine sky. (NPS 2006a)

The report also discusses zenith limiting magnitude, which refers to the faintest stars that can be observed with the naked eye. There are 14,000 stars visible at magnitude 7.0 conditions, 5,000 stars visible at magnitude 6.0 conditions, and only a few dozen stars visible at magnitude 1.0. The best night skies range from magnitude 6.6 to 7.5. The Grand Canyon–Parashant National Monument had a zenith limiting magnitude value of 7.1, which is at the high end of the scale and provides views of approximately 14,000 stars.

3.9.6 Grand Canyon National Park Class I Airshed

Grand Canyon National Park is classified under the CAA as a Class I area. This requires the PSD of air quality and allows only very small increments of new pollution above already existing air pollution levels. An important visual resource component of air quality in Grand Canyon National Park is “visibility.” Scenic vistas can be diminished by haze that reduces contrast, color, and visibility of landscape features. A change in contrast of not more than 5% at sensitive view areas is considered acceptable.

The Cooperative Institute for Research in the Atmosphere operates a network of visibility monitoring stations in or near Class I areas and publishes IMPROVE data. The purpose of this monitoring is to identify and evaluate patterns and trends in regional visibility. Data from three IMPROVE monitors within Grand Canyon National Park show that fine ($PM_{2.5}$) and coarse (PM_{10}) particulates were the largest contributors to the impairment of visibility. These particulates impact the standard visual range for each monitor location. The standard visual range is the distance that can be seen in a given day. The standard visual ranges for the three IMPROVE monitors in Grand Canyon National Park (GRCA1, GRCA2, and INGA1) range from 149 to 178 miles on the best visibility days, 96 to 118 miles on the intermediate days, and 64 to 76 miles on the worst visibility days (IMPROVE 2010).

For a more detailed discussion on Air Quality, see Section 3.2.

3.9.7 Visual Quality Indicators

The specific indicators for visual resource conditions are as follows:

- Consistency with and conformity to designated BLM VRM class objectives;
- Consistency with and conformity to Forest Service scenic quality management or integrity objectives;
- Consistency with and conformance to Park visual objectives from key viewpoints within the Park; and
- Qualitative analysis of the potential changes to the darkness of the night sky in the proposed withdrawal parcels and Grand Canyon National Park.

3.10 SOUNDSCAPES

The Grand Canyon National Park Enlargement Act of 1975 [PL 93-620] established that natural quiet should be protected as a resource and a value to the Park. Natural quiet is defined as the level of all natural sounds in an area, excluding all mechanical, electrical, and other human-caused sounds. Natural quiet is the baseline sound level used for this study.

The information presented in this section was derived from the following reports: *Mining Adjacent to Grand Canyon National Park: Potential Impacts to the Natural Soundscape of the Park*, dated January 28, 2010 (Ambrose 2010a), *Sound Levels of Equipment and Operations at the Arizona 1 Uranium Mine in Northern Arizona*, dated June 21, 2010 (Ambrose 2010b), and *Sound Levels and Audibility of Common Sounds in Frontcountry and Transitional Areas in Grand Canyon National Park, 2007–2008* (Ambrose 2008).

3.10.1 Noise Fundamentals

Airborne sound is the rapid fluctuation of air pressure caused by mechanical vibrations. Noise is defined as unwanted sound that interferes with normal activities or in some way reduces the quality of the environment. Response to noise varies according to its type, perceived importance, appropriateness in the setting, time of day, and the sensitivity of the individual receptor.

Definitions of Acoustical Terms

The following section describes the acoustical terms used throughout this analysis.

- *Ambient noise level* is defined as the composite of noise from all sources near and far, the normal or existing level of environmental noise at a given location.
- *Decibel* (dB) is the physical unit commonly used to describe sound levels. Technically, a dB is a unit of measure that describes the amplitude of sound equal to 20 times the base 10 logarithm of the ratio of the reference pressure to the sound of pressure, which is 20 micropascals (µPa).

Sound measurement is further refined by using a *decibel "A-weighted" sound level* (dBA) scale that more closely describes how a person perceives sound. The dBA scale is logarithmic; therefore, individual dBA values for different sources cannot simply be added together to calculate the sound level for the two sources. For example, two 50-dBA sources, added logarithmically, produce a collective noise level of 53 dBA.

- *Equivalent noise level* (L_{eq}) is the energy average A-weighted noise level during the measurement period.
- *Intruding noise* is the noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends on its amplitude, duration, frequency, time of occurrence, and tonal informational content, as well as the prevailing ambient noise level.
- *Percentile noise level* (L_n) is the A-weighted noise level exceeded during n% of the measurement period. For example, L_{10} is a relatively loud noise exceeded only 10% of the time, while L_{90} is a relatively quiet sound exceeded 90% of the time. People tend to exhibit differing sensitivity to noise depending on the time of day, with noise generated at night being more annoying than that generated during the day.

Sound Levels of Representative Sounds and Noises

A *day-night average noise level* (L_{dn}) is used to determine whether noise would be perceived adversely. The EPA developed an index (threshold) to assess noise impacts from a variety of sources using residential receptors. If L_{dn} values exceed 65 dBA, residential development is not recommended (EPA 1974). Noise levels in a quiet rural area at night are typically between 32 and 35 dBA. Quiet urban nighttime noise levels range from 40 to 50 dBA. Noise levels during the day in a noisy urban area are frequently as high as 70 to 80 dBA. Noise levels above 110 dBA become intolerable and then painful; levels higher than 80 dBA over continuous periods can result in hearing loss. Constant noises tend to be less noticeable than irregular or periodic noises. Table 3.10-1 presents sound levels for some common noise sources and the human response to those decibel levels.

Table 3.10-1. Sound Levels of Representative Sounds and Noises

Source	Sound Level (dBA)	Human Response
Jet Takeoff (Nearby)	150	
Jet Takeoff (50 feet)	140	
50-HP Siren (100 feet)	130	
Loud Rock Concert (Near Stage)	120	Pain threshold
Construction Noise (10 feet)	110	Intolerable
Jet Takeoff (2,000 feet)	100	
Heavy Truck (25 feet)	90	
Garbage Disposal (2 feet)	80	Constant exposure endangers hearing
Busy Traffic	70	
Normal Conversation	60	
Light Traffic (100 feet)	50	Quiet
Library	40	
Soft Whisper (15 feet)	30	Very quiet
Rustling Leaves	20	
Normal Breathing	10	Barely audible
Threshold of Hearing	0	

Source: Beranek (1988).

3.10.2 Noise Assessment Components

Soundscapes are affected by the following factors:

- Proximity to noise sensitive areas (NSAs): NSAs are defined as the occupants of a location where a state of quietness is a basis for use or where excessive noise interferes with the normal use of the location. Typical NSAs include parks and wilderness areas. Natural soundscapes are an accumulation of all natural sounds that occur in the unpopulated parks and wilderness areas. The NSAs of concern in or near the proposed withdrawal area include the following: Kaibab National Forest, the Vermilion Cliffs National Monument, the North Rim of the Park, Bright Angel Point, the east entrance to the Park (Desert View), the South Rim of the Park, and Yavapai Point Museum. The critical question is whether the NSAs will be adversely affected by proposed withdrawal noise.

- "Transmission path" or medium: The "transmission path" or medium for sound or noise is most often the atmosphere (i.e., air), while for vibration, the medium is the earth or a human-made structure. In order for the noise/vibration to be transmitted, the transmission path must support the free propagation of the small vibratory motions that make up the sound and vibration energy. Atmospheric conditions (e.g., wind speed and direction, temperature, humidity, precipitation) influence the attenuation of sound. Barriers and/or discontinuities that attenuate the flow of sound or vibration energy may compromise the path.
- Source: The sources of sound and vibration are any generators of small back-and-forth motions (i.e., motions that transfer their motional energy to the transmission path where it is propagated). The acoustic characteristics of the sources are very important. Sources must generate sound or vibration of sufficient strength, approximate pitch, and duration so that the sound or vibration may be perceived and is capable of causing adverse effects, compared with the natural ambient sounds. The new sources of proposed withdrawal noise/vibration are discussed further in Chapter 4.

3.10.3 Regulatory Setting

The following subsections identify federal, state, and local laws and regulations that are pertinent to the evaluation of the proposed withdrawal area and analysis of soundscape impacts.

Federal laws and regulations: There are numerous laws and guidelines at the federal level that are relevant to the assessment of air and ground transportation noise and vibration impacts. These include the following:

- Federal Highway Administration Procedures for Abatement of Highway Traffic Noise and Construction Noise [23 CFR 772]
- National Environmental Policy Act of 1969 [PL 91-190, 42 USC 4321, *et seq.*, 40 CFR 1506.5]
- Noise Control Act of 1972, as amended [PL 92-574, 42 USC 4901 *et seq.*]
- Occupational Safety and Health Administration (OSHA) Occupational Noise Exposure; Hearing Conservation Amendment (*Federal Register* 48[46]:9738–9785)
- Mine Safety and Health Administration (MSHA) Occupational Noise Exposure [30 CFR 62]
- U.S. Surface Transportation Board Environmental Rules [49 CFR 1105.7(6)]
- Special Flight Rules in the Vicinity of Grand Canyon National Park [14 CFR Part 91 et al.]
- National Park Service Director's Order 47: Soundscape Preservation and Noise Management, December 1, 2004.
- The Coconino County Comprehensive Plan, September 23, 2003.

In addition to the aforementioned regulations, NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

There are no BLM, Forest Service, or state noise regulations or standards applicable to exploration or development activity or to the proposed withdrawal area.

3.10.4 Existing Conditions

All three of the proposed withdrawal parcels border Grand Canyon National Park. The area is naturally quiet and generally not subject to modern sources of unnatural sound intrusion or noise. 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 natural ambient sound level of 20.8 dBA. The existing ambient (L50) sound levels in tourist areas vary, depending on the amount of visitation, but are consistently higher than the L50 levels in the same acoustic zones of non-tourist areas. The L50 of the busiest, most visited front country areas are 20 to 30 dBA higher than the L50 in non-tourist areas of the same acoustic zone. At tourist areas with fewer visitors or with restrictions on vehicle access, the differences are much smaller (Ambrose 2010a).

The existing ambient L50 levels in tourist areas of the Park during the daytime, in the summer, range from 23.7 dBA (measured 3.7 miles below the Grand Canyon rim along Bright Angel Trail) to 56.6 dBA at the west end of Village Loop Road (Ambrose 2008). Current potential sound sources include highway traffic, tour and commercial airplane over flights, vehicles, and Park visitors (Ambrose 2010b).

The current soundscapes of the Kaibab National Forest consist of both natural sounds and a variety of human-generated sounds. The major noise producers include highway traffic, military overflights, and general aviation flights (BLM 2007).

The current soundscape of the Havasupai, Hopi, Hualapai, Kaibab-Paiute, and Navajo reservations consists of both natural ambient sounds and a variety of human-generated sounds. Noise sources include some residential noise, air tour flights, commercial flight patterns, highway traffic, and visitors to the monuments and reservations.

In August 2009, Denison received authorization from the ADEQ to operate its Arizona 1 Mine, located approximately 35 miles south of Fredonia, Arizona. This mine is in the North Parcel of the proposed withdrawal area. The mine started operations in December 2009. Denison Mines provided a list of equipment to be used at the Arizona 1 Mine site that could be considered typical of equipment that would likely be used at other mines in the areas, operating under similar mining conditions (personal communication, Lorraine Christian, BLM 2010). The equipment in use at the Arizona 1 Mine 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
- Electric transformer

The above equipment list was included for illustration purposes only. Any proposed future mine site locations would be expected to use differing numbers and varieties of mining equipment, and any attempt to extrapolate sound levels from data relating to this existing mining operation is impractical and therefore unwarranted.

General Description of Resource

Noise related to uranium mining activities results from initial heavy-duty construction equipment operations (e.g., trucks, backhoes, excavators, etc.) and long-term from production operations (e.g., haul trucks, mine shaft vent fans, sorting screen operations, etc.). The region of influence attributed to any noise source is based on the location of noise-sensitive receptors relative to the activity. To properly evaluate any potential effects that could be caused by noise, each individual sound-producing activity would need to be evaluated/modeled using the specific mine site location, number and types of equipment, operation schedules, site-specific topography, and climatic conditions relative to the projected location of receptors of concern.

Resource Condition Indicators

The soundscape condition indicators to be evaluated in Chapter 4 of this assessment are as follows:

- Discussion of the possible changes in ambient noise levels in the immediate vicinity of any proposed uranium mine sites. The nature of noise modeling requires specific details regarding the locations and distances between all sources and receivers of interest.
- Discussion of the potential increases in ambient noise levels in the immediate vicinity of any proposed uranium mine site operational activities, compared with the existing baseline noise levels at the nearest NSA.
- Discussion of the potential increases in ambient noise levels associated with mine exploration and development activity to determine compliance with applicable federal regulations and federal land manager rules, policies, and orders.

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 have been accurately established, screening level noise models could be run. Either measured or manufacturer noise data from proposed mining equipment would be used for modeling. 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.

Federal law establishes special rules for the air space in and around Grand Canyon National Park. As a minimum condition, any potential helicopter prospecting operations would need to be conducted within those established guidelines. Cursory noise estimates of these operations cannot be reliably completed without knowing specific noise characteristics of the helicopter to be used and detailed flight paths for the prospecting operations.

As a first level evaluation, the noise level values produced by the noise model could be compared directly to related noise standards. The EPA has determined that an L_{dn} of 55 dBA protects the public from indoor and outdoor activity noise interference. NPS, under 36 CFR 2.12, Audio Disturbances, prohibits operation of motorized equipment or machinery that exceeds a noise level of 60 dBA at 50 feet, or, if below that level, nevertheless makes noise that is unreasonable.

Current Value Resource Condition Indicators

The current value or condition of the soundscape within the proposed withdrawal parcels with respect to each of the resource condition indicators is presented in Table 3.10-2.

Table 3.10-2. Soundscape Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Noise disruption from exploration or development activity	The areas subject to noise effects and the intensity of sound from these activities need to be evaluated for each proposed site and all associated operations. Noise from exploration and development activity could disrupt the solitude of visitors to the area, including visitors to the Park.	*Indicator*: The decibel level due to exploration and mining equipment. *Indicator*: The distance and direction between the source and receiver and for the evaluation of noise attenuation to baseline sound levels. *Indicator*: Comparison measured or modeled values with applicable rules, policies, or orders established by the federal land managers. *Indicator*: Comparison of specified values to regulations established by the EPA and the U.S. Department of Transportation.

3.11 CULTURAL RESOURCES

Cultural resources are physical phenomena associated with past or present cultures and include archaeological sites and historic buildings and structures, as well as places of traditional religious and cultural importance. Cultural resources also include TCPs, which is a formal designation for properties vital to a community's practices and beliefs. These properties are tied to a community's cultural identity. Traditional cultural and sacred places, cultural landscapes, and TCPs are addressed in Section 3.12.

Cultural resources refer to both human-made and natural physical features associated with human activity and, in most cases, are finite, unique, fragile, and nonrenewable. The proposed withdrawal area is composed of three parcels, each of which contains unique and distinctive resources that represent several themes that are important to history and prehistory.

Management of resources on all three proposed withdrawal parcels is primarily guided by the NHPA requirements described in Chapter 1. In addition, the BLM and Forest Service have their own supplemental directives and management plans.

3.11.1 Cultural Setting

Archaeologists generally divide the cultural history of the American Southwest into five major periods, whose time spans vary by geographic region. In the Grand Canyon region, these periods include the Paleoindian (9500–6500 B.C.), Archaic (6500 B.C.–A.D. 500), Formative (A.D. 500–1300), Protohistoric (A.D. 1300–1540), and Historic (A.D. 1540–present) (Willey and Phillips 1958). Each of these periods does not represent a single cultural tradition; rather, it signifies the occurrence of several cultures with similar traits that existed at roughly the same time. Even the most "homogeneous" of cultural periods, the mobile hunter-gatherer Paleoindians, can be divided into different traditions based on what type of projectile point was used. The hunter-gatherers of the Archaic produced even more types of projectile points and the first grinding stones for plant processing. The greatest diversity of the prehistoric age can be seen during the Formative, when people practiced agriculture, lived in a variety of structure types, and made and traded many different types of ceramics and other goods. Throughout prehistory, all groups took advantage of the varied resources available in different altitudes and geographic zones. For example, during the Formative and Protohistoric, many people farmed in canyons where the creeks and rivers ran and then would hunt wild game and gather wild plants on the plateaus. With the arrival of the Europeans, the region saw even more varied uses like cattle grazing, mining, timbering, homesteading, railroads, and eventually tourism. See Appendix H for a detailed culture history of the area.

3.11.2 Identification of Prehistoric and Historic Cultural Resources

A Class I inventory of all known cultural resources within the three proposed withdrawal parcels was conducted to quantify site type and distribution (Seymour et al. 2010). The Class I inventory consists of a comprehensive review of files from the BLM, the Kaibab National Forest, and AZSITE (a statewide archaeology database), as well as a review of available literature and maps of the proposed withdrawal area. Sensitivity maps were derived from this information and from analysis of previously published ethnographic information.

Under the NHPA, significant cultural resources are those eligible for the NRHP. To be NRHP eligible, a property must be at least 50 years old (with rare exceptions) and possess integrity of location, design, setting, materials, workmanship, feeling, and association. A site, building, structure, or district may be determined eligible if it meets at least one of four criteria [36 CFR 60.4]:

> Criterion A: Associated with events that have made a significant contribution to the broad patterns of our history;
>
> Criterion B: Associated with the lives of persons significant in our past;
>
> Criterion C: Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> Criterion D: Have yielded, or may be likely to yield, information important in prehistory or history.

Table 3.11-1 provides information on the number of sites and their NRHP eligibility status. Table 3.11-2 enumerates the listed NRHP properties and the criteria under which they were determined eligible.

Within the three parcels, 461 sites have been evaluated and recommended or determined NRHP eligible (see Table 3.11-1). Twelve sites have already been listed in the NRHP (see Table 3.11-2). To date, 201 sites have been recommended or determined ineligible for the NRHP; 1,981 sites have not yet been evaluated with respect to NRHP eligibility status.

Site density per surveyed acre varies by parcel: 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. The South Parcel has the highest number of known sites with the highest percentage of inventoried land. A little less than 23% of the parcel has been subject to systematic inventory. The other two parcels combined have had less than 10% of their area covered. Assuming that the inventory locations were random, at least with respect to the presence or absence of cultural resources, it would be relatively safe to predict a doubling of archaeological sites in the South Parcel. Perhaps as few as 10% of the expected sites have been identified in the North and East parcels. It is likely that the numbers are even higher, since portions of the North Parcel have considerably more available water than the South Parcel.

Site Affiliations and Descriptions

The three parcels contain archaeological sites resulting from thousands of years of human occupation. Table 3.11-3 summarizes the major time periods and cultural affiliations assigned to documented sites. As Paleoindian sites are notably rare, the pre-Formative category combines sites of the Paleoindian and Archaic periods. The Formative category is broadened to include sites of the Protohistoric period, which can be difficult to identify on the basis of site data.

Table 3.11-1. National Register of Historic Places Status of Archaeological Sites and Historic-Age Properties by Parcel

	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**	**1741**	**2,655**

Table 3.11-2. National Register of Historic Places Listed Properties*

Name of Property	Site Number	NRHP Criterion/Criteria
Kane Ranch Headquarters		A
Tusayan Saginaw and Manistee Railroad		A and D
Grand Canyon Railway		A and C
Hull Cabin Historic District		A, B, and C
Grand Canyon Airport Historic District		A and C
Cabin 1	03070400159	A and C
Cabin 6	03070400807	A and C
Tusayan/Moqui Ranger Station	03070400813	A and C
Grand View Lookout Tower and Cabin	03070400621	A and C
Grandview Lookout Tree	03070400860	A
Hull Tank Lookout Tree	03070400868	A
Tusayan Lookout Tree	03070400869	A

*With the exception of Kane Ranch Headquarters, which is in the East Parcel, all are located in the South Parcel.

The pre-Formative category consists of the following Cultural Affiliation subcategories: Archaic, Paleoindian, and a combination of the two. Unknown American Indian sites are sites that lack distinctive artifacts to support assignment to a specific time period or cultural affiliation. Some of these sites may represent hunting or resource collection sites for later Formative peoples, but they lack ceramics and only contain stone artifacts that cannot be attributed to a certain culture or period. If a site was recorded as having multiple occupational periods or was associated with multiple cultural identities, it was labeled as such. This process of combining multiple information sets applies to all subcategories.

The Formative category consists of numerous cultural identities within the subcategory of Cultural Affiliation: Ancestral Puebloan, Cohonina, etc. The Cultural Affiliation subcategory of the Historic period category consists of various cultural identities, including historic Navajo, Euro-American, and American Indian sites of unknown tribal affiliation. Other categories under Cultural Affiliation for the category of the Historic period are sites that had limited information or sites that could not be determined to be historic or prehistoric in origin; these sites were classified as Indeterminate.

Table 3.11-3. Cultural Affiliation Totals for Each Parcel

		North Parcel	East Parcel	South Parcel	Total
Unknown	Unknown American Indian*	272	34	562	**868**
Pre-Formative	Archaic	51	4	68	**123**
	Paleoindian	1	1	0	**2**
	Paleoindian/Archaic	2	0	0	**2**
Pre-Formative Subtotal		*54*	*5*	*68*	***127***
Formative	Ancestral Puebloan	203	96	305	**604**
	Ancestral Puebloan/Virgin	66	1	0	**67**
	Archaic/Ancestral Puebloan	55	1	0	**56**
	Cerbat and Cerbat/Pai	0	0	32	**32**
	Cohonina	0	0	491	**491**
	Paiute	8	0	0	**8**
Formative Subtotal		*332*	*98*	*828*	***1258***
Historic	Euro-American	45	9	98	**152**
	Government	1	0	0	**1**
	Havasupai	0	0	1	**1**
	Navajo	0	0	97	**97**
Historic Subtotal		*46*	*9*	*196*	***251***
Unspecified or Limited Information		39	25	87	**151**
Total		**743**	**171**	**1,741**	**2,655**

* The Unknown American Indian category consists of flaked stone artifact scatters with no temporally or culturally diagnostic projectile points or other flaked tools.

Types of Prehistoric and Historic Sites

The Class I inventory indicates a strong potential for significant prehistoric and historic cultural resources within the three proposed withdrawal parcels in areas that have yet to be inventoried. Because Class III (on-the-ground, intensive) surveys are required prior to authorizing specific surface-disturbing activity, the number of known significant sites is likely to increase over time.

All three parcels contain a diverse range of site types, representing activities and land uses that took place over thousands of years. Approximately one-third of the sites cannot be reliably assigned to a specific cultural tradition or time period. They consist largely of prehistoric or American Indian artifact scatters that lack pottery or other datable items. These sites resulted from temporary use of dispersed locations for traveling, short-term shelter, and collecting natural resources for food, medicine, and production of tools and other items. Although many of these sites may be pre-Formative, others may date to the Formative or later periods, as known Paleoindian and Archaic period sites account for less than 10% of the sites in each parcel.

NORTH PARCEL

As shown in Table 3.11-3, 44% of the known archaeological sites are Ancestral Puebloan sites of the Formative period. Those clearly associated with the Virgin and Virgin/Moapa traditions, centered to the west of the North Parcel, account for about 20% of the Formative sites and are rarely found in the East and South parcels. Archaic materials at 55 Formative sites indicate the reuse of favored locations over thousands of years. Site types include settlements or habitations, temporary camps, granaries and caches used for food storage, and rock art.

Fewer than 10% of the recorded sites date to the Historic period and reflect the legacy of ranching, homesteading, and mining activities. These sites include cabins, corrals, roads, trails, mines, cairns, and artifact scatters.

EAST PARCEL

As shown in Table 3.11-3, 57% of the known archaeological sites are Ancestral Puebloan sites of the Formative period. The range of site types is similar to that of the North Parcel, except for a cluster of water-control features related to farming activities at the base of the Kaibab Plateau.

About 5% of the sites date to the Historic period and are related primarily to ranching and transportation. Inscriptions are located along the routes of the historic Dominguez-Escalante and Mormon Honeymoon trails, which traversed the northern margin of the parcel below the Vermilion Cliffs.

SOUTH PARCEL

As shown in Table 3.11-3, 46% of the known archaeological sites are Ancestral Puebloan sites, primarily associated with the Cohonina tradition of the Formative period. The Cerbat tradition accounts for 4% of the Formative sites. Site types include settlements or habitations, temporary residences, artifact scatters, and resource procurement and processing locations.

Six percent of the sites are from the Historic period and are associated with ranching, mining, logging, and forest management activities. They include cabins, corrals, mines, roads, five lookout towers, and four railroad tracks/beds. The Civilian Conservation Corps constructed many of the roads, towers, and other facilities in the 1930s. There are also 97 recorded sites attributed to use by the Navajo and one site attributed to the Havasupai, including the remains of temporary shelters, hogans, and sweat lodges.

3.11.3 Resource Condition Indicators

Appropriate resource condition indicators for cultural resources are as follows:

- The number of known prehistoric and historic sites to be affected and number of acres to be disturbed by mining exploration and development.
- Changes in settings or visual qualities that contribute to the integrity of cultural resource sites (evaluated qualitatively) and the degree to which reclamation practices can be used to restore the settings of sites.

Current Value Resource Condition Indicators

Although it is difficult to know the current condition of all of the cultural resources in the three proposed withdrawal parcels, sites adjacent to existing access roads have likely been subject to the greatest levels of direct damage and are likely more vulnerable to theft and vandalism. Erosion of archaeological sites caused by newly graded roads and increased vehicular activity may also result in the loss of integrity.

Archaeological site vandalism is a serious problem throughout the western United States. The Kaibab National Forest and the BLM have recorded incidents of site vandalism, particularly at highly visible sites such as pueblos, historic buildings, and other structures. Unfortunately, since many sites have yet to be fully recorded or re-inspected, the total amount of vandalism may not be ascertainable. That said, because of the remote nature of many of the sites, it is likely that many sites have not been vandalized.

3.12 AMERICAN INDIAN RESOURCES

The term American Indian resources refers to places, which may include archaeological sites, that are regarded as important to Indian cultures and traditions. These places may be individual landforms or large landscapes, they may be places associated with sacred beings or ancestors, or they may be places where people came and still come to hunt game or to gather plant resources. Several laws and policies protect American Indian resources:

- The National Historic Preservation Act [16 USC 470] created the NRHP and the Section 106 process, which requires federal agencies to consider the effects of their actions on historic properties, including places of traditional religious and cultural importance to Indian tribes.
- The American Indian Religious Freedom Act [PL 95-341; 42 USC 1996] establishes a national policy to protect the right of American Indians and other indigenous groups to exercise their traditional religions.
- EO 13007, Indian Sacred Sites, was designed to accommodate access to American Indian sacred sites on federal land and to avoid harm to these sites “to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions.”
- NEPA requires assessing potential impacts of a federal undertaking to the human environment, including places of cultural importance, consistent with the stated policy to preserve important cultural aspects of our national heritage.

3.12.1 Traditional Cultural Values and Practices

American Indians in the Southwest have an intimate relationship with the landscape, especially that of the Grand Canyon area (Fairley 2004; Hirst 2006; Stoffle et al. 2005). Many groups see their history and culture as being bound and expressed in the landscape. Often, the landscape was shaped by the actions of ancestors or spirit beings, or these beings and their actions are embodied in natural features and landmarks. All of these beliefs mean that for American Indians the landscape is composed of places that are of “traditional religious or cultural importance” [NHPA (16 USC 470)]. Some of these places are considered by tribes and federal agencies to be TCPs, which may be eligible for the NRHP. TCPs are places that are connected to “those beliefs, customs, and practices of a living community of people” (Parker and King 1998). TCPs generally embody values, beliefs, or practices that are widely shared within the group and have been passed down through generations. To be determined eligible for the NRHP, a property must meet one or more of the eligibility criteria. Few properties have received formal evaluations. This EIS addresses potential impacts to TCPs regardless of their NRHP eligibility status.

There are currently no NRHP-listed TCPs associated with American Indian cultures within the proposed withdrawal parcels. However, many places within the proposed withdrawal area may have qualities that would render them eligible for the NRHP as TCPs. The Kaibab National Forest is currently working on the NRHP nomination of Red Butte as a TCP.

Data on important places within the withdrawal parcels are presently available for the following American Indian groups: Southern Paiute (Las Vegas Paiute Tribe, Kaibab Band of Paiute Indians, Moapa Band of Paiute Indians, Pahrump Paiute Indian Tribe, Paiute Tribe of Utah, which includes the Shivwits Band of Paiute, and San Juan Southern Paiute Tribe), Havasupai Indian Tribe, Hualapai Tribe, Navajo Nation, Hopi Tribe, and Pueblo of Zuni.

Southern Paiute

The Southern Paiute today consist of the Kaibab Band of Paiute Indians, San Juan Southern Paiute, Paiute Indian Tribe of Utah, which includes the Shivwits Band of the Paiute, Moapa Band of Paiute Indians, and Las Vegas Tribe of Paiute Indians. Before the arrival of European-Americans, the Southern Paiute were primarily hunter-gatherers who practiced a limited amount of cultivation. Their traditional territory extended from the Grand Canyon north into Utah and Nevada.

For the Southern Paiute and other Numic language speakers everything in the world has *puhu* (power) (Stoffle et al. 2005). Puhu permeates everything and "is why everything is alive, has a will, and is capable of action" (Stoffle et al. 2005:19). Puhu connects all things and can move throughout the world. For the Southern Paiute, all of their traditional territory is considered sacred because the landscape is connected to stories of mythic beings (Franklin and Bunte 1994). For example, the San Juan Paiute believe that people came about when Coyote opened a quiver that was given to him by Ocean Grandmother. All the different peoples emerged out of the quiver, with the Paiute being last. Coyote opened the quiver southeast of the Colorado River, which is considered the San Juan Paiute's homeland and the center of the world (Franklin and Bunte 1994).

The reservation of the Kaibab Band of Paiute Indians borders the northern border of the North Parcel, and they are the most intimately connected of the Southern Paiute bands to the proposed withdrawal area. Both the North and East parcels are part of their traditional homeland and have been used by them for as long as they can remember. Several important traditional sacred and cultural places for the Kaibab Band of Paiute Indians are located within the boundaries of the proposed withdrawal area.

Havasupai Tribe

The Havasupai Tribe today occupy a 185,000-acre reservation located within Havasu Canyon and up onto the Coconino Plateau; however, their traditional territory stretched from the Colorado River to Bill Williams Mountain and from the Aubrey Cliffs to the Little Colorado River and included the entire South Parcel (Schwartz 1983). Traditionally, Havasupai lived within the Havasu Canyon, which is within the Grand Canyon, in the summer and on the plateau in the winter. Havasupai farmed the canyon bottom in the summer and relied on hunted and gathered resources from the plateau in the winter.

According to their beliefs, the Havasupai peoples emerged from the earth in the Grand Canyon in search of light (Tilousi 1993). Havasupai origin tales tell of a time when the people lived beneath the earth and had no light to hunt by (Smithson and Euler 1994:36; Tilousi 1993). Two brothers traveled through a hole in the earth and acquired the sun and the moon for the people. The Havasupai believe that the Canyon, the surrounding plateau, and all the plants and animals were given to them to care for. The people themselves are a part of the Grand Canyon and the land and cannot be separated from it (Hirst 2006:207). The Havasupai have tales about many of the landforms in and around the Grand Canyon, including landforms within the proposed withdrawal area. It is important to the Havasupai that they are asked "about the sacredness of the area, about places where the bone of our ancestors are buried" (Tilousi 1993).

Hualapai Tribe

Before the arrival of European-Americans, the Hualapai Tribe's traditional territory stretched from the Colorado River south to the Bill Williams River and from the Black Mountains east to Havasu Canyon (McGuire 1983). According to their stories, the Hualapai, along with the Havasupai and Yavapai, were created in the west at Wikame or "Spirit Mountain" by two brother deities (Fairley 2004). All the Pai peoples then journeyed to the Grand Canyon, led by the older of the two brothers, who taught them all they needed to survive in the area (Kroeber 1935:15–26; Hualapai Tribe 1993 and Stevens and Mercer 1998 cited in Fairley 2004:66). They all lived together until a children's fight led to the three tribes' splitting up; the Hualapai and Yavapai parted ways, and the Havasupai moved into the Grand Canyon. The landscape of the Grand Canyon and the surrounding areas is entirely sacred to the Hualapai. Many of the landforms are connected to stories about the ancestors, with the river and the Grand Canyon serving as the "backbone" or Ha' Yi-Data (Hualapai Tribe 1993 and Stevens and Mercer 1998, cited in Fairley 2004:66; Whatoname 2009).

Navajo Nation

The Navajo traditional territory extends from just west of the Rio Grande in New Mexico to the Colorado River in Arizona and from north of the San Juan River to just south of the Little Colorado River (Brugge 1983). The Colorado River itself is sacred and a source of power; it also represents the westernmost boundary of Navajoland (Roberts et al. 1995, cited in Fairley 2004:69-70). According to Navajo stories, the Navajo emerged from earth after they had traveled through several underground worlds (Gill 1982, 1983; Klah 1942; Stephen 1930). Violence and conflicts that sometimes led to destruction caused them to seek a new world each time. Once they had emerged onto the current world's surface, they were in Dinetah, or their traditional homeland, which is bordered by four sacred mountains. These mountains are associated with the cardinal directions and are located at each of the four corners of the world (Gill 1982). Many of the mountains and other landforms seen today were created by the actions of sacred beings after the Navajo emerged from the worlds below. Each place has a corresponding story of how it came to be; the association of the landscape with the sacred beings and their actions makes the entire landscape sacred and in need of protection by the Navajo.

Hopi Tribe

The Hopi traditional territory extends over the entire state of Arizona. The Hopi, along with all other people, emerged into the current world, the Fourth World, from the Third World at a place called Sipapuni located in the Grand Canyon (Fairley 2004; Nuvamsa 2008). Upon emerging into the Fourth World, the Hopi were met by Maasaw, the Earth Guardian, who charged the Hopi with the care of the earth. The different peoples left the Sipapuni and journeyed toward the east (Vecsey 1983). Some stopped and settled for a while before moving east again; these are the builders of the ruins seen throughout the land (Stephen 1929; Vecsey 1983). The Hopi finally settled on Black Mesa; each of the clans arrived separately. Although the Hopi currently do not live near the Grand Canyon, it is the origin place of their people, and they see themselves as stewards of the earth, including the Grand Canyon and the proposed withdrawal area (Ferguson 1997; Nuvamsa 2008).

Pueblo of Zuni

The traditional territory of the Pueblo of Zuni extends into both Arizona and New Mexico. Like the Hopi, the Zuni emerged into the Fourth World in the Grand Canyon. Once they emerged, they were told to seek the "middle place;" once they arrived there, they could settle and build their town (Ferguson and Hart 1985:21–23; Gill 1982). The Zuni traveled for several years and tried to settle in a few places. Each time, their village was destroyed or they decided to move because the location was deemed not to be the middle place (Gill 1982; Parsons 1923). The Zuni eventually asked a series of animals to help them locate the middle place; finally, a water strider found the place and told the Zuni to settle beneath his heart (Parsons 1923). Like the Hopi, the Zuni are intimately connected to the landscape of the Grand Canyon, and, like the Hopi, the ruins found in the area are the towns of their ancestors (Ferguson and Hart 1985:21–23).

3.12.2 American Indian Use Areas

The following discussion is based on research of sources available to the public, as well as a report on important ethnographic resources within the proposed withdrawal area commissioned by the NPS (Hedquist and Ferguson 2010). The following information is entirely from published sources unless otherwise noted. Because of the sensitive nature of some information provided by tribes not found in published literature, some areas may not be discussed in detail.

In addition to the places and landscapes described below, because of association with their ancestors, American Indians often consider prehistoric and historic sites as significant. Most American Indians prefer that archaeological sites not be disturbed and that access to them be limited in order to prevent vandalism.

Colorado Plateau

The Colorado Plateau, both north and south of the Grand Canyon, is a single traditional cultural landscape representative of many cultures over thousands of years. Within this larger landscape, there are several smaller landscapes, as well as specific places that are of concern to one or more tribes for traditional, cultural, or sacred reasons. Several studies have detailed the traditional landscapes of the Southern Paiute on the Arizona Strip, although the area has also been used by other groups (Austin et al. 2005; Stoffle et al. 1997, 2005). These studies have identified several sensitive areas in both the North and East parcels, as well as areas immediately adjacent to the proposed withdrawal area. The cultural landscapes, geographies, and places important to the Southern Paiute vary in size and shape and are not necessarily mutually exclusive. In addition, the Havasupai have expressed cultural concerns about the Kanab Plateau during consultation.

The lands that form the South Parcel represent traditional use areas for several tribes: Southern Paiute, Hualapai, Havasupai, Hopi, Navajo, Yavapai, and Pueblo of Zuni. These tribes share concern for the entire area, as well as specific locations within the parcel. Although there is not a developed “regional landscapes” for all of these tribes currently, we can assume that their traditional territories encompass several regional landscapes that include the proposed withdrawal area.

Many of the important landscapes and places are connected with water. For example, the Southern Paiute consider the Colorado River the “blood vein of the earth” (Stoffle et al. 2005). Other creeks and rivers are smaller veins that are “water connection places,” which link all parts of the land to one another (Stoffle et al. 2005). Springs, as water sources, also are special places. According to Kelly (1964:11–13), springs could be “owned” by Paiute family groups, who would camp there over the course of their seasonal cycle.

Trails served as important communication and trade routes for many different peoples throughout the proposed withdrawal parcels. Many trails followed important water sources or served as pilgrimage routes. Other important areas include places used for traditional hunting and gathering. Kelley (1964) identified several areas within all three proposed withdrawal parcels that were used for various subsistence activities by the Southern Paiute. She identified economic clusters/seasonal cycles and areas used for specific resource procurement activities. Kelly defined these economic clusters/seasonal cycles based on spring location and how groups traveled from spring to spring in order to collect seasonal resources (Kelley 1964:11, 22–23). The lands in the North and East parcels were used primarily by the

Southern Paiute; the lands of the South Parcel were used by the Hopi, Havasupai, and Navajo for subsistence (Hedquist and Ferguson 2010). These areas are not defined as economic clusters/seasonal cycle areas but are considered traditional use areas.

In addition, there are specific religiously and culturally significant places throughout the three proposed withdrawal parcels. These places may be considered sacred to one or more tribes and used for ceremonial, as well as other, purposes.

GRAND CANYON REGIONAL LANDSCAPE

The Grand Canyon regional landscape stretches from Navajo Mountain and the Kaibab Plateau in the east to the Beaver Dam Mountains to the west and from the Paunsaugunt and Markagunt plateaus in the north and the Colorado River in the south, and it is the largest of the Paiute traditional landscapes. The boundaries encompass “the watersheds that drain into the Colorado River” (Stoffle et al. 1997). The Grand Canyon, known as Piapaxa ‘uipi or “Big River Canyon,” is the “central focus of . . . [the] landscape” (Stoffle et al. 1997); however, the Grand Canyon regional landscape consists of myriad connected places throughout the entire area (Stoffle et al. 1997). Importantly, the landscape represents the extent of the traditional Paiute seasonal movement prior to the arrival of Europeans.

North Parcel

KANAB CREEK ECOSCAPE

The Kanab Creek ecoscape stretches from Bulrush and Hack Canyon washes in the east to Snake Gulch to the west and from the confluence of Kanab Creek with the Colorado River in the south to the Pink Cliffs in the north. Like the Grand Canyon regional landscape, the Kanab Creek ecoscape is defined by watersheds (Stoffle et al. 2000). The ecoscape falls within the traditional territory of the Kaibab Band of the Paiute, who farmed along the creek and exploited the various plant and animal resources available throughout the area (Stoffle et al. 1997, 2000). The Kanab Creek ecoscape was also an important north-south trade route and served as a refuge for Paiutes during European-American encroachment (Stoffle et al. 1997, 2000).

KANAB CREEK AND THE COLORADO RIVER

Although they are included in the above landscapes, the Kanab Creek and Colorado River are themselves considered significant places to the Paiute, especially to the Kaibab Band of the Paiute. Although not yet formally evaluated for inclusion in the NRHP, many tribes consider them an important TCP. The Southern Paiute Consortium considers these and “the whole region in and around Grand Canyon as an indivisible Traditional Cultural Property” (Southern Paiute Consortium 2010). For the Navajo, the Colorado River is thought of as a TCP since it plays a role in their creation stories (Molenaar 2005:17). The Zuni and the Hopi emerged in the Grand Canyon from the previous worlds. Although the Zuni consider the confluence of the Little Colorado and Colorado rivers a TCP, the entire Grand Canyon and river habitat are “integrally connected to Zuni religious beliefs, ceremonies, and prayers” (Dongoske 2009:2).

KANAB CREEK GHOST DANCE SITE

A rock art site associated with the Ghost Dance is located within the Kanab Creek Canyon at an unpublished location (Stoffle et al. 2000). The site consists of pictographs painted on and petroglyphs pecked into a sandstone outcrop. It has likely been used for more than 2,000 years. The Kaibab Paiute have identified one panel of white figures as being associated with the Ghost Dance ceremony, which was performed in the late nineteenth century (Stoffle et al. 2000). The Ghost Dance was a revitalization movement that began among the Paiute in Nevada but quickly spread throughout tribes in Northern Arizona and Utah and into the Great Plains (Kehoe 1989).

SPRINGS

Three springs located within the North Parcel are important to the Southern Paiute. Moonshine Spring is located just west of Bulrush Wash, Wa'akarerempa or Yellowstone Spring is located on Yellowstone Mesa, and Tinkanivac or Antelope Spring is located in Antelope Valley (Austin et al. 2005:79; Hedquist and Ferguson 2010:9; Kelley 1964:8). Moonshine and Yellowstone springs also have several archaeological sites associated with them. The Moonshine Ridge ACEC encompasses Moonshine Spring and its associated archaeological sites.

TRAILS

Several trails cross the North Parcel. Along Kanab Creek, a trail stretches from the northern edge of the parcel to the Grand Canyon. The Kanab Creek trail was the Paiute's "entrance" into the canyon (Stoffle et al. 2005:182). Another trail ran from the spring Tinkanivac to the Colorado River (Kelley 1964:88; Stoffle et al. 1994:76).

Although not specifically mentioned in the literature, access routes to culturally significant places south of the parcel must also be considered. Mt. Trumbull, Toroweap, Vulcan's Anvil, and several springs, which are all part of Paiute cultural landscapes, are located just outside the southwest corner of the parcel. Access to these areas is primarily through the North Parcel. Modern access is via roads; however, the existence of trails to this area must be assumed. During consultation, the Hopi Tribe indicated that several places north of the Grand Canyon, including Mt. Trumbull, have traditional cultural importance. The Hopi travel through the North and East parcels to reach places of ritual importance north of the Grand Canyon.

ECONOMIC/SUBSISTENCE AREAS AND TRADITIONAL TERRITORIES

Both the traditional territories Kaibab and Uinkaret bands of the Southern Paiute occur within portions of the North Parcel (Kelley 1934:548, 551). Kelley (1964) identified the Economic Cluster/Seasonal Cycle I as extending from Moonshine Spring north into the current Kaibab Paiute Reservation (Kelley 1964:11). Other important resource procurement areas include an antelope hunting range in Antelope Valley (Austin et al. 2005:3, 80; Kelley 1934:554; Kelley and Fowler 1986:369) and a mescal gathering location along Kanab Creek (Austin et al. 2005:3; Kelley 1934:554; Kelley and Fowler 1986:369).

East Parcel

AESAK CULTURAL LANDSCAPE

The Paiute called House Rock Valley Aesak or "basket-like" (Austin et al. 2005:57). The entire valley was used by the Paiute to gather plant resources and to hunt animals. Although House Rock Valley was traditionally the territory of the Kaibab Paiute, the San Juan Paiute were allowed to collect seeds in the fall. In return, the Kaibab Paiute could collect seeds in the summer from the territory of the San Juan Paiute. As part of this agreement, the host group would hold a round dance for the visitors; the dance allowed continued interaction between the groups and often led to intergroup marriages (Bunte and Franklin 1987:19).

KANE RANCH (OARINKANIVAC AND PAGAMPIAGANTI)

Two springs important to the Paiute sit on the Kane Ranch property: Oarinkanivac and Pagampiaganti. Families would camp at these springs seasonally when foraging for resources (Kelly 1964:10–12).

HOUSE ROCK VALLEY TRAILS

Trails are also an important component for the Paiute of the House Rock Valley (Stoffle et al. 2005). For example, what is now known as the Mormon Honeymoon Trail was once an American Indian trail along the Vermilion Cliffs. This trail accessed several important spring sites along the cliffs, including Deer and House Rock springs. This trail and the sites along it should be considered a connected resource.

Another trail running from Kane Ranch to the Colorado River connects the springs to the Grand Canyon near the location of the Hopi Salt Mine (Kelley 1964:89; Stoffle et al. 1994:76).

ECONOMIC/SUBSISTENCE RESOURCE AREAS

The Paiute Economic Cluster/Seasonal Cycle VIII and Economic Cluster/Seasonal Cycle IX extend into the East Parcel in the north (Hedquist and Ferguson 2010:12, 65–66; Kelley 1964:11–22). Both of these are associated with springs along the Vermilion Cliffs; the Economic Cluster/Seasonal Cycle IX is also associated with Kane Ranch and the two springs located there. Also, areas for hunting deer and antelope are located in the valley (Austin et al. 2005:3; Ferguson and Hedquist 2009:8; Kelley 1934:554; Kelley and Fowler 1986:369).

In addition to the places and landscapes discussed above, several important places are directly adjacent to the proposed withdrawal area and should be considered. These include several sites along the Vermilion Cliffs (including the California condor release site, West Bench Pueblo, Signature Rock, and Jacob's Pool), as well as Vasey's Paradise (personal communication, J. Balsom January 2010).

South Parcel

RED BUTTE

Red Butte is located in the southern portion of the South Parcel and is a known sacred site for the Havasupai, Hualapai, Navajo, Hopi, and Zuni. The Forest Service is currently working on evaluating Red Butte for listing in the NRHP as a TCP for its association and importance to American Indian beliefs and ceremonialism. In addition, the tribes have expressed concern in the past for the travel corridor from Red Butte north to the Grand Canyon (personal communication, J. Balsom January 2010).

NAVAJO CULTURAL LANDSCAPE

The South Parcel is within the Navajo Nation's traditional claim area (Hedquist and Ferguson 2010:249). Within that claim area lies the Coconino Plateau cultural landscape known as Dzil Libáí or Grey Mountain (Linford 2000:69). The area was used mainly in the nineteenth century and served as a battlefield for conflicts between the Navajo and Mexicans (Linford 2000:69). In the South Parcel, the number of archaeological sites of the Historic period attributed to the Navajo (99) indicates that they were regularly using the area. Most of these sites, scattered throughout the parcel, are the remains of sweat lodges and other shelters. These may have been temporary camps associated with hunting, other activities, or periodic travel to the Grand Canyon from the homeland. In addition, a Navajo ceremonial site is located on the Coconino Plateau, but its exact location is unknown (Hedquist and Ferguson 2010:14; Roberts et al. 1995:91).

HOPI TRADITIONAL USE AREA

The Hopi traditional use area or claim area covers the entire state of Arizona, which includes the South Parcel (Hedquist and Ferguson 2010:251; Kuwanwisiwma and Ferguson 2010).

TRAILS

At least two trails run from Hopi Mesa to the Grand Canyon and the territory of the Havasupai. Although the exact locations of the trails are unknown, they are known to run through the South Parcel. At least one trail leads past Red Butte on its way to the Grand Canyon (Colton 1964). Two Navajo trails used to access the canyon and Havasupai territory are found in the northern portion of the South Parcel (Roberts et al. 1995:73–74).

HAVASUPAI SEASONAL CAMPS

The Havasupai traditional use area encompasses the South Parcel (Hedquist and Ferguson 2010:252). Two Havasupai seasonal camps are located in the northern portion of the South Parcel: one is located near Hull Tank; the other is at Rain Tank. The area around Hull Tank is used for pinyon collection while the camp at Rain Tank was primarily associated with trade with the Hopi and Navajo (Manners 1974:106; Wray 1990:19, 46).

Trust Resources and Assets

There are no Trust Resources or Assets located within the proposed withdrawal parcels.

3.12.3 Resource Condition Indicators

Resource condition indicators for cultural landscapes and places are not easily definable or quantifiable. The importance of landscapes and places can be understood through a group or individual’s “sense of place.” Sense of place refers to how people experience and understand a location; the experience and understanding are a product of one’s cultural history and values, such that different groups can experience the same place in different ways (Allen et al. 2009; Farnum et al. 2005). Sense of place is tied to group and individual emotions and backgrounds, making it difficult to define and even harder to quantify. When dealing with cultural landscapes and places, the analysis of possible impacts is dependent on the emotional and intellectual response of the concerned groups and individuals. It is, in essence, their reaction and opinions alone that determine whether there is an impact and the relative significance of that impact. Indicators include the following:

- The proximity and size of possible surface, visual, or auditory disturbance to, or within, identified TCPs.
- Number of acres of total possible disturbance by mineral exploration and development.
- Proximity of traditional use areas to anticipated mineral exploration and development.
- Likelihood of concurrent or overlapping timing of traditional activity with mineral exploration and development.
- Manner and degree of auditory or visual disruptions in the traditional use area.
- Number and types of traditional cultural use areas, sacred sites, cultural landscapes, and trails that could be disturbed by mineral exploration and development.

3.13 WILDERNESS RESOURCES

3.13.1 Wilderness

Permanent wilderness protection for federal lands comes only through Congressional action that creates "statutory" or "designated" wilderness areas. Such lands are managed under the mandates of the Wilderness Act of 1964 [PL 88-577; 16 USC 1131–1136] and any special management instructions that Congress may include in the specific legislation that "designates" specific wilderness areas. The Wilderness Act dictates that wilderness areas are managed to protect and preserve their "wilderness character."

Congressional intent for the meaning of wilderness character is expressed in the Definition of Wilderness, Section 2(c) of the 1964 Wilderness Act. The BLM, Forest Service, NPS and other agencies apply the legal definition to identify 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."

There are three wilderness areas within or immediately adjacent to the proposed withdrawal area: Kanab Creek (which is jointly managed by the BLM and Forest Service and is adjacent to the North Parcel); Paria Canyon–Vermilion Cliffs (jointly managed by the Arizona Strip Field Office and Utah BLM, and adjacent to the East Parcel); and Saddle Mountain (managed by the Forest Service and adjacent to the East Parcel). The Arizona Wilderness Act of 1984 designated these three areas.

These wilderness areas currently provide a standard of solitude and naturalness that ranges from good to outstanding. They contain little to no evidence of surface disturbance, other than former vehicle ways and scattered prospects. Federal lands within wilderness areas are closed to mineral entry, subject to valid existing rights. No valid mineral discoveries have been documented in any of these wilderness areas.

Kanab Creek Wilderness

The Kanab Creek Wilderness is managed jointly by the BLM and Forest Service in accordance with the *Kanab Creek Wilderness Implementation Schedule* (BLM and Forest Service 1988). The Kanab Creek Wilderness straddles the Mohave–Coconino county line and is contiguous along about 14 miles of its boundary with NPS lands in Grand Canyon National Park. The Kanab Creek Wilderness is located on the eastern border of the North Parcel; portions of the wilderness are located within the parcel boundaries but only include the bottom of Hack Canyon. The surrounding canyon rims, as well as all but 200 feet of the slopes and cliffs within Snake Gulch and Hack Canyon, are excluded. Kanab Creek is part of the largest canyon system on the north side of the Grand Canyon. It includes impressive rock formations, colorations, and features carved by wind and water. Numerous springs provide an interesting contrast with the generally arid terrain. The cliffs are home to bands of desert bighorn sheep as well as peregrine falcons.

Paria Canyon–Vermilion Cliffs Wilderness

The Paria Canyon–Vermilion Cliffs Wilderness is managed by the BLM in accordance with the *Paria Canyon–Vermilion Cliffs Wilderness: Wilderness Management Plan* (BLM 1986c) and covers 112,500 acres. The wilderness is located approximately 10 miles west of Page, Arizona, in Coconino County, Arizona, and Kane County, Utah. The wilderness is located along the northern border of the East Parcel. Nationally known for its beauty, Paria Canyon has towering walls streaked with desert varnish, huge red rock amphitheaters, sandstone arches, wooded terraces, and hanging gardens. The 3,000-foot escarpment known as the Vermilion Cliffs dominates the remainder of the wilderness with its thick Navajo sandstone face, steep, boulder-strewn slopes, rugged arroyos, and stark overall appearance. Desert bighorn sheep and peregrine falcon inhabit the area.

Saddle Mountain Wilderness

The Saddle Mountain Wilderness contains a total of 40,539 acres and is managed by the Forest Service. The wilderness straddles the eastern edge of the Kaibab Plateau and is located southwest of the East Parcel. Three permanent springs in North Canyon and one in South Canyon provide water and a gathering place for the local inhabitants, including pronghorn antelope, blue grouse (*Dendragapus obscures*), small mammals, and a buffalo herd. Trailheads that access the wilderness originate at the top of the Kaibab Plateau and at its base in House Rock Valley. The Saddle Mountain Trail parallels the main ridge for approximately 4 miles and rewards hikers with views of the Marble Canyon Gorge, Cocks Comb, House Rock Valley, and the Vermilion Cliffs. It also provides access into Grand Canyon National Park. The North and South canyon trails, 7 and 4 miles long, respectively, follow canyon bottoms.

Proposed Wilderness

A wilderness proposal was prepared for Grand Canyon National Park in 1980; it was updated in 1993 and awaits further action. It proposed a wilderness designation for 1,109,257 acres, with an additional 29,820 acres of potential wilderness within Grand Canyon National Park, pending the resolution of Park boundary and motorized riverboat issues. These areas offer visitors opportunities for solitude and primitive recreation. The management of these areas should preserve the wilderness values and character (NPS 1995).

The 2006 *NPS Management Polices* and Director's Order 41 require that proposed wilderness areas be managed the same as designated wilderness and that no actions be taken that would diminish wilderness suitability until the legislative process for wilderness designation has been completed. Therefore, NPS manages all proposed wilderness areas as wilderness and anticipates the final resolution of wilderness issues and the preparation of a wilderness management plan as future actions. The NPS-proposed wilderness is managed under the wilderness character attributes described in Section 3.13.1.

Nonwilderness undeveloped areas continue to serve primarily as primitive thresholds to wilderness. Areas currently excluded from proposed wilderness inside the Grand Canyon National Park include 1) several dirt roads throughout the Park; 2) the area on the South Rim from Hermits Rest to Desert View; 3) Bright Angel Point on the North Rim (300 feet on either side of paved roads and 150 feet on either side of unpaved roads); 4) the Tuweep developed area; and 5) the corridor trails.

3.13.2 Wilderness Characteristics

Lands that have the tangible qualities of a Wilderness but that have not been designated a Wilderness by an act of Congress are sometimes managed to maintain wilderness characteristics. BLM Instructional Memo 2003-275 presents the guidelines for managing wilderness characteristics. The Arizona Strip Field Office identified approximately 34,764 (BLM 2008b) acres of land adjacent to Kanab Creek Wilderness that possess naturalness, outstanding opportunities for solitude, and outstanding opportunities for primitive and unconfined recreation—characteristics of land described in BLM Instructional Memo 2003-275 as land containing wilderness characteristics. BLM and NPS lands that possess the above values may be managed to maintain or enhance some or all of those characteristics (BLM 2007).

3.13.3 Resource Indicators

The wilderness resource condition indicators used to characterize wilderness are those indicators that reflect the wilderness characteristics that supported the wilderness designation, as described in Section 3.13.1: land that is untrammeled, natural, undeveloped, and offers solitude or a primitive and unconfined type of recreation.

Table 3.13-1. Wilderness Resource Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator
Wilderness areas	Designated wilderness is already withdrawn from location and entry under the Mining Law, subject to valid existing rights. Mining may still occur on these lands and on lands adjacent to designated wilderness areas, which may affect the wilderness characteristics.	*Indicator*: Changes in the land's wilderness characteristics: untrammeled, natural, undeveloped, and opportunities for solitude or a primitive and unconfined type of recreation.

3.14 RECREATION RESOURCES

Recreation activities occurring throughout northern Arizona, including in the proposed withdrawal area and the adjacent Grand Canyon, involve a broad spectrum of pursuits, ranging from dispersed and casual recreation to organized, BLM- and Forest Service–permitted group uses. Typical recreation in the region includes OHV driving, scenic driving, hunting, hiking, wildlife viewing, horseback riding, camping, backpacking, mountain biking, geocaching, picnicking, night-sky viewing, and photography. The region is known for its large-scale undeveloped areas and remoteness, which provide a wide variety of recreational opportunities for users who wish to experience primitive and undeveloped recreation, as well as those seeking more organized or packaged recreation experiences. Figure 3.14-1 provides an overview of recreation in and surrounding the proposed withdrawal area.

The affected environment is based on defining the existing conditions of recreation resources using the management guidelines from the Arizona Strip ROD/RMP (BLM 2008b) and Kaibab LMP/ROD (Forest Service 1988).

3.14.1 Recreation Resource Attractions

A vast network of improved and primitive roads, although remote and often requiring high-clearance vehicles, offers a variety of opportunities for driving for pleasure or vehicle exploring. Figure 3.14-1 illustrates the recreation attraction, including GMUs, campgrounds, overlooks, interpretive sites, and trailheads. Figure 3.14-2 illustrates the existing transportation and access network in the proposed withdrawal area. Remnants of historic trails, such as the Honeymoon Trail, Dominguez-Escalante Route, and the recently designated Old Spanish National Historic Trail, lie within the Arizona Strip. Both the Arizona Strip Field Office and Tusayan Ranger District of the Kaibab National Forest are currently working on revising route designations through separate NEPA processes. The resultant route designations will likely differ from the existing network described in Table 3.14-1 and illustrated in Figure 3.14-2.

The vast majority of BLM lands and the proposed withdrawal area are without formally constructed trails for foot, horse, bike, or motorcycle. Therefore, exploration of its roadless areas via off-route foot or horse travel requires exceptional navigation and outdoor skills. Table 3.14-1 describes the uses of existing routes within the proposed withdrawal area. The Tusayan Ranger District of the Kaibab National Forest has several constructed trails, including the Arizona Trail, a recently designated National Scenic Trail. Table 3.14-1 describes existing routes within the proposed withdrawal area.

Table 3.14-1. Existing Routes within the Proposed Withdrawal Area: Mileage Summary by Use and Maintenance Level

Use Designation	Example of Recreation Use	Miles
Paved roads	Scenic driving, heritage touring	89.71
Unpaved roads	Scenic driving, recreational vehicle use, heritage touring, horseback riding, mountain biking, hiking	3,630.91
Closed roads	Horseback riding, hiking	0.62
Reclaimed roads	Hiking	24.2
Total		**3,745.46**

Sources: BLM (2010f); Forest Service (2010b).

The proposed withdrawal area includes various lands managed to maintain the wilderness characteristics of naturalness, solitude, and opportunities for primitive recreation. These characteristics are defined as follows.

Naturalness: Lands and resources exhibit a high degree of naturalness, are affected primarily by the forces of nature, and are areas in which the imprint of human activity is substantially unnoticeable. The BLM has authority to inventory, assess, and/or monitor the attributes of the lands and resources on public lands, which, taken together, are an indication of an area's naturalness. These attributes may include the presence or absence of roads and trails, fences and other improvements, the nature and extent of landscape modifications, the presence of native vegetation communities, and the connectivity of habitats.

Outstanding Opportunities for Solitude: Visitors may have outstanding opportunities for solitude when the sights, sounds, and evidence of other people are rare or infrequent and where visitors can be isolated, alone, or secluded from others.

Outstanding Opportunities for a Primitive and Unconfined Type of Recreation: Visitors may have outstanding opportunities for primitive and unconfined types of recreation where the use of the area is through non-motorized, non-mechanical means and where no or minimal developed recreation facilities are encountered.

The fact that many of these areas typically include unique scenic beauty and diverse landscape settings increases their recreational quality (BLM 2008b). Recreation sites illustrated in Figure 3.14-1 include trailheads, overlooks and vistas, wildlife viewing areas, camp and picnic grounds, and interpretive sites. These recreation sites are detailed in Table 3.14-2.

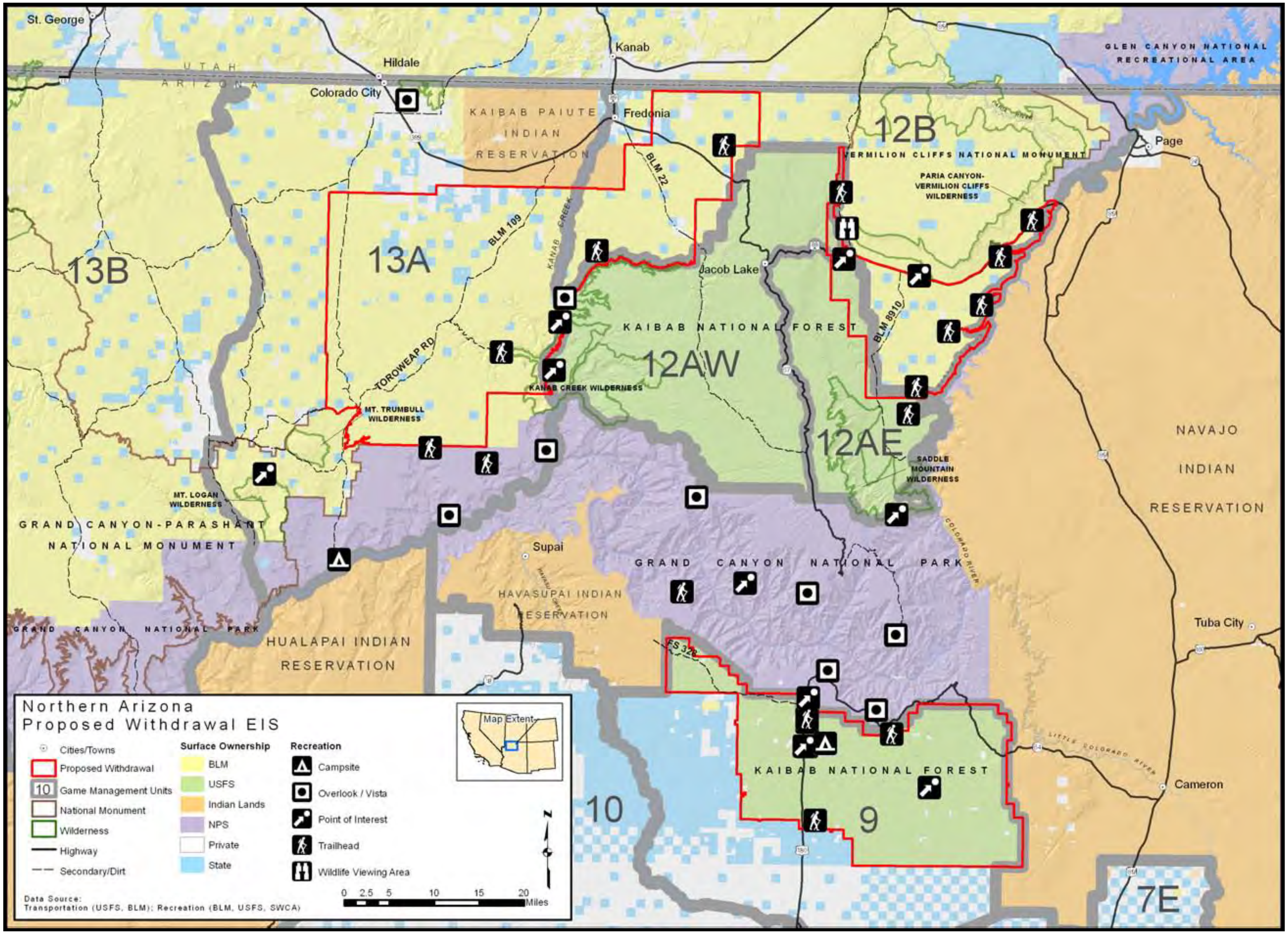


Figure 3.14-1. Recreation overview map.

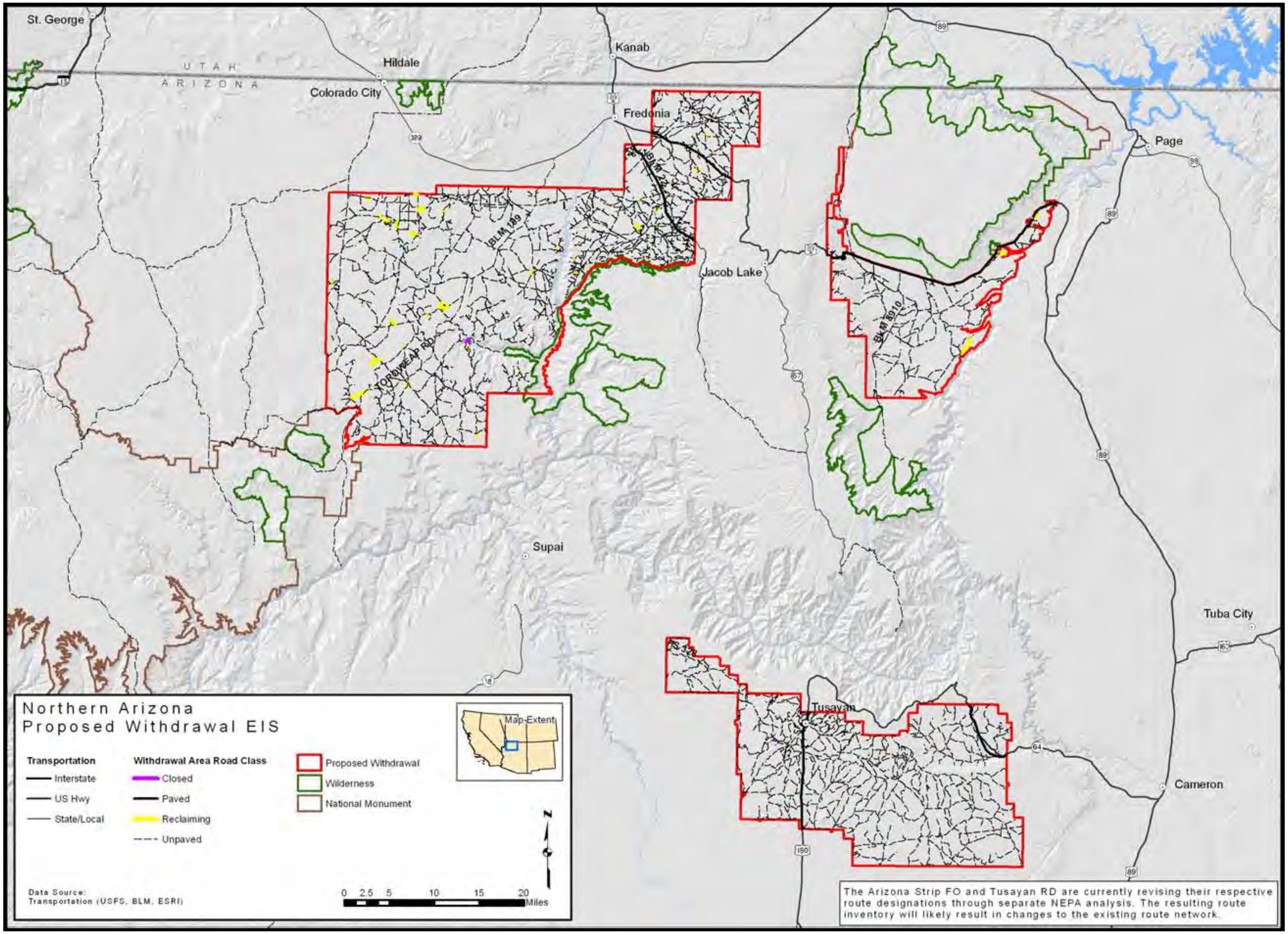


Figure 3.14-2. Transportation map.

Table 3.14-2. Inventory of Recreation Sites and Visitor Data within* the Proposed Withdrawal Area

Proposed Withdrawal Area	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)†
East Parcel	Forest Service	House Rock Valley Overlook Interpretive Site	Interpretive site	5,371
East Parcel	Forest Service	Navajo Trail	Trailhead	Not available
East Parcel	BLM	Soap Creek	Trailhead	328
East Parcel	BLM	Rider Canyon	Trailhead	36
East Parcel	BLM	North Canyon Creek	Trailhead	36
East Parcel	BLM	Badger Creek	Trailhead	120
East Parcel	BLM	Dominquez-Escalante Interpretive Site	Historic Site	10,635
East Parcel	BLM	Condor Interpretive Site	Wildlife/Overlook	4,200
North Parcel	BLM	Hack Canyon	Trailhead	402
North Parcel	BLM	Swapp Trail	Trailhead	Not available
North Parcel	Forest Service	Gunsight Point	Overlook	Not available
North Parcel	Forest Service	Hatch Cabin	Cabin	Not available
North Parcel	BLM	Rock Canyon	Trailhead	Not available
South Parcel	Forest Service	Ten-X Family Campground	Family Campground	Not available
South Parcel	Forest Service	Charlie Tank Group Camp Ground	Group campground	Not available
South Parcel	Forest Service	Tusayan Bike Trails	Trailheads	Not available
South Parcel	Forest Service	Arizona Trail	Trailhead	Not available
South Parcel	Forest Service	Red Butte	Trailhead	Not available
South Parcel	Forest Service	Russell Tank Fishing Parking Area	Fishing site	Not available
Outside Withdrawal Area	NPS	Bass Trail	Trailhead	Not available
Outside Withdrawal Area	NPS	Kanab Point	Overlook	Not available
Outside Withdrawal Area	NPS	150 Mile Canyon	Trailhead	Not available
Outside Withdrawal Area	Forest Service/NPS	South Canyon	Trailhead	54
Outside Withdrawal Area	NPS	SB Point	Overlook	Not available
Outside Withdrawal Area	NPS	Grand Canyon Gateway	Park entrance	4,418,773
Outside Withdrawal Area	NPS/BLM	Tuckup Point	Overlook	Not available
Outside Withdrawal Area	NPS	Toroweap	Campground/Overlook	3,859

Sources: BLM (2009b); Forest Service (2009f); NPS (2009b).

* Access to some recreation sites in Grand Canyon National Park requires users to travel on routes that occur within the proposed withdrawal area; these are therefore considered in this analysis.

† Land management agencies do not track public visitation at some recreation sites.

The open landscapes provide long-distance vistas easily viewed from both paved and unpaved routes. The entire segment of U.S. 89A through the Arizona Strip Field Office is designated by the State of Arizona as a state scenic road. The Arizona Department of Transportation is currently analyzing the potential of U.S. 89A for designation as a National Scenic Byway (personal communication, Richard Spotts, BLM January 2010). The segment, along with the other paved routes mentioned, is part of the multiple-partner Vermilion Cliffs Highways Project, which is an initiative to provide interpretive signs at approximately 23 sites (BLM 2008b).

Grand Canyon National Park manages adjacent lands on the North Parcel and the Marble Platform in House Rock Valley (areas adjacent to the Park in the East Parcel are known as the Marble Platform) to maintain its current undeveloped character. These areas are zoned by the Park as Primitive (NPS 1988). NPS zoning does not apply to activities on adjacent multiple-use lands.

3.14.2 North and East Parcels

Existing Recreation Activities

The plains, plateaus, mountains, cliffs, and sweeping scenery of the Arizona Strip provide a wide range of opportunities for dispersed, moderately regulated recreation. Exploration, driving for pleasure, hiking, backpacking, camping, picnicking, big- and small-game hunting, wildlife observation, and competitive and organized group events are the most common activity types. Motorized or mechanized vehicle use, walking, or horseback riding are typical modes of travel.

Current recreation setting conditions in the proposed withdrawal area range from primitive to rural, with most of the land being semi-primitive motorized and roaded natural. No urban settings are present directly on BLM-administered lands.

Recreation Management—Resources, Signage, and Recreation Facilities

The proposed withdrawal area (North and East parcels) are accessed by a network of unpaved BLM and Forest Service routes. Many are primitive and can be rough much of the year. This system of routes provides a variety of backcountry driving opportunities and access to key destinations and features. Popular routes include the Toroweap Road, Big Springs Road, and BLM Route 8910 (see Figure 3.14-2).

Access to the remote areas within these parcels offers both the hardy, outdoor adventurer and the sightseeing tourist a wide variety of primitive roads that provide outstanding opportunities for 4-wheel-drive (4WD) and all-terrain vehicle (ATV) exploring and driving opportunities to key destinations and features or for just enjoying the variety of recreation activities. Exploration of most of the backcountry areas within the proposed withdrawal area requires excellent navigational, outdoor and, in some places, canyoneering skills (BLM 2008b).

Few formally constructed non-motorized trails are present in the North and East parcels. Other hiking routes in the proposed withdrawal area tend to take advantage of canyon bottoms, such as Soap Creek, Rider and Hack canyons, or old cattle and sheep trails, such as around the Navajo Trail, Arizona Trail, or ridgelines and old roads.

There are no developed camping facilities within the North and East parcels of the proposed withdrawal area. At-large and dispersed camping occurs at many existing primitive or undeveloped sites along existing roads, trails, and spur roads or trails.

Various small interpretive sites, such as the Dominguez-Escalante Site, Condor Release Interpretive Site, and a variety of single interpretive signs are scattered throughout the area, for example at House Rock Valley Overlook and along the historic Honeymoon Trail.

Visitors typically enjoy the area year-round (although access in the winter can be difficult because of mud and/or snow).

The community interface areas see the greatest variety of recreation users and the highest day-use visitation rates (BLM 2008b) in the proposed withdrawal area. Table 3.14-2 shows annual visitation numbers (where available). Because of the remote nature of much of the area and the dispersed nature of most recreation activities in which visitors engage, it is difficult to obtain actual numbers of most visits to the North and East parcels. For example, no reliable visitor data exist for backcountry camping and OHV use, although these activities frequently take place. The estimates for BLM visitor use are based on data collected from various traffic counters, registration sheets, and professional assumptions determined by data collected on field patrol. No social surveys have been conducted for BLM lands within the proposed withdrawal area.

Motorized activities in these areas are popular and increasing, along with the demand for more opportunities. For instance, local community groups envision the potential to establish formal networks of OHV and/or motorcycle routes connecting various communities in the Arizona Strip (BLM 2008b).

The 2009 Recreation Management Information System (RMIS) data show that BLM lands managed by the Arizona Strip Field Office received approximately 182,564 visitors in 2009. The RMIS numbers are generated by strategic traffic counters and visitor sign-in kiosks. The RMIS results for recreation use of the Arizona Strip by recreation activity showed results that were similar to those of the Kaibab's National Visitor Use Monitoring Program (NVUM) data, discussed in Section 3.14.3. Interpretation, nature study, and education were the most frequent recreation activities, with approximately 50% of the 2009 visitors engaging in some form of this (BLM 2009b). Scenic driving/viewing was the second-most common recreation activity in the Arizona Strip, with approximately 26% of the 2009 visitors engaging in some form of scenic viewing/driving for pleasure. Table 3.14-3 illustrates the recreation activity in 2009 for the Arizona Strip.

Table 3.14-3. Arizona Strip Field Office Visitor Use Activity Groupings for 2009

Visitor Use Activity	No. of Participants	Visitor Days
Camping and picnicking	24,778	13,937
Driving for pleasure	48,343	24,172
Hunting	2,421	8,062
Interpretation, education, and nature study	92,439	4,900
Non-motorized travel	7,480	3,398
OHV travel	1,813	806
Specialized non-motor sports, events, and activities	5,288	1,271
Winter/non-motorized activities	2	1
Total	**182,564**	**56,547**

Source: BLM (2009c).

3.14.3 South Parcel

The recreation study area for Forest Service lands within the proposed withdrawal area includes the South Parcel, which encompasses the Tusayan Ranger District of the Kaibab National Forest. In addition, portions of the Kanab Creek Wilderness occur in the North Parcel of the proposed withdrawal area. The Kanab Creek Wilderness is jointly managed by the BLM and the Forest Service. The East Parcel also includes Kaibab National Forest land along the western boundary of the parcel.

The Tusayan Ranger District is bordered on the east by the Navajo Reservation, where the rugged Coconino Rim drops off toward the Little Colorado River. To the south, Red Butte dominates the landscape. This volcanic hill is a remnant of past volcanic activities and has cultural significance for many American Indian tribes. With its close proximity to several tribes, the Tusayan Ranger District is an important area for forest product gathering as well as for traditional and ceremonial uses.

The Tusayan Ranger District lies to the south of Grand Canyon National Park. Millions of visitors from the United States and abroad pass through the Tusayan Ranger District every year. The Ten-X Campground offers basic amenities and close proximity to the Grand Canyon. Mountain bikers, hikers, and equestrians enjoy the Arizona National Scenic Trail, which crosses the South Parcel from south to north and passes into Grand Canyon National Park (see Figure 3.14-1). There are backcountry camping, scenery, and wildlife viewing opportunities. The Tusayan Ranger District is known for its trophy-sized elk. There are excellent hunting opportunities for deer, elk, and pronghorn antelope (Forest Service 1988). Many people gather fuel wood for both personal and commercial use. Christmas tree cutting is a popular winter activity (Forest Service 2009h).

Visitors have different motivations for the activities in which they want to participate and preferences for the recreation setting in which they like to recreate. For some forest visitors, traveling on a scenic developed or primitive road with friends or family is ideal. For other forest visitors, visiting remote areas where the signs of human development are absent is ideal. With recognition of such differences in user preferences, the primary aim of managing outdoor recreation is to provide an environment in which visitors can enjoy a satisfying experience in a range of settings.

Existing Recreation Activities

Recreation activities within the Tusayan Ranger District (South Parcel) are similar to those within the Arizona Strip. Unique landscapes, climate, vegetation, and wildlife provide a wide array of recreation opportunities. Developed recreation sites are uncommon in the Tusayan Ranger District (Forest Service 2009h). Exploration, driving for pleasure, hiking, backpacking, camping, picnicking, big- and small-game hunting, wildlife observation, and competitive and organized group events are the most common activity types. Motorized or mechanized vehicle use, walking, or horseback riding are typical modes of travel.

Current recreation setting conditions in the Forest Service lands within the proposed withdrawal area range from Primitive to Rural. No urban settings are present; however, the proposed withdrawal area interfaces with the community of Tusayan (see Figures 3.14-1 and 3.14-2, depicting key attraction sites and recreation settings, respectively).

Recreation Management—Resources, Signage, and Recreation Facilities

The South Parcel of the proposed withdrawal area has approximately 1,892 miles of maintained, unpaved Forest Service roads and trails (Forest Service 2010b). Many are primitive and can be rough much of the year. This system of roads and trails provides a variety of backcountry driving opportunities and access to key destinations and features (see Figure 3.14-2).

Access to these remote areas offers both the hardy, outdoor adventurer and the sightseeing tourist a wide variety of primitive roads that provide outstanding opportunities for 4WD and ATV exploring and driving opportunities to key destinations and features or for just enjoying the variety of recreation activities.

Red Butte, the Arizona Trail, and the Tusayan Bike Trails are among the few formally constructed trails for foot, horse, or bike in the Tusayan Ranger District of the proposed withdrawal area.

There are two developed camping facilities within the South Parcel of the proposed withdrawal area. Ten-X Campground, and Charlie Tank Group Campground are all located along the Grand Canyon

Gateway corridor along U.S. 180/SR 64 (see Figure 3.14-1). Dispersed camping occurs at many existing primitive or undeveloped sites along existing routes and spur routes.

The 2005 NVUM report (the best available visitation data) estimated that the Kaibab National Forest received up to 225,000 annual visits to recreation facilities in 2005. Among these site visits, most visitations occurred in undeveloped areas; these areas were also the sites for stays of the longest duration, as shown in Table 3.14-4.

Table 3.14-4. Duration of Visits to Kaibab National Forest

Visit Type	Average Duration (hours)	Median Duration (hours)
Site visit	19.3	3.7
Day use developed	2.7	2.0
Overnight use developed	26.9	18.8
Undeveloped areas	45.5	3.0
Designated Wilderness	10.5	4.3
National Forest visit	35.7	6.0

Source: Forest Service (2009f:FY 2005 data).

The most popular recreation activity for the Kaibab National Forest in 2005 was viewing natural features, with 54.7% of all visitors, followed by hiking and walking for pleasure, with 47.2%. Table 3.14-5 details recreation participation by activity in the Kaibab National Forest.

Table 3.14-5. Activity Participation on Kaibab National Forest

Activity	Total Activity Participation (%)*†	Main Activity (%)‡	No. of Respondents for Whom Main Activity¶	Average Hours Spent Doing Main Activity (Hours)
Some other activity	26.1	22.6	206	4.3
Viewing natural features	54.7	17.2	76	6.5
Hiking/walking	47.2	12.0	97	4.4
Driving for pleasure	44.2	11.4	42	3.1
Viewing wildlife	44.8	5.8	18	7.1
Developed camping	13.7	5.4	65	23.7
Other non-motorized	8.3	5.4	71	8.0
Motorized trail activity	7.0	4.9	7	1.3
Hunting	4.9	4.6	9	42.0
Relaxing	36.7	3.7	49	23.4
Primitive camping	13.2	3.1	29	21.3
Bicycling	6.4	2.1	8	7.3
Fishing	3.6	1.6	9	7.9
Downhill skiing	1.6	1.4	43	3.2
Resort use	8.9	1.3	5	21.8
Visiting historic sites	21.5	1.2	6	3.8
Backpacking	2.8	0.9	5	10.4
Picnicking	12.4	0.8	5	8.8

Table 3.14-5. Activity Participation on Kaibab National Forest (Continued)

Activity	Total Activity Participation (%)*[†]	Main Activity (%)[‡]	No. of Respondents for Whom Main Activity[¶]	Average Hours Spent Doing Main Activity (Hours)
OHV use	3.4	0.8	1	2.0
No activity reported	0.5	0.7	5	
Nature study	10.9	0.5	5	15.0
Horseback riding	2.4	0.2	1	5.0
Nature center activities	18.9	0.1	2	3.2
Non-motorized water	0.2	0.1	4	3.4
Cross-country skiing	0.1	0.1	3	4.0
Other motorized activity	1.7	0.0	0	
Gathering forest products	1.7	0.0	0	
Motorized water activities	0.3	0.0	0	
Snowmobiling	0.0	0.0	0	

Source: Forest Service (2009f:FY 2005 data).

* Survey respondents could select multiple activities, so this column may total more than 100%.

[†] The number in this column is the number of survey respondents who indicated participation in this activity.

[‡] Survey respondents were asked to select just one of their activities as their main reason for the forest visit. Some respondents selected more than one, so this column may total more than 100%.

[¶] The number in this column is the number of survey respondents who indicated this activity was their main activity.

3.14.4 Recreation Opportunity Spectrum

Bureau of Land Management Recreation Opportunity Spectrum

Critical to producing recreation opportunities is the condition of recreation settings on which those opportunities depend. The condition of recreation settings is on a spectrum from Primitive to Urban and can be classified and mapped, based on the variation that exists in the various physical, social, and administrative attributes of any landscape. The physical setting describes variations in components such as remoteness, naturalness, and facilities. The social setting reflects the variations in components such as group size, number and types of contacts, encounters between individuals or groups, and the evidence of use by others. The administrative setting can reflect variations in the kind and extent of components such as visitor services, management controls, user fees, and mechanized use.

Forest Service Recreation Opportunity Spectrum

The Kaibab LRMP/ROD (Forest Service 1988) ROS mapping classified the Tusayan Ranger District in the Roaded Natural and Semi-primitive Motorized ROS classes. In 2003 and 2004, when ROS existing conditions were inventoried and re-mapped as part of the South Zone Recreation Desired Future Condition project, it was documented that some of the Roaded Natural areas have trended toward Roaded Modified and Rural ROS conditions, and some Semi-primitive Motorized and Semi-primitive Non-Motorized areas have changed to Roaded Natural and Roaded Modified ROS classes. The net result of the landscape's becoming more uniform appearing, more roaded, and more managed is a loss of a spectrum of available recreation settings and opportunities across the South Zone, particularly the Semi-primitive Motorized and Semi-primitive Non-motorized ROS settings. Although very limited and becoming even more so, there are still areas that meet Semi-primitive Motorized and Semi-primitive Non-motorized ROS class requirements on the Tusayan Ranger District. The loss of Semi-primitive Motorized and Semi-primitive Non-motorized ROS areas is usually considered irreversible (Forest Service 2004).

Recent survey results indicated recreation users (visitors and local residents) to the Tusayan Ranger District participate in a wide variety of recreation activities in a broad spectrum of recreation settings. Survey results also indicated that users have a preference for pursing recreation experiences and activities in more natural-appearing landscapes, consistent with Primitive, Semi-primitive Non-motorized, Semi-primitive Motorized, and Roaded Natural ROS class settings. The survey results demonstrated a growing gap between recreation visitors' demand for more natural-appearing ROS class settings and the trend toward more managed-appearing ROS class conditions (Forest Service 2004).

Using the ROS as a basis for classifying existing recreation setting character conditions, the proposed withdrawal area contains combinations of five out of the six recreation environments shown in Figure 3.14-3 and described in Table 3.14-6. They range from areas that are primitive, have low use, and involve inconspicuous administration to rural areas near communities with higher use and a highly visible administrative presence. The wide variety of moderately regulated recreation settings in the proposed withdrawal area greatly enhances the quality of recreation experience and benefit outcomes for most visitors.

Table 3.14-6. Recreation Opportunity Spectrum within the Proposed Withdrawal Area

ROS	Total Acreage
Primitive	7601
Primitive−Pristine	25
Semi-primitive Non-motorized	109,934
Semi-primitive Motorized	590,849
Roaded Natural	285,398
Roaded Modified	12,789
Rural	2104
Urban	518
No ROS designation	65,217
Total	***1,074,953***

Sources: BLM (2009a); Forest Service (2009e).

NPS Backcountry Zoning System

The Grand Canyon National Park backcountry lands, which are outside the proposed withdrawal area, are divided into Use Areas based on established patterns of use and resource management considerations. Use Area boundaries are defined according to identifiable topographic features, such as ridge tops and drainages.

To better guide management actions in the backcountry and to provide an opportunity for a wide variety of backcountry experiences, each Use Area is classified into one of four Management Zones: Corridor, Threshold, Primitive, or Wild (see Figure 3.14-4). The zones provide different recreational opportunities and levels of resource protection. Use Areas on or accessed via the Kanab Plateau (North Parcel) and Marble Platform (East Parcel) are primarily zoned as Primitive.

3.14.5 Management Units

Management units are Geographic Areas (GAs) with similar resource management goals that are identified to better manage resources. The BLM and Forest Service are required to conduct projects consistent with management prescriptions developed for specific management units. Figure 3.14-5 shows the management units within the proposed withdrawal area.

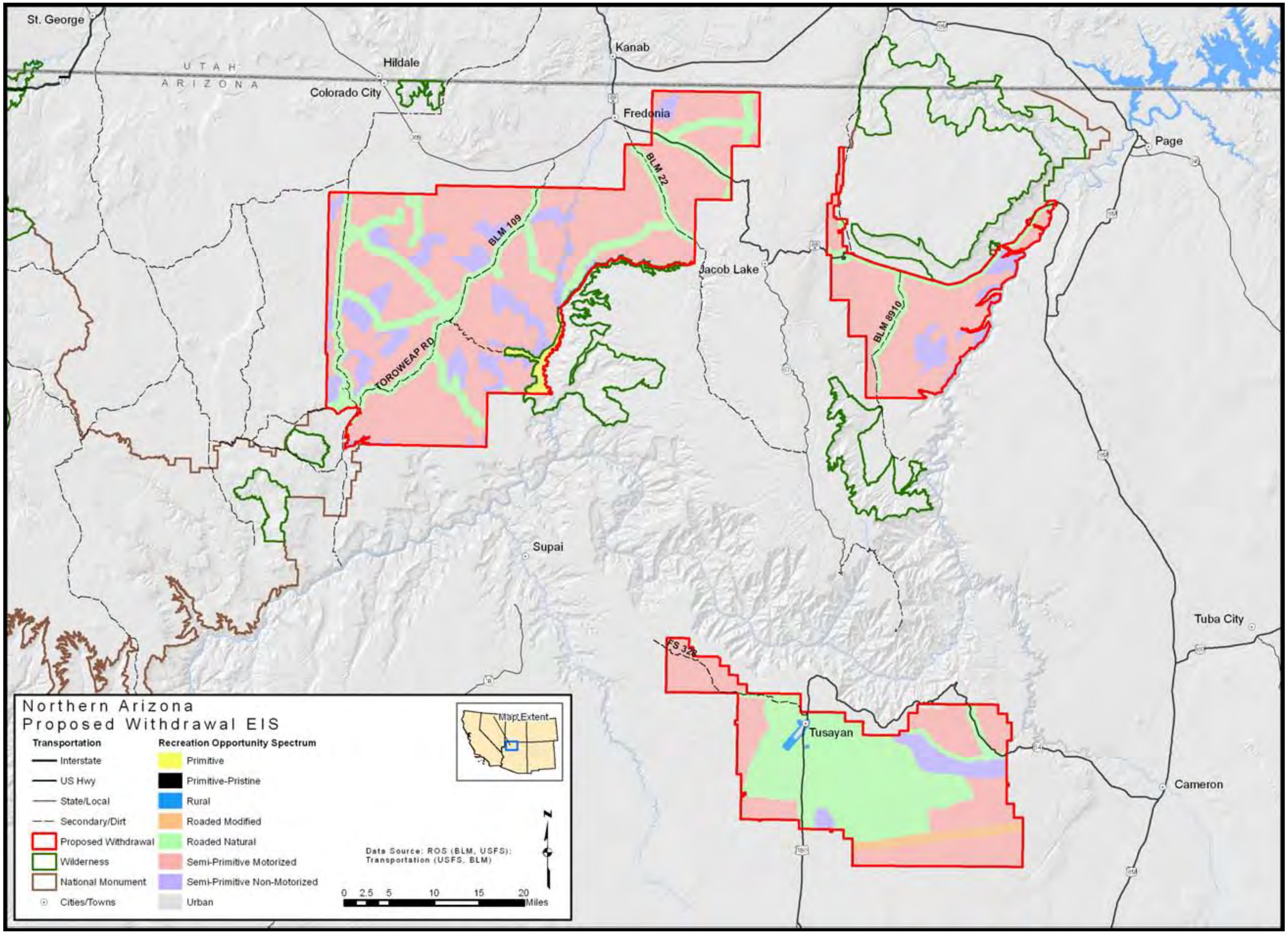


Figure 3.14-3. Recreation Opportunity Spectrum map.

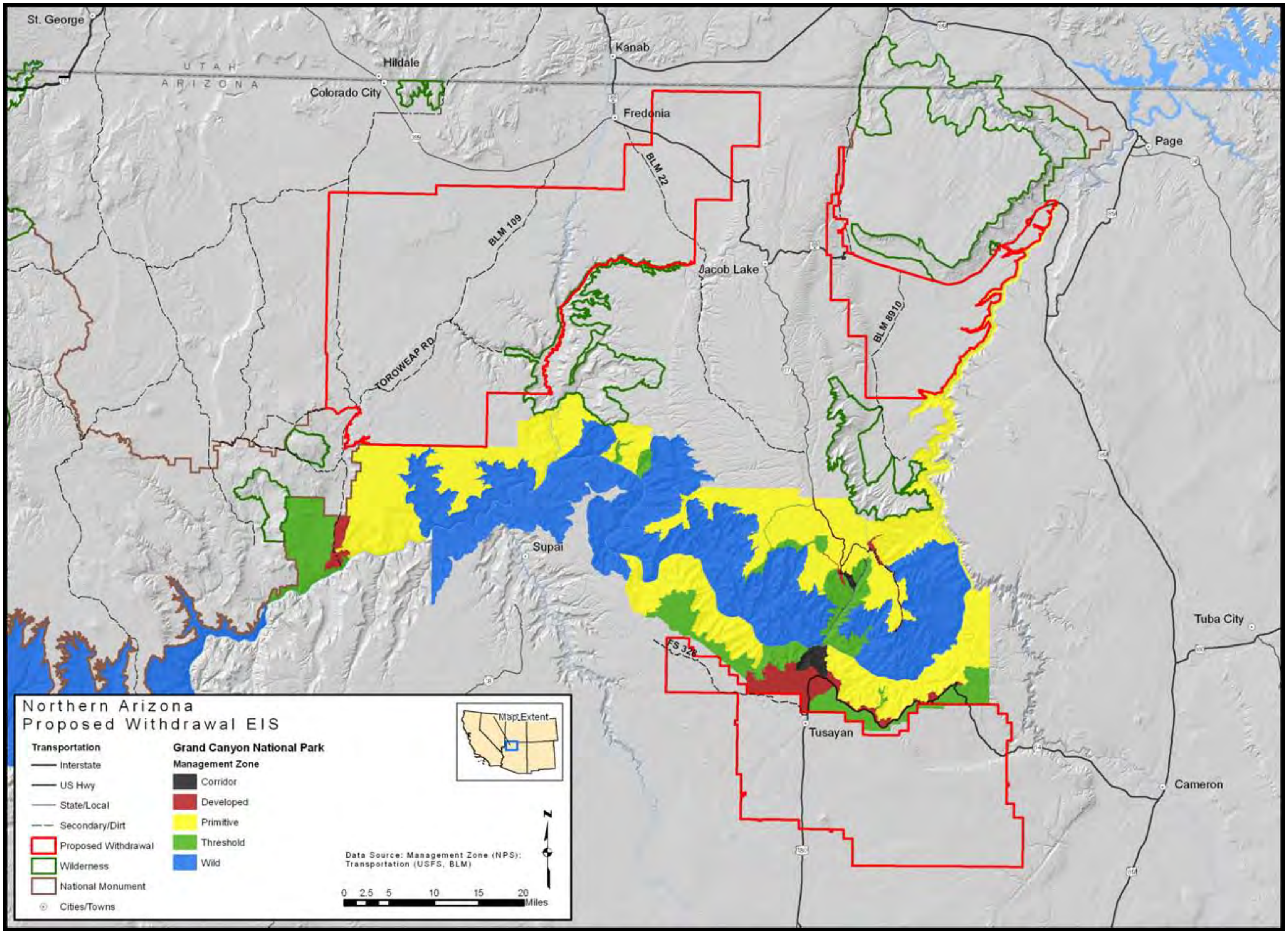


Figure 3.14-4. Park backcountry management zones map.

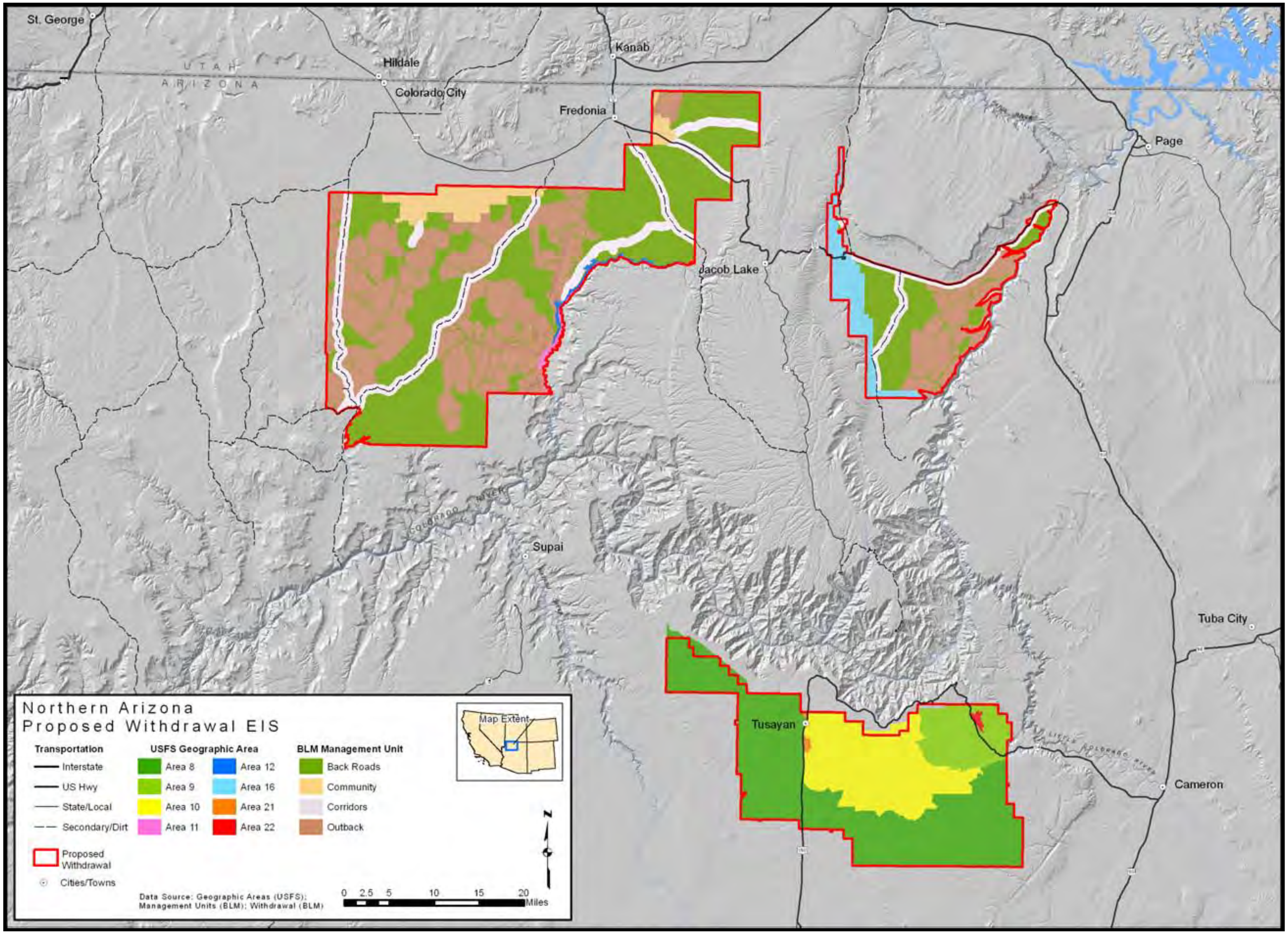


Figure 3.14-5. Management units within the proposed withdrawal area.

Bureau of Land Management Lands

The BLM uses four management unit categories (Community, Corridors, Back Roads, and Outback) to guide land use decisions and provide access into specific GAs with similar landscapes, resources, and resource uses (BLM 2008b). These four management unit types range from “close to home” opportunities to “more primitive” and “self-directed” opportunities.

COMMUNITY MANAGEMENT UNIT (RURAL TRAVEL MANAGEMENT AREA)

BLM-administered lands within the Community Management Unit provide opportunities for community growth and development. These lands also offer the widest variety of recreation opportunities and provide short-term or day-use recreation activities “close to home.” Lands within the Community Management Unit may also provide resources, such as fuelwood and mineral materials, access to permitted commercial and recreation activities, and scenic backdrops or settings for communities.

Portions of the North and East parcels are within the Community Management Unit (BLM 2008b). These areas are concentrated along the northern border of the Arizona Strip, primarily around the communities of Colorado City, Fredonia, and Marble Canyon.

CORRIDORS MANAGEMENT UNIT (BACKWAYS TRAVEL MANAGEMENT AREA)

Lands within the Corridors Management Unit occur along major travel routes, providing, among other things, access to the Back Roads and Outback management units. They offer a variety of recreation opportunities. These areas also provide access opportunities for short-term or day-use recreation activities related to vehicle touring. In the North Parcel, BLM Roads 5, 109, 22, and U.S. 89A are located within the Corridors Management Unit. In the East Parcel, BLM Road 8910 and U.S. 89A are located within the Corridors Management Unit.

BACK ROADS MANAGEMENT UNIT (SPECIALIZED TRAVEL MANAGEMENT AREA)

Lands identified within the Back Roads Management Unit are characterized by predominantly natural or natural-appearing environments of moderate to large size with moderate probabilities of experiencing isolation from the sights and sounds of other people. These natural-appearing landscapes and open spaces contribute to high-quality visitor experiences. While concentrations of users will be low, evidence of other user will be relatively high. These lands may also provide resources such as fuelwood and mineral materials. Portions of the North Parcel and the western and northeastern portions of the East Parcel are within the Back Roads Management Unit (BLM 2008b).

OUTBACK MANAGEMENT UNIT (PRIMITIVE TRAVEL MANAGEMENT AREA)

Lands within the Outback Management Unit provide opportunities for undeveloped, primitive, and self-directed recreation opportunities. Lands classified as within the Outback Management Unit are characterized by predominantly natural or natural-appearing environments of moderate to large size. The lowest level of landscape modifications is expected, compared with the other management units. Remote settings, natural landscapes, solitude, and opportunities for primitive recreation are minimally impacted by human activity. Portions of the North Parcel and the eastern portion of the East Parcel are within the Outback Management Unit (BLM 2008b).

Forest Service Lands

The Kaibab National Forest is divided into 11 discrete GAs. All the land within a given GA is managed under the same emphasis to ensure consistency, efficiency, and integration of management practices across the GA. In addition to GAs, the forest is also divided into Land Use Zones that contain additional or special direction within one or more GA. All GAs are managed to attain resource management objectives and contribute to bringing desired conditions into being. All desired conditions focus on conservation of the ecosystem and the human environment. The Forest Service lands within the proposed withdrawal area are located within GAs 8–12 and 16 and within Land Use Zones 20–22.

GEOGRAPHIC AREA 8—SOUTHERN TUSAYAN WOODLAND

Lands within GA 8 are situated across the southern portion of the South Parcel. The area contains sensitive travelways such as SR 64 and the Arizona National Scenic Trail, important scenic features such as the Red Butte proposed TCP, and recreation resources. The area is managed to maintain semi-primitive recreation opportunities. A major utility corridor crosses the southern portion of this GA. The area has high potential for uranium and low to moderate potential for oil and gas. Open grasslands are scattered throughout the area and provide important forage areas for livestock (Forest Service 1988).

GEOGRAPHIC AREA 9—UPPER BASIN

Lands within GA 9 are situated across the northeastern portion of the South Parcel. The area contains sensitive travel corridors, including SR 64, and scenic features such as the Coconino Rim escarpment. Recreation features include the Arizona National Scenic Trail, Grandview Lookout Tower, cross-country ski trails, and historic sites. The area is managed to maintain Semi-primitive recreation opportunities. Open grasslands are scattered throughout the area and provide important forage areas for livestock and big game. The area has moderate to high potential for uranium and low potential for oil and gas (Forest Service 1988).

GEOGRAPHIC AREA 10—TUSAYAN FORESTLAND

Lands within GA 10 are located in the central section of the South Parcel. Recreation use within the area is moderate, with several areas of concentrated use. Use consists mostly of dispersed camping, hunting, and sight-seeing. Most of the area is grazed by cattle from late spring until fall. The area has moderate potential for uranium and other minerals (Forest Service 1988).

GEOGRAPHIC AREA 12—WESTERN NORTH KAIBAB WOODLAND

GA 12 includes portions of the west, north, and east sides of the North Kaibab Ranger District of the Kaibab National Forest. A small strip of this GA is located along Kanab Creek and the eastern border within the eastern edge of the North Parcel. The area consists of moderate-use areas that occur along roads and access points overlooking the Grand Canyon. Several of these roads also lead to trailheads that provide access to Kanab Creek Wilderness and Grand Canyon National Park. The area is managed to maintain non-motorized recreation opportunities. Visually sensitive areas occur along U.S. 89A, Forest Road 422, the rim of the Grand Canyon, and several forest roads leading to points overlooking the Grand Canyon. Management activities in these areas are visually subordinate to the characteristic landscape. The area was removed from livestock grazing through a NEPA decision in 2001; the area has not been grazed by permitted livestock since the mid-1990s. The area has moderate to high potential for uranium; however, most of the area is closed to mineral entry and location, subject to valid existing claims (Forest Service 1988).

GEOGRAPHIC AREA SPECIAL AREA 11—KANAB CREEK WILDERNESS

Lands within GA 11 include the Kanab Creek Wilderness, located in the western part of the North Kaibab Ranger District of the Kaibab National Forest. The portion of Hack Canyon that is managed by the Forest Service, in the eastern portion of the North Parcel, is located within this GA. Use of this wilderness is low and is concentrated in Kanab Creek and Snake Gulch and along the trail system, which links the area to adjacent lands of Grand Canyon National Park. The area is managed for the VQOs of preservation background. The area has moderate to high potential for uranium and other minerals; however, the Arizona Wilderness Act of 1984 withdrew the area to mineral entry and location, subject to valid existing rights (Forest Service 1988).

GEOGRAPHIC AREA 16—EASTERN NORTH KAIBAB WOODLAND

Lands within GA 16 include the Buffalo Ranch and the extreme east side of the North Kaibab Ranger District of the Kaibab National Forest. The western portion of the East Parcel is located within this GA. Recreation use within the area is low; however, the Forest Service will provide extensive management of recreation, visual, and heritage resources. The area is grazed by cattle and bison. The area has moderate potential for uranium and other minerals (Forest Service 1988).

LAND USE ZONE 21—EXISTING DEVELOPED RECREATION SITES

This management area includes 15 major existing public- and private-sector developed recreation sites and other small sites, including trailheads and interpretive sites on the Kaibab National Forest. Two existing developed recreation sites are located in the South Parcel. All existing developed recreation sites are withdrawn to mineral entry under the mining laws. The VQO of partial retention for developed recreation sites allows management activities that remain visually subordinate to the characteristic landscape. Roads accessing developed recreation sites are maintained at Level 4 or higher (Forest Service 1988).

LAND USE ZONE 22—PROPOSED DEVELOPED RECREATION SITES

This management area includes areas that have been proposed to be developed into recreation sites. One proposed developed recreation site in the South Parcel is located along SR 64 in the northeastern portion of the parcel. Proposed recreation sites are open to mineral entry; however, it appears that none of the sites involve lands known to contain valuable mineral resources. The ultimate location of a proposed developed recreation site is generally based on a combination of desirable attributes of a given area. These sites are managed for the VQO of partial retention of foreground (Forest Service 1988).

3.14.6 Resource Condition Indicators

For recreation resources, condition indicators include visitor use by activity (primitive, dispersed recreation versus developed, motorized-based recreation); acres within the ROS designations; desired recreation experiences; and the miles, acres, or number of recreation sites that are currently designated in the proposed withdrawal area.

3.15 SOCIAL CONDITIONS

3.15.1 Overview

The study area for this analysis includes the counties most likely to be affected by the proposed withdrawal. In Arizona, these are Coconino and Mohave counties, and in Utah these are Kane, San Juan, and Washington counties. Prominent cities and towns within these counties include Flagstaff, Page, Tuba City, Cameron, Gap (chapters within the Navajo Nation), Fredonia, and Colorado City in Arizona and Kanab, Blanding, Big Water, Hildale, and St. George in Utah (Figure 3.15-1).

This five-county socioeconomics study area covers more than 46,000 square miles in northern Arizona and southern Utah. Federal (BLM, Forest Service, and NPS) lands, specifically the Arizona Strip, Kaibab National Forest, and Grand Canyon National Park dominate the landscape in the region. Other than a handful of towns and cities in each county, the study area is relatively remote and sparsely populated. Population centers in Coconino and Mohave counties are generally located south of the proposed withdrawal parcels. With the exception of tribal communities located along tribal routes and St. George, Utah (located along I-15), communities in the area tend to be located far from major transportation corridors and industrial centers, and in general the small towns and communities within the counties have maintained their rural character.

Communities profiled in this section were methodically selected for analysis based on two criteria: 1) they are located within 50 linear miles of the boundary of the proposed withdrawal parcels; and 2) they are communities for which there are Census Bureau data (Table 3.15-1).

Availability of data is an important component in describing study area communities. The methodology described above and definition of selected communities to profile are intended to provide a snapshot of the demographic characteristics of the area for which data exist. Please note that Kayenta, Arizona, and Blanding, Utah, are outside the 50-mile-radius study area. Blanding, Utah, is discussed specifically because it is the major uranium processing center in the region (White Mesa Uranium Mill). Kayenta, Arizona, is included because mining haul traffic would likely travel through Kayenta en route to Blanding. Although Kayenta and Blanding are outside the 50-mile-radius study area, both communities are included in the social characteristics discussion to provide a complete snapshot of the demographic characteristics of the region.

American Indians who live within the study area reside predominantly in Coconino County and form part of the Navajo Nation, Hopi Tribe, Hualapai Tribe, Havasupai Indian Reservation, and Kaibab Band of Paiutes. Some of the Navajo Nation chapters (chapters are local government subdivisions, or communities) in the area include Cameron, Bodaway, Tuba City, and LeChee. Hopi chapters in Coconino County include Moenkopi and West Dinnebito. Although these tribes are composed of smaller chapters, the tribal demographic information is discussed for the overall tribe, not for the individual communities and chapters within each tribe.

Area Communities

Local community and residents value access to federal lands and resources for a variety of reasons, “whether for earning a living, traditional and subsistence uses such as personal woodcutting, or for recreating” (BLM 2005b:43). Communities located close to lands such as the Grand Canyon, Kaibab National Forest, and BLM lands (including national monuments) also have economies that are tied to these lands. Residents from elsewhere visit and/or relocate to these areas for what may be perceived to be a better quality of life attributable to the rural nature of communities in the study area, as well as potential recreation opportunities such as OHV use, big-game hunting, hiking/walking/running, backpacking,

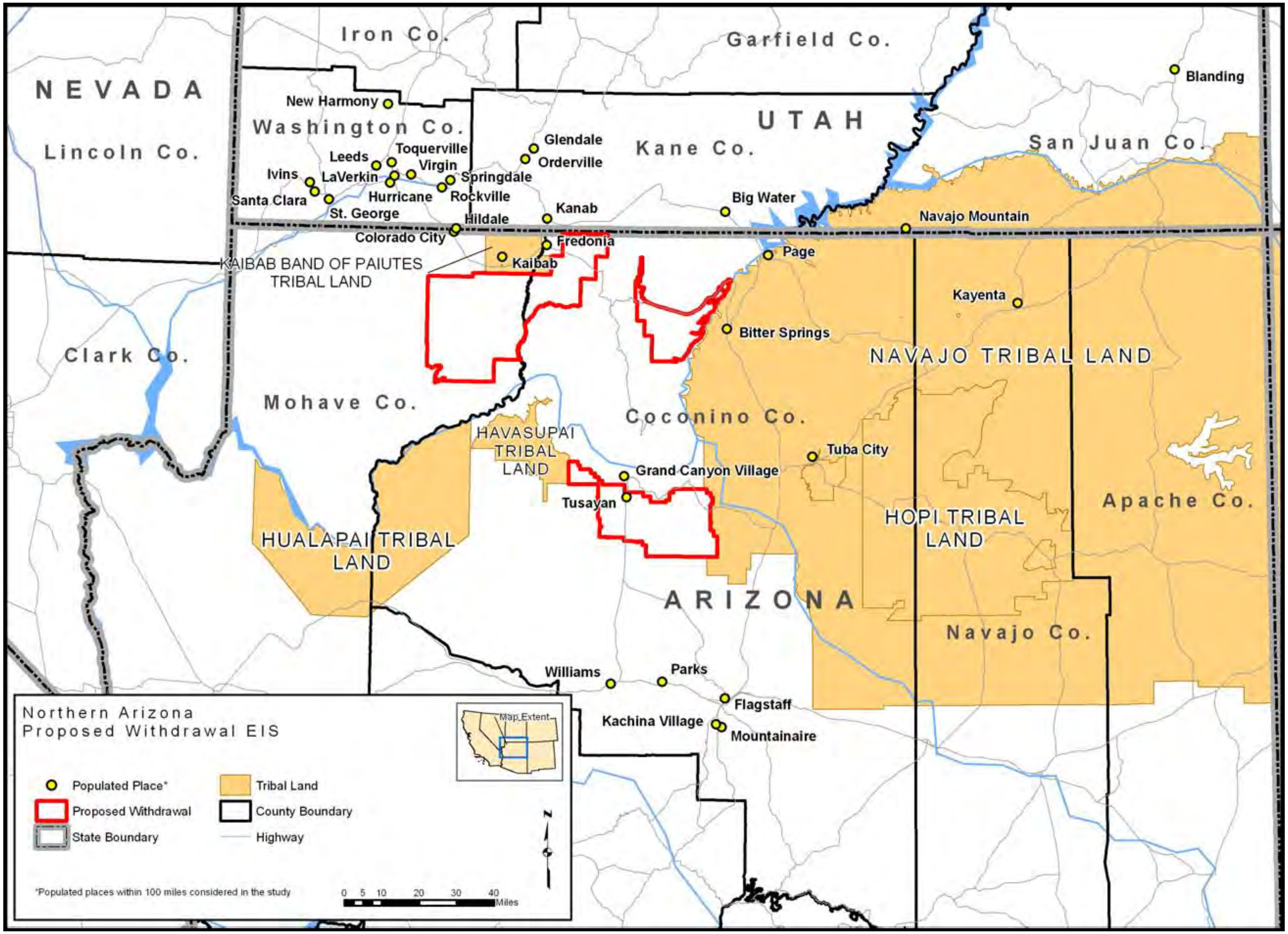


Figure 3.15-1. Population centers in the vicinity of the proposed withdrawal area.

and viewing opportunities. This, in turn, generates more money, which is directed to local, regional, and state economies. Thus, there are economic benefits from tourist activity, as well as potential economic benefits associated with communities that can provide workers and derive other economic benefits from mineral exploration and development on study area federal lands.

Table 3.15-1. List of Counties and Communities Considered for this Study

County	Populated Place	Straight Distance from nearest Proposed Withdrawal Parcel (miles)	Driving Distance from nearest Withdrawal Parcel (miles)	Nearest Proposed Withdrawal Parcel	Incorporated
Arizona					
Coconino	Tuba City	29.0	45.0	South	
	Tusayan Census designated place (CDP)	0.00	0	South	×
	Grand Canyon Village CDP	2.32	5	South	
	Fredonia	3.15	5	North	×
	Bitter Springs CDP	5.63	15	East	
	Page	11.97	42	East	×
	Havasupai Indian Reservation	12.55	0	North	
	Parks CDP	33.37	51	South	
	Williams	35.31	41	South	×
	Flagstaff	37.77	62	South	×
	Kachina Village CDP	44.67	71	South	
	Mountainaire CDP	45.50	71	South	
	Navajo Nation	0.00	0	South, East	
	Hopi Reservation	25.22	45	South	
Mohave	Kaibab Band of Paiutes*	0	0	North	
	Kaibab CDP	4.46	5	North	
	Hualapai Tribe[†]	9.6	122	North	
	Colorado City	11.92	20	North	×
Navajo	Kayenta[§]	47.15	138	North	
Utah					
Kane	Kanab	5.75	12	North	×
	Big Water	18.13	55	East	×
	Orderville	22.22	33	North	
	Glendale	23.97	38	North	
San Juan	Navajo Mountain CDP	48.75	130	East	
	Blanding[‡]	131.00	230	East	×
Washington	Hildale	12.75	23	East	×
	Rockville	23.71	58	North	
	Springdale	25.45	55	North	
	Hurricane	26.91	45	North	
	Virgin	27.43	53	North	
	La Verkin	28.15	47	North	
	Toquerville	31.82	50	North	
	Leeds	32.48	57	North	

Table 3.15-1. List of Counties and Communities Considered for this Study (Continued)

County	Populated Place	Straight Distance from nearest Proposed Withdrawal Parcel (miles)	Driving Distance from nearest Withdrawal Parcel (miles)	Nearest Proposed Withdrawal Parcel	Incorporated
Utah, continued					
Washington	St. George	33.48	63	North	×
	Santa Clara	37.78	70	North	
	Ivins	40.35	70	North	
	New Harmony	47.15	73	North	

* The Kaibab Indian Reservation is located within Mohave and Coconino counties.

† The Hualapai Tribe is located within Mohave and Coconino counties.

‡ Blanding is not within the distance-defined study area; however, it is included in this study because of the uranium mill and associated economic activity.

§ Kayenta is discussed in Section 3.15 but included in the economic discussion in Section 3.16.

Many area communities that have access to federal lands (such as BLM, Forest Service, and NPS lands) have strong ties to these lands; residents can form a strong sense of identity based on the cultural and geographic nature of the area. Communities like St. George, Colorado City, Fredonia, Page, and Williams exist in relative isolation, whereas communities like Flagstaff have more of a tourism focus and are close to, and benefit more directly from, each area's unique resources.

Population and other demographic data for communities in the study area are presented below in Section 3.15.1.

Demographics

Population data were obtained from the Census Bureau, ADOC, and the State of Utah Governor's Office of Planning and Budget. Table 3.15-2 summarizes historical and projected populations within the study area.

ARIZONA

Estimates from Census Bureau data and ADOC indicate considerable growth in Arizona over the past 20 years. In 1990, Arizona had a population of 3,665,228, which increased by 40% to 5,130,632 by 2000 (ADOC 2009e). From 2000 to 2008, the state saw a more modest population increase of 26.7% (see Table 3.15-2). Projections for the state between 2010 and 2050 predict dramatic growth, with an 83.3% growth rate.

The Coconino County population in 2000 was 116,320, up 20.4% from 96,591 in 1990. Population continued to increase with a total population of 128,558 in 2008 (Census Bureau 2008b). From 2010 to 2020, population projections could increase by 12.7%, with an average annual growth rate of 1.3% (ADOC 2009b). Within Coconino County, Kachina Village had the most growth between 1990 and 2008, at 103.0%. In that period, Flagstaff's total population also increased by over 40%. Fredonia and Grand Canyon Village experienced negative growth rates. On the Navajo Nation, population in Tuba City grew 12.32% between 1990 and 2000 and is expected to continue growing from 2010–2040, with a 20.03% increase (see Table 3.15-1).

Table 3.15-2. Historical and Projected Population within the Study Area

Location	Population 1990*	Population 2000†	Population 2008‡	Total Change in Population (%)1990–2000	Total Change in Population (%)2000–2008	Total Change in Population (%)1990–2008	Projected Population 2010‡	Projected Population 2020‡	Projected Population 2030‡	Projected Population 2040‡	% of 2000 Population, American Indian
U.S.	248,709,873	281,421,906	304,059,724	13.2%	8.0%	22.3%	308,936§	335,805§	363,584§	391,946§	0.9%
Arizona	3,665,228	5,130,632	6,500,180	40.0%	26.7%	77.3%	6,999,810	8,779,567	10,347,543	11,693,553	5.0%
Coconino County	96,591	116,320	128,558	20.4%	10.5%	33.1%	141,457	159,345	173,829	186,871	28.5%
Bitter Springs	NP	547	1,059	NR	93.6%	NR	1,162	1,600	1,954	2,273	98.7%
Flagstaff	45,857	52,894	64,692	15.3%	22.3%	41.1%	66,879	76,199	83,746	90,541	10.0%
Fredonia	1,207	1,036	1,145	−14.2%	10.5%	−5.1%	1,167	1,260	1,335	1,403	11.4%
Grand Canyon Village	1,499	1,460	1,460	−2.6%	0%	−2.6%	1,460	1,460	1,460	1,460	18.8%
Havasupai Indian Reservation	NR	503	NR	NR	NR	NR	NR	NR	NR	NR	90.1%
Hopi Tribe	NR	1,134	NR	NR	NR	NR	NR	NR	NR	NR	97.3%
Kachina Village	1,711	2,664	3,474	55.7%	30.4%	103.0%	3,636	4,328	4,888	5,392	4.3%
Mountainaire	NP	1,014	1,278	NR	26.0%	NR	1,331	1,556	1,738	1,902	7.7%
Navajo Nation¶	NR	23,216	NR	NR	NR	NR	NR	NR	NR	NR	95.8%
Tuba City	7,323	8,225	NR	12.32%	NR	NR	9,251	9,981	10,572	11,104	92.0%
Page	6,598	6,809	7,253	3.2%	6.5%	9.9%	7,341	7,720	8,027	8,303	26.7%
Parks	NP	1,137	1,661	NR	46.1%	NR	1,766	2,213	2,575	2,901	0.7%
Tusayan	NP	562	616	NR	9.6%	NR	627	673	711	745	15.8%
Williams	2,532	2,842	3,289	12.2%	15.7%	29.9%	3,378	3,759	4,068	4,346	1.7%
Mohave County	93,497	155,032	196,281	65.8%	26.1%	109.9%	221,443	281,668	330,581	367,952	2.4%
Kaibab Band of Paiutes	NR	212	218	NR	2.83%	NR	242	261	276	289	66.8%
Kaibab (Census Designated Place)	NP	275	290	NP	5.5%	NR	294	316	334	348	52.7%
Hualapai Tribe	1,532	1,353	1,836	-11.68%	35.70%	19.84%	1,955	2,503	2,948	3,289	92.6%
Colorado City	2,426	3,334	4,540	37.4%	36.2%	87.1%	4,835	6,196	7,302	8,147	0%
Navajo County	77,658	97,470	112,975	25.51%	15.91%	45.48%	123,172	147,045	165,647	180,054	47.7%
Kayenta	4,372	4,922	NR	12.58%	NR	NR	5,369	5,784	6,107	6,358	91.7%

Table 3.15-2. Historical and Projected Population within the Study Area (Continued)

Location	Population 1990*	Population 2000†	Population 2008‡	Total Change in Population (%)1990–2000	Total Change in Population (%)2000–2008	Total Change in Population (%)1990–2008	Projected Population 2010‡	Projected Population 2020‡	Projected Population 2030‡	Projected Population 2040‡	% of 2000 Population, American Indian
Utah	1,722,850	2,233,169	2,736,424	29.6%	22.5%	58.8%	2.927,643	3,652,547	4,387,831	5,171,391	1.3%
Kane County	5,169	6,046	6,577	17.0%	8.8%	27.2%	6,893	8,746	10,394	12,034	1.6%
Big Water	326	417	NR	27.9%	NR	NR	452	573	680	788	2.9%
Glendale	282	355	NR	25.9%	NR	NR	384	488	578	669	0.6%
Kanab	3,289	3,564	NR	8.4%	NR	NR	4,111	5,216	6,198	7,177	1.0%
Orderville	422	596	NR	41.2%	NR	NR	664	841	998	1,156	0.5%
San Juan County	12,621	14,413	15,055	14.2%	4.5%	19.3%	15,053	15,319	16,653	18,051	55.7%
Blanding	3,162	3,162	NR	0%	NR	NR	3,257	3,314	3,604	3,908	28.9%
Navajo Mountain	NP	379	NR	NR	NR	NR	NR	NR	NR	NR	96.8%
Washington County	48,560	90,354	137,589	86.1%	52.3%	183.3%	168,078	279,864	415,510	559,670	1.5%
Hildale	1,325	1,895	NR	43.0%	NR	NR	2,430	4,058	6,008	8,092	0.5%
Hurricane	3,915	8,250	NR	110.7%	NR	NR	16,381	27,287	40,512	54,568	1.0%
Ivins	1,630	4,450	NR	173.0%	NR	NR	10,477	17,436	25,886	34,867	1.2%
La Verkin	1,771	3,392	NR	91.5%	NR	NR	5,162	8,592	12,756	17,182	1.3%
Leeds	254	547	NR	115.3%	NR	NR	980	1,623	2,410	3,246	0.7%
New Harmony	101	190	NR	88.1%	NR	NR	241	392	595	801	0.5%
Rockville	182	247	NR	35.7%	NR	NR	319	532	789	1,063	0%
Santa Clara	2,322	4,630	NR	99.4%	NR	NR	9,325	15,532	23,061	31,062	0.3%
Springdale	275	457	NR	66.2%	NR	NR	687	924	1,163	1,399	1.8%
St. George	28,502	49,663	77,352	74.2%	55.8%	171.4%	84,245	140,268	208,254	280,507	1.6%
Toquerville	488	910	NR	86.5%	NR	NR	1,514	2,519	3,742	5,040	0.9%
Virgin	229	394	NR	72.1%	NR	NR	634	1,063	1,566	2,109	0.5%

Notes: NP = no projection available at this geographic level; NR = not reported; – = not calculated due to lack of information.
[*] Source: Census Bureau (1990).
[†] Source: Census Bureau (2000).
[‡] Sources: ADOC (2009e); Governor's Office of Planning and Budget (2010a).
[§] U.S. projected population written in thousands.
[¶] Navajo Nation Chapters within the study area were combined for the total Navajo Nation population in Coconino County.

In 2000, the Mohave County population was 155,032, up from 93,497 in 1990. Within that decade, population increased by 65.8%. In 2008, population figures continued to grow, with a total population of 196,281. Within Mohave County, Colorado City experienced increases in total population of 87.1% between 1990 and 2008. Overall, population forecasts continue to show an upward trend. From 2010 to 2020, Mohave County's population is projected to increase by 27.2%, with an average annual growth rate of 2.7% (ADOC 2009c).

Population in Navajo County increased by 25.51% between 1990 and 2000, and by 15.91% between 2000 and 2008. Overall, population increased by 45.48% over the 18-year period between 1990 and 2008. Within Navajo County, Kayenta experienced a 12.58% growth in population between 1990 and 2000 (see Table 3.15-1). Population is projected to continue growing through 2040; Navajo County is anticipated to increase by another 46.18% between 2010 and 2040, while Kayenta's growth could increase by an additional 18.42% for the same period (ADOC 2009f).

UTAH

From 1990 to 2000, Utah's population increased by 29.6%, with a similar increase of 22.5% between 2000 and 2008. Between 1990 and 2008, Utah experienced a growth increase of 58.8% and is expected to continue growing. Predicted population growth for Utah is even more dramatic than for Arizona, with a projected 104% increase between 2010 and 2050.

In 1990, Kane County had a population of 5,169, growing by 17.0% in 2000 to a population of 6,046. In 2008, the county had a total population of 6,577, an increase of 8.8% from 2000. Kane County's population is anticipated to continue growing. From 2010 to 2020, population projections show an increase of 26.9%, with an average annual growth rate of 2.7% (Governor's Office of Planning and Budget 2010b). From 1990 to 2000, Big Water and Kanab saw a population increase of 27.9% and 8.4%, respectively.

In 2000, San Juan County had a population of 14,413, up from 12,621 in 1990. In this period, population grew by 14.2%. From 2010 to 2020, San Juan County is projected to grow very little, with an expected increase of 1.8% and an average annual growth rate of 0.16% (Governor's Office of Planning and Budget 2010b). From 1990 to 2000, the population of Blanding remained consistent, at 3,162, and experienced zero growth. Data for 2008 were not available. In 1990, Navajo Mountain was not included in the Census, so data are available only for 2000. Data for 2008 were not available.

Within the economic study area for the proposed withdrawal, Washington County has experienced the most growth and is expected to continue growing. In 2000, the total population was 90,354, up by 86.1% from 48,560 in 1990. In 2008, the total population was 137,589. From 2010 to 2020, Washington County's population is projected to increase by 66.5%, with an average annual growth rate of 6.7% (Governor's Office of Planning and Budget 2010b). It is likely that Washington County's high growth rate may be the result of the high growth rate of St. George. From 1990 to 2000, Hildale had a total population increase of 43.0%, while St. George increased by 74.2%. According to the St. George Chamber of Commerce, the high growth rate in St. George may be attributable to mild temperatures, recreation and scenic opportunities, and potential for business development (St. George Chamber of Commerce 2010). Other communities in Washington County also experienced growth rates higher than 85% between 1990 and 2000, including Hurricane, Ivins, La Verkin, Leeds, New Harmony, Santa Clara, and Toquerville. Data for 2008 were not available.

Stakeholder Values

In general, there are two basic perspectives on mineral exploration and development on the Arizona Strip and the Kaibab National Forest: people who support continued mineral exploration and development, and people who would prefer that mineral exploration and development not continue. Many different stakeholders have expressed an interest in the proposed mineral withdrawal because they support the withdrawal, or do not, or they fall somewhere along a spectrum between the two perspectives. Also, there are varying perspectives within different groups; for instance, many American Indians value the mineral exploration and development for the economic benefits (i.e., employment, see “Mineral Activity Support” discussion below), while other tribal members are influenced by negative experiences associated with uranium mining in the past (see “Withdrawal Support” discussion below). In summary, there are varying interests between individuals and groups who support mineral exploration and development and those who support withdrawal.

Stakeholders include American Indian tribes, local governments, area communities, mining companies, recreationists, and environmental and preservation groups, to name a few.

In many people’s minds, the proposed withdrawal area cannot be separated from the Grand Canyon itself. In fact, people often have such a strong sense of place attached to the Grand Canyon, even if they have never visited it, that potential changes to land management on the Arizona Strip and Kaibab National Forest could have important impacts to people’s quality of life related to the Grand Canyon. The Grand Canyon, along with the Kaibab National Forest and the BLM lands that form the withdrawal parcels, serve as important places of recreation for a variety of stakeholders. The Grand Canyon is a cultural and natural icon for Americans; however, not everyone goes to the Grand Canyon to “see” the same canyon.

Because the Grand Canyon and the surrounding area represent a unique place in the Southwest landscape, people’s values, beliefs, and attitudes are shaped by each individual’s “sense of place” of the area. A variety of factors will influence how people view the Grand Canyon, resulting in differing perspectives, whether the individual is a local resident, or national or international visitor. For this proposed withdrawal, more than 80,000 scoping comments from nearly every state in the United States and from more than 90 countries were submitted; this high level of national and international interest illustrates the importance of the Grand Canyon to people within Arizona, as well as across the United States and internationally.

Alternatively, many local residents (particularly those who live in Kane and Washington counties, Utah) do not necessarily associate the proposed withdrawal parcels with the Grand Canyon. Many families have lived in the area for several generations and have strong connections to the land for earning a living and traditional and subsistence uses. Many residents of the communities surrounding the North Parcel are descendents of the Mormon pioneers who settled the area in the 1860s. These people still have strong connections to the land. Access to public land and resources, whether for earning a living, traditional and subsistence uses such as personal woodcutting, or for recreating, is very important to the local people.

Clearly many people, especially local residents, may be linked to public lands in multiple and overlapping ways. The nature of people’s linkages strongly influences their values and attitudes toward public lands, and their social and cultural relationships to the land and to other people. These relationships are much more nuanced than any numbers in a social and economic profile can convey. They involve sentiments and emotions, attachments to specific special places, and beliefs and traditions developed through contact with public lands.

The following discussion presents some general ideas on how perspectives are developed and what they are related to, although there are likely to be any number of reasons people support the withdrawal or oppose it, or some variation in between. This discussion is not intended to be exhaustive but rather to present an overview of potential stakeholder values related to the proposed withdrawal.

MINERAL ACTIVITY SUPPORT

Many people, area communities, and local governments would benefit economically from continued or increased mineral exploration and development within the proposed withdrawal area. Mineral exploration and development can provide jobs, increase labor income, and provide tax revenue to local communities and the state, either directly from mining-related jobs, or indirectly from related businesses, construction purchases, etc.

States such as Arizona and Utah benefit from the proximity of a vast array of federal lands by providing economic benefits ranging from recreation opportunities to mineral exploration and development. State and local governments have long viewed these federal lands as being detrimental to the economic health of their communities because of lost property tax revenues; thus, mineral exploration and development and the benefits of this activity can offset lost property tax revenue.

Mineral development also creates new roads, which many recreationists support as these roads open access to area lands that have been previously inaccessible to vehicles. Recreationists enjoy increased access for sight-seeing, leisurely driving, OHV use, etc.

WITHDRAWAL SUPPORT

Regardless of current changes in mining technology, many people do not embrace mineral exploration and development because they are concerned that continued or increasing mineral exploration and development could impact their quality of life since they benefit economically, scientifically, spiritually, or emotionally, or otherwise from area lands being preserved.

Many people would like to see the proposed withdrawal lands removed from mineral exploration and development because they prefer the solitude they can experience, to see the area landscape and views preserved, the scientific value of the area to be preserved, etc. Each person with some attachment to the proposed withdrawal area has a different reason for their opinions and feelings regarding area lands and mineral exploration and development on these lands.

Some recreationists enjoy the remote and relatively undeveloped character of the area and seek out and expect solitude and semi-primitive recreation experiences when visiting the Grand Canyon region. These types of recreationists, unlike those discussed under “Mineral Activity Support” above, likely prefer that there is less access to area lands, less transformation of the landscape, etc.

For American Indians, in particular, past experiences with health problems from working in mines, radiation contamination from dust and debris, the processing of ore on the reservations, and the spillage of radioactive materials into water systems have all affected how people view uranium mining. For example, the Navajo have been deeply affected by the mining of uranium on Navajo Nation lands and land bordering the Navajo Nation. From the 1940s through the 1970s, several uranium mines were set up on Navajo lands (Brugge and Goble 2002). These mines were welcomed as sources of employment for men in an area with very little employment. However, Navajo and non-Navajo miners worked in unsafe conditions with no protective gear against contamination and were not informed about the danger of radiation. Many Navajo miners later developed lung cancer or other ailments. Families of miners were affected through contaminated clothing or water (Johansen 1997). Other incidents also directly affected the Navajo; in 1979, a dam near Church Rock, New Mexico, that contained tailings and radioactive water burst and spilled 1,100 tons of tailings and millions of gallons of radioactive water in the Rio Puerco (Johansen 1997). The spill contaminated the drinking water for Navajos and their livestock, and clean-up efforts and public notification were inadequate. These types of experiences and the long-term environmental and health effects influence how all uranium mining is viewed by American Indians, regardless of the technology used or current best management practices (BMPs) for mining.

American Indian groups, such as the Havasupai, Hualapai, Hopi, Navajo, Zuni, and Southern Paiute, view the Grand Canyon, Arizona Strip, and Kaibab National Forest as integral to their culture. American Indians in the region descend from these six tribes and have long inhabited the region. Many of these groups see the area as part of their homeland. The Grand Canyon itself serves as a focal point for many of these homelands and in some cases as the actual point of origin for a people. American Indians feel a deep connection to their homeland. The land is a physical manifestation of their history and is alive; therefore, most American Indians feel that the Grand Canyon and the surrounding areas are sacred land. A detailed discussion of American Indian perspectives on the Grand Canyon can be found in Section 3.12 of this EIS.

Public Health and Safety

Public health aspects of uranium mining for this EIS are considered in terms of potential effects that would result at mines (from natural uranium ore); potential health effects at the mills or other off-site processing centers (from concentrated or depleted uranium) are not considered here. Uranium is a naturally occurring element that is also radioactive; its toxicity to humans varies according to its chemical form and route of exposure. Generally, exposure to uranium can be harmful in some manner via inhalation, ingestion, or skin exposure. It is important to note that nationwide, people are exposed to an average of about 300 millirems per year (mrem/yr) of natural background radiation (National Council on Radiation Protection and Measurements 1987). Table 3.15-3 presents a summary of natural background radiation doses reported by the U.S. Department of Energy (2007) for the nation and the Blanding area.

Table 3.15-3. U.S. and Blanding Area Natural Background Radiation Doses

Radiation Source	U.S. Average Natural Background Radiation Dose (mrem/yr)	Blanding Area Natural Background Radiation Dose (mrem/yr)
Cosmic and cosmogenic radioactivity	28	68
Terrestrial radioactivity	28	74
Internal radioactivity	40	40
Inhaled radioactivity	200	260
Total	**300**	**440**

Source: U.S. Department of Energy (2007).

HEALTH RISKS

All mine operations are required to comply with stringent safety and health standards administered by the 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 mineral exploration and development would require the necessary MSHA mine permits and an MSHA-approved miner training plan, escape and evacuation plan, and ventilation plan.

The discussion of potential health risks associated with uranium mining that follows is based primarily on a 1999 report on the chemistry and toxicological effects of natural and depleted uranium (Craft et al. 2004), a report from the Agency for Toxic Substances and Disease Registry (1999), and from Technical Fact Sheets on Radionuclides (Argonne National Laboratory 2005; EPA 2000, 2010m).

Cancer

Radioactive material (thus, uranium) can be a cause of cancer. Scientists have never detected harmful radiation effects from low levels of natural uranium, although some harmful effects may be possible. Exposure to uranium can be harmful and carcinogenic under any one of three conditions: inhalation of, ingestion of, or skin exposure to uranium. Inhalation exposure to uranium can cause potentially harmful health effects from both chemical and radioactive exposure, especially if the exposure is over a long period. Potentially harmful health effects from ingested or skin exposure to natural and depleted uranium appear to be solely chemical in nature, not radiological. Inhalation, ingestion or skin exposure to uranium could result from exposure at the mines on site, as well as exposing miner's families to uranium if material is carried home on worker's skin, hair, or clothing. The practice of not wearing protective clothing or taking unwashed clothing home was more common prior to creation of MSHA in the 1970s. Each mine imposes safety mechanisms designed to reduce on-site and off-site exposure, such as wearing protective clothing and gear, and removing this clothing or gear before leaving the mine site, taking a shower, etc. Additionally, per MSHA [30 CFR 75.1712], operators are required to provide adequate facilities for miners to change from the clothes worn underground, to provide for the storing of such clothes from shift to shift, and to provide sanitary and bathing facilities.

Natural and/or depleted uranium are only weakly radioactive and are not likely to cause cancer from radiation; no human cancer has been documented as a result of exposure to natural or depleted uranium (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010). Depleted uranium is a byproduct of uranium enrichment and processing.

However, uranium can decay into other radionuclides, which can cause cancer if the exposure is great enough and for a long enough period. Doctors who studied lung and other cancers in uranium miners did not find a link to uranium radiation's being the cause of these cancers. The miners smoked cigarettes and were exposed to other substances that are known to cause cancer, and the observed lung cancers were attributed to large exposures to radon and its radioactive transformation products (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Ionizing Radiation

Ionizing radiation is derived from radioactive materials and is a result of the radioactive decay of uranium. Research conducted through Biological Effects of Ionizing Radiation (BEIR) Series VII (BEIR 2006), indicates that risk of developing cancer is related to the dose of the radiation and that any dose would increase this risk. In other words, the dose does not have to reach a specific level before it can cause increased risk—just increasing exposure increases the risk. Similarly, reports from the World Health Organization (2010) state that lung tissue damage is possible after inhalation of uranium, leading to a risk of lung cancer that increases with increasing radiation dose.

However, it is important to note that while risk increases, because depleted uranium is only weakly radioactive, very large amounts of dust (on the order of grams) would have to be inhaled for the additional risk of lung cancer to be detectable in an exposed group.

BEIR (2006:267) states, "Risk may depend on the type of cancer, the magnitude of the dose, the quality of the radiation, the dose-rate, the age and sex of the person exposed, exposure to other carcinogens such as tobacco, and other characteristics of the exposed individual. Despite the abundance of epidemiologic and experimental data on the health effects of exposure to radiation, data are not adequate to quantify these dependencies precisely." BEIR (2006) developed their risk model based on types and levels of radiation different from that seen with uranium, making it difficult to extrapolate their results to a prediction of radiation effects from uranium.

"Because of the extreme difficulty of assessing dose and effects of internally ingested uranium, it is therefore necessary to use available animal and human data to establish exposure limits. Based on those studies, the evidence suggests that exposure to natural uranium is unlikely to be a significant health risk in the population and may well have no measurable effect" (Lantz 2010:3).

Kidney Disease

Scientists have seen chemical effects from uranium exposure; in fact, kidney disease is the most prominent adverse health outcome. People have developed signs of kidney disease after intake of large amounts of uranium (for example, Gulf War veterans with embedded uranium shrapnel).

Animals have also developed kidney disease after they have been exposed to large amounts of uranium. The following discussion of kidney damage in animals is included to illustrate potential impacts on humans; the effects discussed below have been observed in animals and can also occur in humans if the uranium dose is high enough. See Sections 3.7 and 3.8 for a full discussion of potential health impacts to fish and wildlife and special status species.

In animals, kidney damage is the principal toxic effect of uranium, especially to its soluble compounds (Craft et al. 2004; Lantz 2010). The kidneys have been identified as the most sensitive target of uranium poisoning, consistent with the metallotoxic action of a heavy metal. The effects of uranium exposure seem to be primarily at the cellular level. The toxic response of the kidney is caused by the accumulation of uranium in cells lining the kidney (renal tubular epithelium), which results in premature cellular death and atrophy in the kidneys' tubular wall. The major functions of the cells lining the kidney include reabsorbing water and small molecules from the filtrate into the blood and secreting wastes from the blood into the urine. If the cells in the lining are prematurely dying or atrophying, the result is decreased reabsorption efficiency; this effect has been found in humans and animals. Heavy metal ions, such as uranyl ions (an oxidized state of uranium), are also effective in delaying or blocking the cell division process, thereby magnifying the effects of cell death. As noted, above, these effects on the kidney have been observed in animals and can also occur in humans if the uranium dose is high enough. However, these effects have only been seen in certain severe poisoning incidents in humans (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Lung Toxicity

Human and animal studies have shown that long-term retention in the lungs of large quantities of inhaled insoluble uranium particles (e.g., carnotite dust [4% uranium as uranium dioxide and triuranium octaoxide, 80%–90% quartz, and <10% feldspar]) can lead to serious respiratory effects. However, animals exposed to high doses of purified uranium (as uranyl nitrate hexahydrate, uranium tetrachloride, uranium dioxide, uranium trioxide, uranium tetraoxide, uranium fluoride, or uranium acetate) through the inhalation or oral route failed to develop these respiratory ailments. The lack of significant pulmonary injury in animal studies with insoluble compounds indicates that other factors, such as diverse inorganic particle abrasion or chemical reactions, may contribute to these effects (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

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 and associated radon decay products (also known as "radon daughters" or "radon progeny"), 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 (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Other Toxicities

It is not known whether exposure to uranium causes reproductive effects in people. Very high doses of uranium have caused reproductive problems (reduced sperm counts) in some experiments with laboratory animals; however, most studies show no effects. Further, it is not known whether exposure to uranium has effects on the development of the human fetus. Very high doses of uranium in drinking water can affect the development of the fetus in laboratory animals. One study reported birth defects, and another reported an increase in fetal deaths (Agency for Toxic Substances and Disease Registry 1999; Argonne National Laboratory 2005; Craft et al. 2004; EPA 2000, 2010m; Lantz 2010).

Radon

Radon is considered a Class A carcinogen, which indicates that it is known to cause cancer in humans. Radon is the leading cause of lung cancer among non-smokers and the second leading cause of lung cancer overall. An estimated 21,000 deaths per year are attributed to radon gas exposure; 13% of those deaths are among people who never smoked (EPA 2010n).

Inhalation of radon and radon decay products (RDPs) is the method of exposure known to increase the risk of lung cancer. When the radon is exhaled, some of the RDPs are trapped in the lungs. As the trapped RDPs undergo radioactive decay and emit alpha energy, the particles can strike sensitive lung tissue, causing chemical and/or physical damage to the DNA. It is important to note that not everyone who breathes radon gas will develop lung cancer. Risk of developing lung cancer associated with radon exposure also includes 1) how much radon is in the indoor environment; 2) the amount of time spent in that indoor environment; and 3) whether the person smokes or has ever smoked.

The only known health effect of radon is an increased risk of lung cancer, and exposure to elevated radon levels does not result in any warning symptoms like headaches, nausea, fatigue, or skin rashes. The only way to know whether a person is being exposed to elevated radon levels is to test the indoor environment (National Research Council's Commission on Life Sciences 1999).

Ingestion of Wildlife Exposed to Uranium

As discussed in Sections 3.6 through 3.8 on vegetation, fish and wildlife, and special status species biota can be exposed to chemical and radiation hazards through various pathways, including ingestion (soil, food, and water), inhalation, and various cell absorption processes. The potential linkage between chemical and radiation hazards associated with mining operations and biota are considered in those sections. The potential linkage between human ingestion of contaminated vegetation, fish, and wildlife exposed to uranium is discussed below.

As with human exposure to uranium discussed above, wildlife exposed to uranium can be harmful if it is inhaled, ingested, or via skin exposure. For vegetation, plants can be dusted with uranium or feed off of contaminated water. Wildlife can be exposed by eating contaminated vegetation, eating other contaminated wildlife, or drinking contaminated water. Wildlife can also be exposed by inhaling dust.

Human consumption of contaminated vegetation and wildlife could result in human health risks. See previous discussions on health risks associated with ingestion of uranium for a description of these risks.

HUMAN SAFETY RISKS

As previously noted, there are also potential safety risks associated with the mining operations themselves. In general, public safety risks are mitigated by proposed safety mechanisms mandated by the land managing agencies such as BLM and Forest Service, as well as MSHA. In general, mine operations are secured with locking gates to prevent public access and are reclaimed to a standard to ensure that ground surface integrity is not compromised.

Transportation Conflicts

The potential transportation conflicts associated with mine traffic include traffic accidents with other vehicles. As discussed in Section 3.14 (Recreation; see Table 3.14-1), there is a total of 89.71 miles of paved roads and 3,360.91 miles of unpaved roads in the proposed withdrawal area. Recreation sites and visitation data are also discussed in Section 3.14 (Recreation; see Table 3.14-2); visitation for recreation sites considered in this study (see Section 3.14), for which there are data, totaled 4.43 million visitors in 2009. Recreation sites were identified when located within a proposed withdrawal parcel, or when access through a proposed withdrawal parcel is required (see Table 3.14-2). Thus, an estimated 4.43 million visitors are using a network of 3,450.62 miles of paved and unpaved roads to access area recreation sites.

For existing and future mine sites in the proposed withdrawal area, no processing facilities would be located at the mine sites and all ore would be hauled off-site. Because of the decentralized nature of breccia pipe deposits, ore would be hauled by truck. All of the routes described below are heavily traveled by local, national, and international tourists visiting the region.

Access routes for haul traffic from the North Parcel include use of SR 98, SR 389, U.S. 89A, U.S. 89, U.S. 160, U.S. 191, and SR 163 passing through Fredonia, Page, Kaibito, and Kayenta, Arizona, and Kanab, Mexican Hat, and Bluff, Utah, terminating in Blanding, Utah.

Access routes for haul traffic from the East Parcel include use of U.S. 163, U.S. 89A, U.S. 89, U.S. 160, U.S. 191, and U.S. 163 passing through Marble Canyon, Page, Kaibito, and Kayenta, Arizona, and Mexican Hat, and Bluff, Utah, terminating in Blanding, Utah.

Access routes for haul traffic from the South Parcel are divided between the east and west halves of the parcel. Haul traffic from the west half of the South Parcel use SR 64, U.S. 89, U.S. 160, U.S. 191, and SR 163 through Cameron, Tuba City, Tonalea, Cow Springs, and Kayenta, Arizona, and Bluff, Utah. Haul traffic from the east half of the South Parcel use SR 64, I-40, U.S. 89, U.S. 160, U.S. 191, and SR 163 through Tusayan, Red Lake, Williams, Parks, Bellemont, Flagstaff, Gray Mountain, Cameron, Tuba City, Tonalea, Cow Springs, and Kayenta, Arizona, and Bluff, Utah.

Currently, ore trucks cannot exceed 25 mph on unpaved roads. Estimates for current use include approximately 6,326 haul trips per mine over a 4- to 5-year period (an annual average of 24–30 trips per week, or 5–6 trips per day per mine). Average annual daily traffic counts on highways detailed above range from 1,000 vehicles per day on less traveled routes like U.S. 191 at U.S. 160, up to 37,000 vehicles per day on I-40 at Flagstaff (Arizona Department of Transportation 2008).

Environmental Justice

The EPA's Office of Environmental Justice defines environmental justice as

> the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group[s] should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies.

Meaningful involvement means that 1) community residents in the potential impact area have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; 2) the public's contribution can influence the regulatory agency's decision; 3) the concerns of all participants involved will be considered in the decision-making process; and 4) the decision-makers seek out and facilitate the involvement of those in the potential impact area (EPA 2003b). Environmental justice is achieved when everyone, regardless of race, culture, or income, enjoys the same degree of protection from environmental and health hazards and has equal access to the decision-making process, in order to have a healthy environment in which to live, learn, and work (EPA 2003b).

EO 12898 (February 11, 1994) and its accompanying memorandum have the primary purpose of ensuring that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." To meet this goal, EO 12898 specified that each agency develop an agency-wide environmental justice strategy.

DEFINING MINORITY AND/OR LOW-INCOME POPULATION

Minority Communities

Minority or low-income communities that may be addressed in the scope of NEPA analysis are generally considered as follows:

1. Minority—Individual(s) classified by Office of Management and Budget Directive No. 15 as Black/African American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other non-white persons.
2. Minority Population—Minority populations should be identified where either:
    - the minority population of the affected area exceeds 50%; or
    - the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low-Income Population

A population is considered low income if it meets the criteria for poverty guidelines established by the Department of Health and Human Services poverty guidelines. Families and persons are classified by the Census Bureau as below poverty level if their total family income or unrelated individual income is less than the poverty threshold specified for the applicable family size, age, and number of related children under 18 present. Poverty status is determined for all families (and, by implication, all family members).

For persons not in families, poverty status is determined by their income in relation to the appropriate poverty threshold. Thus, two unrelated individuals living together may not have the same poverty status.

MINORITY AND/OR LOW-INCOME POPULATIONS IN THE STUDY AREA

Minority Communities

Based on the criteria presented above, there are 10 communities in the study area in which the minority population exceeds 50%, based on 2000 Census data: Bitter Springs, the Havasupai Indian Reservation, Hopi Tribe, and Tuba City, and the Navajo Nation in Coconino County; the Kaibab Reservation (Kaibab Band of Paiutes), Kaibab Census Designated Place (CDP), and Hualapai Tribe in Mohave County, and Navajo Mountain in San Juan County (see Table 3.15-2). Kayenta in Navajo County is also considered a minority community using criteria listed above.

Additionally, Hispanic populations in Tusayan and Williams are considered environmental justice populations because of the presence of a minority population as a percentage of the affected area that is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. Tusayan is 30.2% Hispanic, while Williams is 32.3% Hispanic, compared with the county’s percentage of 10.9%.

Low-Income Population

Approximately 18.2% of the Coconino County population and 13.9% of the Mohave County population lived below the poverty level, compared with 13.9% for the state of Arizona in 2000 (Census Bureau 2008b).

Communities in Coconino County with a total number of individuals living below poverty level equal to or exceeding the county’s percentage were Bitter Springs and Tusayan, as well as the Havasupai Indian Reservation, Tuba City, Navajo Nation, and Hopi Tribe. All communities of the study area within Mohave County, including the Kaibab Reservation (Kaibab Band of Paiutes) and Hualapai Tribe, exceeded the county’s percentage. Additionally, Kayenta in Navajo County exceeded the county and state percentage.

In the same year, approximately 7.9% of the Kane County population, 31.4% of the San Juan County population, and 11.2% of the Washington County total population lived below the poverty level, compared with 9.4% for the state of Utah (Census Bureau 2008b). Communities in Kane County with a total number of individuals living below poverty level equal to or exceeding the county’s percentage were Big Water and Orderville; in San Juan County, Navajo Mountain exceeded the county threshold, and in Washington County, both Hildale and St. George had a higher percentage than that of the county.

Environmental Justice Communities

In summary, communities that meet the criteria for identification as an “Environmental Justice community” 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, Hopi, Navajo, Paiute (Kaibab Band), and Hualapai.

3.15.2 Social Condition Indicators

Mineral exploration and construction, operation, and maintenance of proposed uranium mine facilities and/or the proposed withdrawal of mineral estates and the associated reduction in mineral development have the potential to affect social conditions resources. Resource indicators include those conditions listed below and described in Section 3.15.1:

- Demographics;
- Stakeholder Values;
- Public Health and Safety; and
- Environmental Justice.

Demographics

Indicators of potential effects to demographics will be measured in terms of projected population and historical trends in growth. Changes in demographics can also be attributed to potential employment opportunities and will be analyzed concurrently with effects on employment.

Stakeholder Values

Indicators of potential effects on stakeholder values could be affected by changes in land management related to the proposed withdrawal parcels; impacts would result if local or non-local individuals' or community's values and beliefs are compromised. As discussed in Section 3.15.1, stakeholder values are assessed using two basic perspectives: mineral exploration and development support, or withdrawal support. Accordingly, impacts to stakeholder values are assessed qualitatively.

Public Health and Safety

Indicators of potential effects on public health and safety are described in terms of where known health risks from exposure to uranium and uranium decay products would occur. Risks include health effects resulting from inhalation of, ingestion of, or skin exposure to uranium; health issues can involve cancer, lung toxicity, and kidney disease. Effects will be measured by indicators that establish the likelihood that mineral exploration and development could result in human exposure to uranium ore and the likelihood that that exposure could manifest itself as health impacts.

Environmental Justice

Indicators of potential environmental justice conditions would be evaluated by assessing the presence, and percentage of, minority and/or low-income populations in the study area and the distribution of benefits versus anticipated effects.

The following resource condition indicators apply to social conditions in the study area (Table 3.15-4).

Table 3.15-4. Social Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Demographics	There could be changes in population levels associated with decreased mineral exploration and development under a proposed withdrawal. Likewise, the continued mineral development in the absence of a proposed withdrawal could involve local population increases as additional workers are required.	*Indicator:* The current and projected population for counties and communities in the study area.
Stakeholder Values	Stakeholder values may be affected by changes in land management related to the proposed withdrawal areas.	*Indicator:* Public comments during scoping indicating general support for the withdrawal or support for mineral exploration and development (and no withdrawal).

Table 3.15-4. Social Condition Indicators (Continued)

	Description of Relevant Issue	Resource Condition Indicator(s)
Public health effects	The transportation of uranium ore between mines and the mill raises questions about potential public exposure to uranium-bearing dust or ore in the event of an accident and release during ore transport.	*Indicator:* Estimated number of haul trips through local communities. *Indicator:* Potential exposure, public health risk, from single incident, effectiveness of cleanup, and total anticipated incidents.
Environmental justice	The 1994 EO (12898) on environmental justice requires federal agencies to address environmental justice when implementing their respective programs. Environmental justice is the equitable distribution of proposed withdrawal benefits and risks with respect to low-income or minority populations. In the case of uranium mining in the proposed withdrawal area, it is the distribution of the proposed withdrawal benefits, primarily economic, compared with the distribution of the proposed withdrawal impacts, such as pollution or risk of pollution that is the issue.	*Indicator:* Identification of populations considered low income and/or minority in the proposed withdrawal area that would either be adversely affected or benefit from the activity. *Indicator:* Distribution of proposed withdrawal risks or adverse effects on the above populations. *Indicator:* Distribution of proposed withdrawal benefits to the above populations. *Indicator:* Comparison of minority/low-income populations' risks and benefits with those for non-minority/non-low-income populations.

3.16 ECONOMIC CONDITIONS

Economic study factors, discussed below, include population and demographics; employment, unemployment, and personal income; industry and economy; taxes and revenues; and mineral, tourism, and recreation economics. Mining and tourism economics are discussed in employment, unemployment, and personal income, as well as in industry and economy; recreation economics is discussed in its own section. The economic study area is generally rural, with two major urban centers (Flagstaff, Arizona, and St. George, Utah) within 50 miles of the proposed withdrawal area. Federal lands constitute the majority of the area; all five counties have a large land area with a dispersed population.

The study area for economic conditions is the same as the study area described for social conditions (see Section 3.15).

3.16.1 Existing Conditions

Economic Activity

INDUSTRY EMPLOYMENT

The Bureau of Economic Analysis (BEA) estimates annual employment and earnings for counties throughout the United States. Total annual employment includes both full-time and part-time jobs, so that individuals with more than one job will be counted twice. The employment estimates include those who are employed by businesses and public entities, as well as individuals who are self-employed. Data were obtained from BEA regarding total annual employment by industry for each county and for Arizona and Utah for 1990, 2000, 2007, and 2008 to examine trends over this study period. Although, on average, employment grew between 2000 and 2007, from 2007 to 2008, employment decreased as the nation experienced an economic crisis. Data from the ADOC and the Utah Department of Workforce Services also were obtained to provide the latest information. Information below was available at the state and county level.

Arizona

In 1990, the services sector provided the most industry employment for Arizona, at 28.9%, followed by retail trade, at 18.0%; government, at 11.8%; and manufacturing, at 10.3% (BEA 2009a–j) (Table 3.16-1). Construction accounted for only 5.7% (BEA 2009a–j). In 2000, the service sector increased by 3.3% to 32.2%, followed by retail trade at 17.2% and government at 11.0%. The construction sector also saw a 1.4% increase to 7.1%. In 2007, the services sector continued to provide the most industry employment to Arizona, at 41.9%; followed by the retail trade sector, at 11.7%, and the finance, insurance, and real estate sector, at 11.1%. From 2000 to 2007, the construction sector grew by 165.5%, accounting for 8.2% of the state's industry employment. However, in 2008, the number of construction jobs fell by 56.1%, reflective of the nation's housing market crisis. In the same year, the services sector experienced a similar decrease of 54%.

Similar to the state, the services sector dominated Coconino County's industry between 1990 and 2008. Services accounted for 30% of the county's industry employment in 1990, 33% in 2000, and 42.9% in 2007 and remained stable at 42.8% in 2008. The number of service jobs in that period grew by 153.2%. While the services sector dominated industry employment in Coconino County in 2008, state and local government followed, at 19.6%, with retail at 11%.

The services sector was also prevalent in Mohave County from 1990 to 2007, growing by a total of 265%. In 1990, the services sector provided the most industry employment, at 27.2%, followed by retail trade at 24.2% and construction at 11.2%. In 2000, the services sector continued to provide the most industry employment, at 28.8%, followed by state and local government at 12.1% and construction at 9.9%. In 2007, the services sector provided 38.5% of the industry employment, followed by retail trade at 15.9%; construction at 11.5%; state and local government at 10.6%; and finance, insurance, and real estate at 10.6%.In 2008, the services sector continued to provide the most industry employment, at 38.6%, followed by retail trade at 15.8% and finance, insurance, and real estate at 11.2%.

Utah

In 1990, the services sector provided the most industry employment to Utah, at 28.2%, followed by retail trade at 16.6%, state and local government at 11.9%, and manufacturing at 11.9% (BEA 2009a–j) (Table 3.16-2). In 2000, the services sector continued to provide the most industry employment to Utah, at 30.2%, followed by retail trade at 16.6% (BEA 2009a–j). In 2007, the services sector was prevalent, at 38.7%; followed by finance, insurance, and real estate at 11.6%; retail trade at 11.1%; state and local government at 10.3%; and construction providing 8.2% of industry employment to the state (BEA 2009a–j). In 2008, the services sector continued to provide the most industry employment to the state of Utah, at 39.1%, followed by finance, insurance, and real estate at 12.2%; retail trade at 11%; and state and local government at 10.5%.

In 1990, the services sector provided the most industry employment to Kane County, at 28.1%, followed by state and local government at 16.8% (BEA 2009h). In 2000, the trend remained the same, with the services sector providing 27.1% of the county's industry employment, followed by government at 15.4% (BEA 2009h). In 2007, the services sector continued to provide the most industry employment to Kane County, at 19%, followed by government at 13.5% and retail at 10.9% (BEA 2009h). In 2008, the leisure/hospitality sector, specific to tourism-related employment, provided the most industry employment in Kane County, at 27.8%, followed by government at 22.0% and other services at 14.2% (Utah Department of Workforce Services 2009). The "other services" sector is essentially composed of animal services, given that the Best Friends Animal Sanctuary is one of the largest employers in Kane County.

Table 3.16-1. Arizona Employment by Industry

Industry	Arizona (No. of Jobs) 1990	Arizona (No. of Jobs) 2000	Arizona (No. of Jobs) 2007	Arizona (No. of Jobs) 2008	Coconino County (No. of Jobs) 1990	Coconino County (No. of Jobs) 2000	Coconino County (No. of Jobs) 2007	Coconino County (No. of Jobs) 2008	Mojave County (No. of Jobs) 1990	Mojave County (No. of Jobs) 2000	Mojave County (No. of Jobs) 2007	Mojave County (No. of Jobs) 2008
Farm employment	19,297	19,657	28,287	26,639	313	240	1,681	1,674	342	318	526	524
Agriculture services, forestry, fishing, and other	26,365	43,283	17,164	16,232	(D)	472	239	251	360	583	(D)	(D)
Mining (coal, metal, nonmetal, oil and gas)	15,673	12,761	16,212	19,565	(D)	158	272	295	102	145	297	433
Construction	107,050	198,890	284,251	246,811	2,329	3,991	5,408	4,891	4,128	5,376	8,449	7,166
Manufacturing	194,298	224,991	194,283	187,446	3,551	2,969	4,277	4,445	2,767	3,479	4,038	3,937
Transportation and public utilities	84,390	124,851	110,725	111,674	1,982	1,952	2,388	2,426	1,558	2,435	2,212	2,245
Wholesale trade	82,181	121,863	120,793	119,500	795	1,371	1,367	1,311	857	1,460	1,393	1,271
Retail trade	340,267	479,988	403,175	393,437	10,735	15,133	9,416	9,437	8,930	12,963	11,697	11,352
Finance, insurance, and real estate	170,281	280,858	383,565	399,263	2,055	4,664	7,128	7,594	3,321	4,324	7,818	8,038
Services	546,866	899,879	1,457,814	1,405,898	14,580	22,969	36,618	36,919	10,032	15,616	28,386	27,735
Federal, civilian	45,843	48,152	52,356	54,429	3,054	3,323	2,880	2,899	366	546	516	508
Federal, military	38,197	33,096	33,789	33,842	378	283	275	278	357	360	404	408
State government	61,595	81,026	87,997	88,039	3,560	(D)	5,859	6,019	324	(D)	541	543
Local government	161,801	226,475	275,608	282,500	4,808	(D)	7,573	7,731	3,486	(D)	7,267	7,429
Total full-time and part-time employment	**1,894,104**	**2,795,770**	**3,454,908**	**3,437,191**	**48,543**	**69,647**	**85,381**	**86,170**	**36,930**	**54,170**	**73,781**	**71,828**

Source: BEA (2009h).

Note: (D) = not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals. BEA does not provide this information.

Table 3.16-2. Utah Employment by Industry

	Utah (No. of Jobs)				Kane County (No. of Jobs)				San Juan County (No. of Jobs)				Washington County (No. of Jobs)			
Industry	**1990**	**2000**	**2007**	**2008**	**1990**	**2000**	**2007**	**2008**	**1990**	**2000**	**2007**	**2008**	**1990**	**2000**	**2007**	**2008**
Farm employment	19,148	20,475	18,835	18,921	163	159	133	132	280	285	721	716	462	560	541	540
Agriculture services, forestry, fishing and other	5,834	11,017	3,177	3,360	17	(D)	(D)	(D)	32	(D)	(D)	(D)	221	569	(D)	(D)
Mining (coal, metal, nonmetal, oil and gas)	9,682	9,305	14,000	16,203	(D)	(L)	(D)	(D)	454	314	388	337	131	212	440	434
Construction	42,780	93,353	136,749	124,746	79	(D)	363	303	140	282	425	398	1,721	5,379	10,955	8,928
Manufacturing	111,628	136,070	134,740	133,810	103	(D)	(D)	165	210	198	130	167	1,702	2,628	3,389	3,209
Transportation and public utilities	46,554	67,555	59,505	60,824	89	106	(D)	(D)	232	187	(D)	(D)	1,014	2,054	3,486	3,555
Wholesale trade	42,616	56,908	53,440	54,707	31	42	49	49	85	99	(D)	(D)	548	1,162	1,522	1,566
Retail trade	155,631	231,695	186,217	187,436	598	780	500	96	643	749	485	506	4,715	10,915	9,654	9,537
Finance, insurance, and real estate	69,267	131,749	193,705	207,583	(D)	268	371	400	114	(D)	287	318	1,772	5,098	8,668	9,293
Services	264,365	416,015	647,949	665,004	668	995	869	1,977	935	1,349	1,130	1,362	6,128	13,513	24,174	28,720
Federal, civilian	39,894	32,499	35,568	35,371	55	109	100	97	194	200	154	154	284	504	485	504
Federal, military	19,399	16,222	16,768	16,540	40	31	29	28	100	74	64	65	385	468	588	594
State government	44,018	61,687	66,660	88,039	57	59	62	63	251	355	404	402	438	739	1,112	1,175
Local government	67,402	93,309	106,406	110,316	342	508	556	562	878	1,174	1,147	1,120	1,737	3,369	4,767	5,115
Total full-time and part-time employment	**938,218**	**1,377,859**	**1,673,719**	**1,702,493**	**2,374**	**3,678**	**4,576**	**4,639**	**4,548**	**5,508**	**6,491**	**6,566**	**21,258**	**47,170**	**74,993**	**74,358**

Source: BEA (2009h).

Note: (D) = not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals. BEA does not provide this information.

San Juan County's largest sectors in 1990 were government and services, with state and local government at 24.8% and services at 20.6% (BEA 2009h). In 2000, the government sector grew to 27.8%, and services grew to 24.5%. In 2007, the government sector fell but continued to provide the most industry employment, at 23.9% (BEA 2009h). In 2008, the most industry employment to San Juan County was provided by the government sector, at 34.3%, followed by the leisure/hospitality sector at 14.4% (Utah Department of Workforce Services 2009). The mining sector took a hit in 2008 with the closure of the Lisbon Valley Copper mine, one of the county's large employers (Utah Department of Workforce Services 2009).

In 1990, the services sector provided the most industry employment to Washington County, at 28.8%, followed by retail trade at 22.2% (BEA 2009h). In 2000, the services sector remained relatively static, at 28.6%; retail trade at 23.1%; construction at 11.4%; finance, insurance, and real estate at 10.8%; and state and local government at 8.7% (BEA 2009h). In 2007, Washington County's state and local government sector decreased and provided only 7.8% of industry employment. The construction sector continued to grow and provided 14.6% of industry employment to the county, followed by retail trade at 12.9% (BEA 2009h). In 2008, the services sector provided for 38.6% of the county's industry employment; followed by retail trade at 12.8%; finance, insurance, and real estate at 12.5%; and construction at 12% (BEA 2009h). Construction in Washington County experienced the largest hit, with an 18.5% loss in jobs.

Tourism Sectors Employment

According to IMPLAN, industry employment for tourism-related sectors in 2008 was 53,222, or 25.2% of the region's employment. Of the five-county study area, tourism-related sectors in Coconino County generated the most employment at 20,004, or 27.7% of the sector total. Sectors included in the broader category of tourism for this analysis include hunting and trapping; food and beverage stores and drinking locales; gasoline stations; clothing, sporting goods, and general merchandise stores; lodging; travel arrangement and reservation services; and transportation (transit/ground passenger and scenic/sightseeing).

It is important to note that not all employment in tourism-related industries can be attributed to tourism. Only a portion of employment in hotels, restaurants, and other sectors are due to tourism. These ratios can be applied to employment, employment compensation, and industry output. Using U.S. National Tourism Impact (TI) ratios for each sector, actual tourism-related employment for the region is estimated. Using these ratios, for example, industry employment for the "other amusement-gambling-and recreation" sector was 1,627 in the five-county study area in 2008 (IMPLAN 2008); using the TI ratio for this sector (20%), the portion of industry employment attributed to actual tourism is 325.4. As shown in Table 3.16-3, using adjusted TI ratios for all tourism-related sectors, actual tourist-related employment totaled 10,296 in 2008. Adjusting sector output using the TI ratios, approximately 4.8% of total employment in the study area is attributable to tourism.

Mining Sector Employment

According to IMPLAN, industry employment for mining-related sectors in 2008 was 901.1, or 0.4% of the region's employment (Table 3.16-4). Of the five-county study area, the mining sector in San Juan County generated the most employment, at 329.6, or 36.6% of the sector total, followed by Washington County at 262.9 and Mohave County at 216.9. Employment provided by the mining industry in 2008, however, was 4.4% less than that provided by tourism in the area.

INDUSTRY WAGES

Employment by industry is discussed earlier in this section under Economic Activity. The following discussion on employment focuses on overall numbers of jobs and average wages per job.

Table 3.16-3. Tourism-Related Sectors: Industry Employment, Using IMPLAN (2008) and Adjusted Using Tourism Impact Ratios

Industry	Coconino	Mohave	Kane	San Juan	Washington	Total
Hunting and trapping	0.3	0.3	0.2	0.0	0.7	**1.5**
Transit and ground passenger transportation	3.4	5.9	0.0	0.3	8.7	**18.3**
Scenic and sightseeing transportation	18.2	7.4	0.0	0.7	4.3	**30.7**
Motor vehicle and parts	204.6	409.9	6.8	3.9	277.6	**902.8**
Food and beverage stores	48.1	42.0	2.0	2.7	36.0	**130.8**
Health and personal care stores	41.3	52.0	1.7	2.1	67.5	**164.6**
Gasoline stations	127.9	193.2	14.3	24.2	81.9	**441.4**
Clothing and clothing accessories stores	22.7	9.7	0.5	0.0	21.7	**54.6**
Sporting goods—hobby—book and music stores	20.3	12.3	0.5	0.3	28.1	**61.5**
General merchandise stores	57.5	102.4	3.7	1.5	63.6	**228.6**
Miscellaneous store retailers	31.3	31.7	1.1	0.8	24.1	**89.0**
Travel arrangement and reservation services	1.8	14.0	0.0	0.1	1.4	**17.2**
Other amusement—gambling—and recreation	163.3	73.3	5.7	12.3	70.9	**325.4**
Hotels and motels, including casino hotels	2,535.8	489.4	202.2	199.2	851.2	**4,277.8**
Other accommodations	122.1	203.3	34.7	0.0	42.2	**402.4**
Food services and drinking places	1,293.0	795.0	88.6	62.5	825.2	**3,064.3**
Auto repair and maintenance (except car)	21.8	35.0	2.6	0.9	24.8	**85.2**
Total	**4,713.4**	**2,476.7**	**364.4**	**311.3**	**2,430.0**	**10,296.0**

Source: IMPLAN (2008).

Table 3.16-4. Mining Sectors: Industry Employment, Using IMPLAN (2008)

Industry	Coconino	Mohave	Kane	San Juan	Washington	Total
Extraction of oil and natural gas	11.7	1.6	1	79.2	5.9	**99.4**
Mining coal	0	0	0	0	0	**0**
Mining iron ore	0	0	0	0	0	**0**
Mining cooper, nickel, lead, and zinc	0	160.6	0	133.6	0	**29402**
Mining gold, silver, and other metal ore	7.4	0	30.5	6.6	0	**44.5**
Mining and quarrying stone	23.6	16.2	0	1.1	16.6	**57.5**
Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	15.9	22.5	0	50.6	105.8	**194.8**
Mining and quarrying other nonmetallic minerals	1.6	5	0	0	121.4	**128**
Drilling oil and gas wells	0	4.3	0	0	9.6	**13.9**
Support activities for oil and gas operations	0	0	0	55.9	0	**55.9**
Support activities for other mining	0	6.7	0	2.6	3.6	**12.9**
Total	**60.2**	**216.9**	**31.5**	**329.6**	**262.9**	**901.1**

Source: IMPLAN (2008).

Arizona

The average annual wage in Arizona has steadily increased, rising from $21,432 in 1990 to $32,841 in 2000 (a 53.2% increase), while the number of jobs has increased by 47.6% (Table 3.16-5) (BEA 2009a–j). In 2007, the average wage in Arizona was $42,214, an increase of 28.5% over the 2000 average wage. From 2000 to 2007, the number of jobs in the state increased by 24.9%.

Table 3.16-5. Arizona Wages and Number of Jobs, 1990–2007

Area	Average Annual Wage Per Job 1990	Average Annual Wage Per Job 2000	Average Annual Wage Per Job 2007	Number of Jobs 1990	Number of Jobs 2000	Number of Jobs 2007
U.S.	$23,423	$35,054	$44,605	139,380,900	166,758,800	180,943,800
Arizona	$21,432	$32,841	$42,214	1,909,879	2,819,302	3,520,657
Coconino County	$18,320	$25,109	$35,123	48,977	70,286	85,848
Mohave County	$17,177	$23,836	$32,135	37,255	54,637	75,929

Notes: Source for 1990 and 2000 data is BEA (2009j); all dollar estimates are in Year 2000 dollars, adjusted for inflation. The employment estimates used to compute the average wage are a job, not person, count. People holding more than one job are counted in the employment estimates for each job they hold.

The average annual wage in Coconino County in 2000 ($25,109) was 71.6% of the national average and 76.5% of the state average. Wages in Coconino County increased by 37.1% from 1990 to 2000. In the same period, the number of jobs increased by 43.5%, similar to the state's increase of 47.6%. In 2007, the average wage in Coconino County was $35,123, an increase of 39.9% over the 2000 average wage. Over the same period, the number of jobs in the County also increased by 22.1%. The largest employers in Coconino County are ARA Leisure Services, City of Flagstaff, Coconino Community College, Coconino County, Flagstaff Unified School District, Flagstaff Medical Center, Grand Canyon Railway, Forest Service, NPS, Navajo Generating Station, Navajo Government Executive Branch, Navajo Tribal Utility Authority, Northern Arizona University, Pittsburg and Midway Coal Mining Company, Nestle Purina Petcare, Samaritan Family Health Center, Grand Canyon National Park (NPS), Tooh-Dineh Industries, Tuba City Indian Medical Center, Tuba City Unified School District #15, Walgreens, Wal-Mart Stores, Window Rock Unified School District, SCA Tissue, Southwest Wind Power, and W.L. Gore and Associates, Inc. (ADOC 2009b).

The average annual wage of Mohave County in 2000 ($23,836) was 68.0% of the national average and 72.6% of the state average. The 2000 wage in Mohave County was 38.8% higher than in 1990. For the same period, the number of jobs increased by 46.7%. In 2007, the average wage in Mohave County was $32,135, an increase of 34.8% over the 2000 average wage. Over the same period, the number of jobs in the county increased by 39%. The largest employers in Mohave County are American Woodmark Corporation, Western Arizona Regional Medical Center, Ford Proving Grounds, Goodyear Tire and Rubber Company, Guardian Fiber Glass, Havasu Samaritan Regional Hospital, IWX Motor Freight, Kingman Regional Medical Center, Laidlaw Corporation, McKee Foods, Mohave Community College, Mohave County, Praxair Inc., Silver Ridge Village, Smith's Food and Drug Centers, Sterlite Corporation, Lake Havasu City, True Serv, Wal-Mart Stores, and West Coast Netting (ADOC 2009c).

Tourism and Mining Sector Wages

Table 3.16-6 illustrates the annual mean wage per occupation in Arizona. Although the tourism-related sectors (i.e., sales and related occupations, food preparation and serving related occupations) provide more industry employment than the mining sector in the study area, wages for employees in these sectors are typically low. According to the Bureau of Labor, the 2009 mean annual wage for an Arizona employee in the food services sector was $21,230 (Bureau of Labor Statistics [BLS] 2009a). For personal care and services, the mean annual wage was slightly higher, at $26,560 (BLS 2009a). Within the mining sector, which qualifies under the 'construction and extraction' industry, mean annual wages for various mining jobs ranged from $44,510 to $72,060.

Table 3.16-6. Arizona Annual Mean Wage by Occupation, 2009

Occupation	Annual Mean Wage
Management	$90,270
Business and Financial Operations	$58,830
Computer and Mathematical Science	$71,200
Architecture and Engineering	$70,850
Life, Physical, and Social Science	$57,830
Community and Social Services	$39,440
Legal Occupations	$82,220
Education, Training, and Library	$42,220
Arts, Design, Entertainment, Sports, and Media	$45,080
Healthcare Practitioner	$69,890
Healthcare Support	$27,150
Protective Service	$41,330
Food Preparation and Serving Related Occupations	$21,230
Building and Grounds Cleaning and Maintenance	$23,520
Personal Care and Service	$26,560
Sales and Related Occupations	$35,260
Office and Administrative Support	$32,210
Farming, Fishing, and Forestry	$19,970
Construction and Extraction	$38,290
Installation, Maintenance, and Repair	$41,150
Production	$32,750
Transportation and Material Moving	$32,550

Source: BLS (2009a).

Utah

The average wage in Utah also has steadily increased over the same period, rising from $19,781 in 1990 to $29,318 in 2000 (an increase of 48.2%). In 2007, the average wage in Utah was $37,722, an increase of 28.7% over the 2000 average wage. From 2000 to 2007, the number of jobs in the state increased by 20.6%.

The average wage of Kane County in 2000 ($18,799) was 53.6% of the national average and 64.1% of the state average. From 1990 to 2000, wages in Kane County increased by 46.0%. In the same period, the number of jobs increased by 56.8%, greater than the state's increase of 47.0%. In 2007, the average wage in Kane County was $26,836, an increase of 42.8% over the 2000 average wage. Over the same period, the number of jobs in the county also increased by 23.1%.

The average wage of San Juan County in 2000 ($22,355) was 63.8% of the national average and 76.3% of the state average. The 2000 wage in San Juan County was 38.6% higher than in 1990. For the same period, the number of jobs increased by 22.1%. In 2007, the average wage in San Juan County was $29,212, an increase of 30.7%. Over the same period, the number of jobs in the county increased by 9.2%.

Table 3.16-7. Utah Wages and Number of Jobs, 1990–2007

Area	Average Annual Wage Per Job 1990	Average Annual Wage Per Job 2000	Average Annual Wage Per Job 2007	Number of Jobs 1990	Number of Jobs 2000	Number of Jobs 2007
U.S.	$23,423	$35,054	$44,605	139,380,900	166,758,800	180,943,800
Utah	$19,781	$29,318	$37,722	944,329	1,387,847	1,673,907
Kane County	$12,873	$18,799	$26,836	2,388	3,744	4,609
San Juan County	$16,131	$22,355	$29,212	4,565	5,573	6,086
Washington County	$15,356	$22,867	$30,310	21,432	47,552	75,086

Notes: Source for 1990 and 2000 data is BEA (2009j); all dollar estimates are in Year 2000 dollars, adjusted for inflation. The employment estimates used to compute the average wage are a job, not person, count. People holding more than one job are counted in the employment estimates for each job they hold.

The average wage of Washington County in 2000 ($22,867) was 65.2% of the national average and 80.0% of the state average. From 1990 to 2000, wages in Washington County increased by 48.9%. In the same period, the number of jobs increased by 121.9%, significantly exceeding the state's increase of 47.0%. In 2007, the average wage was $30,310, an increase of 32.5% over the 2000 average wage. Over the same period, the number of jobs in the county also increased by 57.9%.

Tourism and Mining Sector Wages

Similar to Arizona, the tourism-related sectors in the Utah portion of the study area also provided more industry employment than the mining sector. Although abundant, annual mean wages in 2009 for employees of this sector were generally low, as shown in Table 3.16-8. For example, employees in the food preparation and serving-related industries had an annual mean wage of $20,200, with personal care services at $24,030 (BLS 2009b). Employees in the mining sector typically earned more, with annual mean wages ranging from $48,790 to $68,950 within the mining industry (BLS 2009b).

Table 3.16-8. Utah Annual Mean Wage by Occupation, 2009

Occupation	Annual Mean Wage
Management	$85,590
Business and Financial Operations	$57,450
Computer and Mathematical Science	$67,730
Architecture and Engineering	$68,770
Life, Physical, and Social Science	$51,710
Community and Social Services	$36,080
Legal Occupations	$86,800
Education, Training, and Library	$42,730
Arts, Design, Entertainment, Sports, and Media	$42,830
Healthcare Practitioner	$65,600
Healthcare Support	$24,760
Protective Service	$35,580
Food Preparation and Serving-Related Occupations	$20,200
Building and Grounds Cleaning and Maintenance	$22,940
Personal Care and Service	$24,030
Sales and Related Occupations	$33,650
Office and Administrative Support	$29,250
Farming, Fishing, and Forestry	$25,680

Table 3.16-8. Utah Annual Mean Wage by Occupation, 2009 (Continued)

Occupation	Annual Mean Wage
Construction and Extraction	$38,720
Installation, Maintenance, and Repair	$41,170
Production	$31,830
Transportation and Material Moving	$32,040

Source: BLS (2009b).

INDUSTRY OUTPUT

It is important to note that economic modeling considers a regional economy; for this proposed withdrawal, the regional economy is considered to include Mohave and Coconino counties in Arizona and San Juan, Kane, and Washington counties in Utah. For this reason, industrial output is not discussed at the community level. In characterizing industry output for the study area, it is the value of industry production that is considered. Economic output is presented in constant 2008 dollar terms, rounded to the nearest thousand.

Output in Coconino County is dominated by manufacturing (10.56% of the county's total) and construction (6.22%). Output in Mohave County is dominated by rental activity (6.13% of the county's total) and manufacturing (5.62%). Output in Kane County is led by food services (8.73% of the county's total), followed closely by grant-making/social advocacy groups (8.48%). Output in San Juan County is dominated by extractive activities such as mining (11.54% of the county's total) and oil and gas extraction and support (10.44%). Finally, output in Washington County is dominated by manufacturing (22.78% of the county's total), construction (11.71%), and real estate establishments such as brokers, agents, realtors, etc. (4.53%).

Payroll from state and local government, although not an industry sector, contributes a significant amount to each county's output. In some cases, payroll from state and local government jobs is the single greatest contributor to regional output; state and local payroll in Coconino County contributes to 9.64% of area output, 8.29% in Mohave County, 7.34% in Kane County, 13.85% in San Juan County, and 3.70% in Washington County.

Tourism Sector Output

Towns and cities throughout Coconino, Mohave, Kane, San Juan, and Washington counties that are located near public lands profit economically from expenditures made by visitors to area lands. Visitors to the region enjoy thousands of acres of undeveloped land and scenery. The Grand Canyon, as well as remote and rural areas of these counties, are tourist destinations and are ideal areas for nature-based activities that are popular in the region, such as hiking, camping, wildlife viewing, scenic viewing, hunting, and fishing. Towns in the area benefit from visitors to the region who book hotel rooms, eat, purchase gas, and shop, among other activities.

Along with mineral exploration and development, tourism and recreation are important contributors to the economic stability of the area; economic benefits are derived from direct spending on food, gas, lodging, etc., but also from sales tax generated from visitor spending. Local and sales tax revenue is extremely important in rural (or non-urban) areas. This is because tourism often forms a larger proportion of the economic activity in these areas and also because special excise taxes on tourists and visitors (i.e., from food and lodging, etc.) are paid more heavily by visitors than residents (Runyan 2008).

According to IMPLAN, industry output for tourism sectors in the five-county study area in 2008 was $3.52 billion, or 15.6% of the region's production output. Of the five-county study area, tourism sectors in Coconino County generated the most output, at $1.39 billion, or 6.2% of the overall region, followed by Mohave County at $1.11 billion and Washington County at $869.74 million. As previously noted, sectors included in the broader category for tourism for this analysis include food and beverage stores and drinking locales; gasoline stations; clothing, sporting goods, and general merchandise stores; lodging; travel arrangement and reservation services; and transportation (transit/ground passenger and scenic/sightseeing).

As previously noted, not all economic activity in tourism-related industries can be attributed to tourist spending. Using U.S. national TI ratios for each sector, actual tourist spending-related industry output for the region is estimated (Table 3.16-9). Using these ratios, for example, industry output for the "scenic and sightseeing transportation" sector was $46.87 million in the five-county's study area in 2008 (IMPLAN 2008); using the TI ratio for this sector (3%), the portion of industry output attributed to actual tourist spending is $1.40 million. Using adjusted TI ratios for all tourism-related sectors, actual tourist spending-related industry output totaled $732.63 million, or 3.2% of the region's economy in 2008.

Table 3.16-9. Tourism-Related Sectors: Industry Output, Using IMPLAN (2008) and Adjusted Using Tourism Impact Ratios

Industry	Coconino*	Mohave*	Kane*	San Juan*	Washington*	Total*
Hunting and trapping	0.03	0.04	0.01	0.00	0.04	**0.13**
Transit and ground passenger transportation	0.81	1.28	0.00	0.07	3.28	**5.46**
Scenic and sightseeing transportation	0.78	0.38	0.01	0.01	0.20	**1.40**
Motor vehicle and parts	10.43	21.84	0.26	0.13	14.65	**47.33**
Food and beverage stores	18.84	19.82	0.51	0.75	12.19	**52.13**
Health and personal care stores	0.47	0.82	0.01	0.01	0.64	**1.97**
Gasoline stations	4.20	5.66	0.37	0.38	1.85	**12.48**
Clothing and clothing accessories stores	1.62	0.72	0.02	0.001	1.63	**4.00**
Sporting goods—hobby—book and music stores	0.92	0.50	0.01	0.007	1.11	**2.56**
General merchandise stores	3.04	5.55	0.16	0.04	3.65	**12.45**
Miscellaneous store retailers	1.46	1.31	0.03	0.02	0.94	**3.79**
Travel arrangement and reservation services	0.20	1.23	0.00	0.006	0.13	**1.58**
Other amusement—gambling—and recreation	22.02	8.53	0.73	1.43	8.07	**40.81**
Hotels and motels, including casino hotels	219.62	31.43	12.29	13.16	64.41	**340.94**
Other accommodations	10.52	16.57	1.94	0.00	3.28	**32.33**
Food services and drinking places	74.11	41.45	5.13	3.39	42.58	**166.68**
Auto repair and maintenance (except car)	1.81	2.67	0.16	0.06	1.80	**6.52**
Total	**370.95**	**159.89**	**21.72**	**19.53**	**160.52**	**732.63**

Source: IMPLAN (2008).

Note: Totals based on complete estimates.

* Millions of dollars.

Mining Sector Output

As shown in Table 3.16-10, in 2008, output in the mining sector totaled $267.50 million in the five-county study area and accounted for 1.18% of industrial output (IMPLAN 2008). In terms of individual counties, industrial output in the mining sector accounted for 24% in San Juan County, followed by 0.96% in Mohave County, 0.72% in Washington County, 0.18% in Coconino County, and 0.04% in Kane

County. Industrial output in San Juan County can likely be attributed to the uranium processing mill (White Mesa Mill) in Blanding, Utah.

Table 3.16-10. Mining Sectors: Industry Output, Using IMPLAN (2008)

Industry	Coconino*	Mohave*	Kane*	San Juan*	Washington*	Total*
Extraction of oil and natural gas	4.96	0.76	0.16	36.42	4.25	**46.57**
Mining coal	0	0	0	0	0	**0**
Mining iron ore	0	0	0	0	0	**0**
Mining cooper, nickel, lead, and zinc	0	57.76	0	57.10	0	**114.86**
Mining gold, silver, and other metal ore	2.91	0	16.78	3.88	0	**23.58**
Mining and quarrying stone	4.71	2.72	0	0.15	1.37	**8.96**
Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	2.16	3.04	0	5.34	8.72	**19.27**
Mining and quarrying other nonmetallic minerals	0.25	0.52	0	0	24.72	**25.49**
Drilling oil and gas wells	0	1.94	0	0	5.89	**7.83**
Support activities for oil and gas operations	0	0	0	15.20	0	**15.20**
Support activities for other mining	0	2.99	0	0.99	1.69	**5.69**
Total	**15.01**	**69.75**	**16.95**	**119.11**	**46.66**	**267.50**

Source: IMPLAN (2008).

* Millions of dollars.

Economic Diversity

Industry output varies in the region, with different industry activities supporting different counties. There is almost no overlap between the top two industries of each county in the study area; however, there is some overlap between the top 10 industries of each county. For instance, the “food services and drinking places” and “rental activity” sectors are in the top 10 of all five counties. Health care services (either private hospitals or health practitioner offices) dominate Coconino, Mohave, and Washington counties, whereas the hotel sector ranks in the top 10 for Coconino, Kane, and San Juan counties.

The Shannon-Weaver Diversity Index (SWDI) can measure the economic diversity of the study area. The SWDI evaluates the extent to which the economic activity of a region is distributed between a number of industries in the region. In general, more diverse economies will have larger multipliers because more inputs will be provided locally. The SWDI is determined by IMPLAN by calculating the number of industries in the region against how well distributed employment is throughout all of the regional industries. The SWDI ranges from zero to one: an index of one would be “perfect” diversity when there is equal distribution of employment throughout all of the regional industries, whereas as output and employment become concentrated in fewer industries, the index would be closer to zero. The higher the diversity index, the more stable the economy is assumed to be. The index for each county is presented in Table 3.16-11.

Mohave and Washington counties have the highest diversity indices (0.70 and 0.69, respectively). Kane County, Utah, has the lowest index at 0.58, although all counties in the study area have an SWDI over 0.50, which indicates that the regional economies are more diverse than not. The greater the diversity in the region, the more resilient the economy is in the face of change because the economy is more stable. For comparison, Maricopa County, Arizona, has an SWDI of 0.71650, and Salt Lake County, Utah, has an SWDI of 0.73881.

Table 3.16-11. Shannon-Weaver Diversity Index for Each County in the Study Area

County	Index
Coconino	0.65102
Mohave	0.70194
Kane	0.58673
San Juan	0.59016
Washington	0.69139

Source: IMPLAN (2008).

Employment, Personal Income, and Unemployment

EMPLOYMENT

Although industry employment is previously discussed, major employers for each of the counties within the study area are summarized below.

Arizona

Information on the state's overall major employers was not available; however, according to the ADOC, the largest employers in Coconino County are ARA Leisure Services, City of Flagstaff, Coconino Community College, Coconino County, Flagstaff Unified School District, Flagstaff Medical Center, Grand Canyon Railway, Forest Service, NPS, Navajo Generating Station, Navajo Government Executive Branch, Navajo Tribal Utility Authority, Northern Arizona University, Pittsburg and Midway Coal Mining Company, Nestle Purina Petcare, Samaritan Family Health Center, Grand Canyon National Park (NPS), Tooh-Dineh Industries, Tuba City Indian Medical Center, Tuba City Unified School District #15, Walgreens, Wal-Mart Stores, Window Rock Unified School District, SCA Tissue, Southwest Wind Power, and W.L. Gore and Associates, Inc. (ADOC 2009b).

The largest employers in Mohave County are American Woodmark Corporation, Western Arizona Regional Medical Center, Ford Proving Grounds, Goodyear Tire and Rubber Company, Guardian Fiber Glass, Havasu Samaritan Regional Hospital, IWX Motor Freight, Kingman Regional Medical Center, Laidlaw Corporation, McKee Foods, Mohave Community College, Mohave County, Praxair Inc., Silver Ridge Village, Smith's Food and Drug Centers, Sterlite Corporation, Lake Havasu City, True Serv, Wal-Mart Stores, and West Coast Netting (ADOC 2009c).

Utah

According to the Utah Department of Workforce Services, the largest employers for the state are Intermountain Health Care; the State of Utah; University of Utah, Utah State University, and Brigham Young University; Wal-Mart Stores; Hill Air Force Base; Granite, Jordan, Alpine, and Davis county school districts; Kroger Group; Salt Lake County; Internal Revenue Service; U.S. Postal Service; ATK Launch Systems; and Albertsons (Utah Department of Workforce Services 2009).

The largest employers for Kane County are Best Friends Animal Sanctuary, Aramark (Lake Powell Resorts), Kane County School District, Kane County Hospital, the federal government, Kane County, Honey IGA Supercenter, State of Utah, Thunderbird Restaurant/Motel, Parry Lodge, Zions First National Bank, Glazier's Food Town, Zion Mountain Resort, Quality Inn, Abundant Life Academy, Best Western Red Hills, and Ponderosa Resort (Utah Department of Workforce Services 2009).

The largest employers in San Juan County are San Juan School District, State of Utah, San Juan County, College of Eastern Utah–San Juan, Aramark Services Management, Montezuma Creek Community Health, Monument Valley Lodge, San Juan Hospital, White Mesa, Black Oil Company, Four Corners Regional Care Center, Blanding Grocery, the Navajo Nation, Gouldings, Denison Mines, Lisbon Valley Mining Company, and Encana Oil and Gas USA (Utah Department of Workforce Services 2009).

The largest employers in Washington County are Washington School District, Intermountain Health Care, Wal-Mart Stores, City of St. George, Dixie College, Cross Creek Manor, SkyWest Airlines, the federal government, Washington County, Viracon, Cinnamon Hills Youth Center, Lin's Supermarket, Sunroc Corp, Red Mountain Spa, Albertsons, Harmons, City of Washington, and Costco (Utah Department of Workforce Services 2009).

PERSONAL INCOME

Personal income trend data are obtained from the BEA (2003) and summarized for the study area.

Arizona

In 1989, the median household income for the state of Arizona was $24,540. In 1999, the median household income increased to $40,558. Between 1989 and 1999, the median household income in Arizona increased by 47.3%. In 2008, the median household income was $51,124 (Census Bureau 2008b). The median household income throughout Arizona continued to increase by 26.1% between 1999 and 2008. Arizona's per capita personal income (PCPI) in 1989 was $13,461 and increased by approximately 50.6% through 1999 to $20,275 (Census Bureau 2008b). Per capita income continued to increase by 26.5% through 2008 at $25,639. From 1989 to 2008, there was an overall increase of 90.5%. In 1990, the rate was 5.3%, and in 2000, it was 4.0% (Arizona Workforce Informer 2010).

In 1989, the median household income for Coconino County was $26,112. In 1999, it was $38,256. Communities within Coconino County that had a median household income less than that of the county were Bitter Springs ($24,886), Flagstaff ($37,146), Fredonia ($30,288), Tusayan (34,917), and Williams ($32,455) (Census Bureau 2008b). The Navajo Nation in Coconino County also had a lower median household income, at $26,782, while the Havasupai Indian Reservation was even lower, at $20,114 (Sonoran Institute 2000). The Hopi Tribe was comparable to the county, at $37,581 (Sonoran Institute 2000). From 1989 to 1999, the median household income in Coconino County increased by 46.5%. In 2008, the median household income was $49,611 (Census Bureau 2008b). From 1999 to 2008, the median household income increased by 29.7%. Coconino County's PCPI in 1989 was $10,580, increasing by 62.0% through 1999 to $17,139. From 1999 to 2008, the county's PCPI increased by 34.8% to $23,103 (Census Bureau 2008b).

In 1989, the median household income for Mohave County was $24,002. From 1989 to 1999, the median household income in Mohave County increased by 31.3% to $31,521 (Census Bureau 2008b). Colorado City had a higher median household income, at $32,826; Kaibab CDP was $21,458 (Census Bureau 2008b). From 1999 to 2008, the median household income increased by 25.6%. In 1989, the PCPI in Mohave County was $11,933. In 1999, it was $16,788, an increase of 40.7% from 1989. In 2008, it was $21,143, an increase of 25.9% from 1999 and an increase of 77.2% from 1989 (Census Bureau 2008b).

Utah

In 1989, the median household income in Utah was $29,470, and in 1999, it rose to $45,726, an increase of 55.2%. In 2008, the median household income was $56,484, an increase of 23.5% from 1999 (Census Bureau 2008b). From 1989 to 2008, the overall increase was 91.7%. Utah's PCPI in 1989 was $11,029.

In 1999, it was $18,185, an increase of 64.9% (Census Bureau 2008b). In 2008, PCPI increased by 26.6% to $23,020. From 1989 to 2008, there was an overall increase of 108.7%.

In 1989, the median household income in Kane County was $21,134. In 1999, the median household income was $34,247. The median household income for Big Water was $30,278, $35,938 for Glendale, $35,125 for Kanab, and $35,769 in Orderville (Census Bureau 2008b). In 2007, the median household income was $42,268, an increase of 23.4% from 1999 (Utah Department of Workforce Services 2009). From 1989 to 2007, the overall increase was 100.0%. In 1989, the PCPI was $8,721 (Census Bureau 2008b). In 1999, it grew by 77.2% to $15,455 (Census Bureau 2008b). From 1999 to 2007, it increased by 91.9% to $29,663 (Utah Department of Workforce Services 2009). From 1989 to 2007, there was an overall increase of 240.1%.

In 1989, the median household income in San Juan County was $17,289. In 1999, the median household income increased by 62.7% to $28,137. The median household income was $32,991 in Blanding, $26,635 in Halls Crossing, and $32,188 in Oljato–Monument Valley (Census Bureau 2008b). Navajo Mountain's median household income was much lower, at $14,196. From 1989 to 1999, the median household income in San Juan County increased by 62.7%. In 2007, the median household income was $34,561, an increase of 22.8% from 1999 (Utah Department of Workforce Services 2009). From 1989 to 2007, the overall increase was 99.9%. In 1989, the PCPI in San Juan County was $5,907 (Census Bureau 2008b). From 1989 to 1999, there was an increase of 73.2%, to $10,229 (Census Bureau 2008b). In 2007, it was $17,170, an increase of 67.9% from 1999 (Utah Department of Workforce Services 2009). From 1989 to 2007, there was an overall increase of 190.7%.

In 1989, the median household income in Washington County was $24,602. In 1999, the median household income increased to $37,212. In Hildale, the median household income was less than that of the county, at $32,679, whereas in St. George, it was $36,505, in Hurricane $32,865, in La Verkin $35,949, in New Harmony $34,583, in Toquerville $34,038, and in Virgin Town $36,953 (Census Bureau 2008b). Ivins was higher than that of the county, at $41,297, along with Leeds at $41,250, Rockville at $37,917, Santa Clara at $52,770, and Springdale at $41,607 (Census Bureau 2008b). In 2008, the median household income in Washington County was $49,747 (Census Bureau 2008b). From 1989 to 1999, the median household income in Washington County increased by 51.3%. From 1999 to 2008, the median household income increased by 33.7%. From 1989 to 2008, the overall increase was 102.2%. In 1989, the PCPI in Washington County was $9,450 (Census Bureau 2008b). It increased by 68.0% through 1999 to $15,873 (Census Bureau 2008b). In 2008, the PCPI was $21,354, an increase of 34.5% from 1999 and an increase of 126.0% from 1989.

UNEMPLOYMENT

As defined by BEA, employment is the total number of persons 1) performing any type of labor for pay or profit; 2) working at least 15 hours per week on an unpaid basis in family enterprises; and 3) temporarily absent for non-economic reasons. Employment under this definition includes all full-time and part-time jobs. The BEA employment count is a measure of occupied jobs, rather than a measure of employed persons. If an individual holds two separate jobs at any given time, the individual is counted twice, since two employment positions are occupied.

In 1990, the national annual average unemployment rate was 5.6%. In 2000, the rate dropped to 4.0%, and in 2008, the rate increased to 5.8%. The unemployment rate increased in 2009, when it jumped to 9.3% (BLS 2010). The last time the U.S. had such a high percentage was in 1941, when the unemployment rate was 9.9% (BLS 2010). Information for unemployment was available at the state and county level.

Arizona

In 1990, the unemployment rate for the state of Arizona was 5.5% (Arizona Workforce Informer 1999). The unemployment rate fell to 4.0% in 2000 (Arizona Workforce Informer 2000). In 2008, the unemployment rate increased to 5.5% (ADOC 2009a). As in the rest of the country, the unemployment rate significantly increased in 2009 to an average rate of 9.0% (Arizona Workforce Informer 2009a).

In 1990, the unemployment rate in Coconino County was 7.5%, falling to 4.5% in 2000 (Arizona Workforce Informer 2010). In 2008, the unemployment rate for Coconino County was less than that of the state, at 5.1% (Arizona Workforce Informer 2010). In that same year, the unemployment rate for Flagstaff was 3.5%, Fredonia 7.0%, Page 4.6%, and Williams 4.8% (ADOC 2009b). In 2009, the average rate of unemployment in Coconino County was 7.4% (Arizona Workforce Informer 2009b).

In 1990, the unemployment rate in Mohave County was 4.9%, falling by 0.5% in 2000 to 4.4% (Arizona Workforce Informer 2010). In 2008, the unemployment rate for Mohave County was more than that of the state, at 6.5% (ADOC 2009c). In that same year, the unemployment rate in Colorado City was 4.5% (ADOC 2009c). In 2009, the average unemployment rate in Mohave County was 9.7% (Arizona Workforce Informer 2009b).

Utah

In 1990, the unemployment rate in the State of Utah was 4.4%, and in 2000 it was 3.4% (Governor’s Office of Planning and Budget 2006). In 2008, the unemployment rate remained stable, at 3.4% (Utah Department of Workforce Services 2009). In 2009, the unemployment rate almost doubled, increasing to 6.5% (Governor’s Office of Planning and Budget 2010b).

In 1990, the unemployment rate in Kane County was 6.1%, decreasing to 3.8% in 2000 (Governor’s Office of Planning and Budget 2006). In 2008, the unemployment rate in Kane County was 0.6% lower than that of the state, at 4.0% (Utah Department of Workforce Services 2009). In December 2009, the unemployment rate increased to 7.2% (Utah Department of Workforce Services 2009).

In 1990, the unemployment rate in San Juan County was high, at 9.0%, falling by 1.0% in 2000 to 8.0% (Governor’s Office of Planning and Budget 2006). In 2008, the unemployment rate in San Juan County was 2.6% higher than that of the state, at 6.0% (Utah Department of Workforce Services 2009). In December 2009, the unemployment rate was 12.3% (Utah Department of Workforce Services 2009).

In 1990, the unemployment rate in Washington County was 4.0%, decreasing to 3.5% in 2000 (Governor’s Office of Planning and Budget 2006). In 2008, the unemployment rate in Washington County was 4.6%, 1.2% higher than that of the state (Utah Department of Workforce Services 2009). In the same year, the unemployment rate for St. George was 4.6% (BLS 2010). In December 2009, the unemployment rate almost doubled, increasing to 8.7% (Utah Department of Workforce Services 2009).

Taxes and Revenues

The proposed withdrawal has the potential to change regional and local tax revenue; therefore, the following inventory includes a summary of severance, sales and use, and lodging taxes, as well as payment in lieu of taxes (PILT).

SEVERANCE TAXES

A severance tax is imposed in both Arizona and Utah, in lieu of a transaction privilege tax, on mining metalliferous minerals such as gold, nickel and uranium; the rate is 2.5% in Arizona and 2.6% in Utah. The rate is applied to 50% of the difference between the gross value and the production cost. A severance tax is an excise tax imposed on the present and continuing privilege of removing, extracting, severing, or producing any material in each state. In 2008, severance taxes collected by the State of Arizona accounted for 0.32% of the State's total tax collection, while Utah's collected severance tax revenue accounted for 1.78%. Table 3.16-12 summarizes the state severance tax collections for Arizona and Utah between 2001 and 2008. Over this period, revenue collected from severance taxes increased dramatically, from $4.2 million to $43.8 million in Arizona (an increase of 937%) and from $51.8 million to $106.1 million in Utah (an increase of 104.4%). Arizona severance tax collection has increased each year, while in Utah there was a 44.13% decline between 2001 and 2002 and a 56.23% decline between 2006 and 2007. The reasons for these changes (increases or decreases in mineral exploration and development and/or changes in value) are unclear.

Table 3.16-12. State Government Severance Tax Collections, in Dollars (2001–2008)

	2001	2002	2003	2004	2005	2006	2007	2008
Arizona	4,218,000	6,417,000	14,662,000	15,544,000	26,338,000	40,494,000	43,560,000	43,757,000
Utah	51,853,000	28,972,000	37,788,000	50,009,000	73,434,000	99,517,000	43,560,000	106,060,000

Sources: Census Bureau (2001–2008a).

Note: Census Bureau data not available for Arizona until 2001.

SALES AND USE TAX

Sales taxes apply to the retail sale of personal property or services within the state. Arizona levies a 5.6% general sales (transaction privilege) tax on consumers, which is just above the national average of 5.4%; currently, there is an additional 1% temporary, 2-year increase on the sales tax rate. Individual cities or communities within each county can also levy an additional sales tax. Coconino County assesses an additional 0.975% general sales tax, for a county total of 6.575%; Mohave County assesses an additional 0.25% general sales tax, for a county total of 5.85%. It is important to note that Arizona does not charge sales tax on food purchased at retail outlets for home consumption, such as food purchased at grocery stores. As discussed in the Lodging Tax section below, some communities assess an additional bed or lodging tax in addition to the sales taxes.

Utah levies a 4.7% general sales and use (transaction privilege) tax on consumers, slightly lower than Arizona. Kane, San Juan, and Washington counties assess an additional local sales and use tax, mass transit, and county option tax, totaling 6.95% for Kane County and 5.95% for both San Juan and Washington counties (State of Utah 2009). Like Arizona, individual cities or communities within each county can also levy an additional sales tax, and some communities assess an additional bed or lodging tax.

Use tax complements sales tax and is imposed on tangible personal property purchased for storage or use in each state for which the state sales tax was not paid at the time of purchase. Thus, use tax prevents sales tax avoidance or the payment of a lesser tax rate by making purchases outside the tax jurisdiction where first use, storage, or other consumption will occur. State use tax is shared between the state government and the county of origin (i.e., the county where the tax was imposed) on the same distribution basis as sales tax. The use tax rate is the same as the transaction privilege (sales) tax rate.

Between 2003 and 2008 in Arizona and Utah, there was an increase of 48% and 31% in sales tax collections for each state, respectively. Sales tax revenue in Arizona increased each year between 2003 and 2008, except for a 1.73% drop between 2007 and 2008. In Utah, collected sales tax revenue also increased each year, except for an 18.83% decline between 2005 and 2006. State-collected sales and use tax revenue is summarized in Table 3.16-13.

Table 3.16-13. Sales/Use Tax Collections, in Dollars (2003–2008)

	2003	2004	2005	2006	2007	2008	% Change 2003–2008
Arizona	551,147,900	610,178,800	669,901,400	791,160,300	828,966,000	814,609,500	47.80%
Coconino County	20,320,000	23,670,000	19,270,000	21,660,000	25,040,000	28,090,000	38.24%
Fredonia	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Page	3,298,470	4,179,964	4,489,875	5,608,928	6,642,357	7,121,927	115.92%
Williams	2,700,241	2,800,080	3,643,008	3,561,874	2,520,531	N/A	N/A
Flagstaff	23,805,566	25,683,000	27,054,000	30,015,000	32,335,000	33,129,000	39.16%
Mohave County	19,345,487	21,208,833	24,627,942	27,992,499	29,878,867	28,088,199	45.19%
Colorado City	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Utah	201,448,400	214,224,000	232,954,500	189,079,300	262,503,700	264,403,400	31.25%
Kane County*	368,423	331,311	331,822	387,505	384,204	407,111	10.50%
Kanab*	458,089	484,187	513,148	590,241	658,531	689,663	50.55%
Big Water*	36,329	34,760	36,683	40,197	46,779	50,355	38.61%
San Juan County*	784,691	763,739	802,347	885,543	1,205,040	1,364,722	73.92%
Blanding*	366,289	354,124	381,301	440,713	539,389	561,488	53.29%
Washington County*	502,586	579,135	638,505	692,393	637,123	811,217	61.41%
St. George*	9,087,837	10,158,951	11,848,249	14,308,045	15,647,263	15,513,808	70.71%
Hildale*	166,278	183,442	195,650	232,152	258,222	243,434	46.40%

Sources: Census Bureau (2003–2008a).
Note: N/A = Not applicable.
* Data from Utah State Tax Commission (2005, 2009).

In terms of sales and use taxes revenues by municipalities, there was also an overall increase between 2003 and 2008. The greatest increase occurred in Page, Arizona, with an increase of 116% during the study period. The lowest increase was in Kane County, with an increase of 10.5% between 2003 and 2008. No 2008 data were available for Williams, Arizona, but there was a substantial drop in sales tax revenue for this city between 2006 and 2007 (–29.25%).

In Arizona, severance and sales taxes are distributed to area counties and cities (Table 3.16-14). In terms of how taxes are distributed, as previously noted, Utah severance taxes are not redistributed to counties and municipalities; therefore, no data are presented here. Overall distribution in Arizona increased for the 5-year period between 2003 and 2008, with the exception of Page (which had a 1.11% decrease between 2003 and 2008). However, it is important to note that there was a 9.0% to 13.5% decrease in distribution to the cities and counties between fiscal year (FY) 2007–2008 and FY 2008–2009; cities listed in Table 3.16-14 experienced a 13.43% decrease, while Coconino County's decrease was 10.84% and Mohave County's decrease was 9.31%. The reasons for these changes (increases or decreases in mineral exploration and development and or taxable sales, and/or changes in value) are unclear.

LODGING (TRANSIENT ROOM) TAX

Arizona

The Arizona state tax for lodging is 5.5%. Communities, by voter approval, may impose an additional lodging excise tax on sleeping accommodations for guests staying fewer than 31 days. This tax extends to mobile accommodations, such as tents, trailers, and campers. The revenue from these taxes goes to various recipients. The Arizona Research and Resource Hospitality Center at Northern Arizona University collects lodging tax and revenue data; only communities with more than 10 properties report collections. Only incorporated communities within 100 miles of the proposed withdrawal area are reported below. According to the Coconino County Asset Inventory by the Rural Policy Institute, Center for Business Outreach, Northern Arizona University, Flagstaff has 83 bed-and-breakfasts and hotels/motels, Williams has 41, and Page has 15. Fredonia is an incorporated community in the study area but does not collect a separate lodging tax. Colorado City has a lodging tax but does not have any hotel or motel properties. Bed tax collections for cities in the study area increased between FY 2000–2001 and FY 2005–2006. Williams experienced the most significant growth in collected lodging tax during this period (80.73%).

Table 3.16-14. Transaction Privilege and Severance Tax Distribution in Arizona, in Dollars

	FY 2003–2004	FY 2004–2005	FY 2005–2006	FY 2006–2007	FY 2007–2008	FY 2008–2009	% Change 2003–2008
Arizona	–	–	–	–	–	–	–
Coconino County	14,362,293	15,127,441	16,990,411	17,652,655	17,161,720	15,301,303	6.54%
Fredonia	87,037	95,975	110,937	105,501	102,013	88,312	1.46%
Page	572,044	630,788	729,120	675,780	653,437	565,694	−1.11%
Williams	238,765	263,284	304,326	298,921	289,038	250,226	4.80%
Flagstaff	4,443,781	4,900,116	5,663,983	5,815,412	5,623,144	4,868,072	9.55%
Mohave County	15,239,251	17,231,461	20,349,087	22,051,895	21,046,522	19,087,627	25.25%
Colorado City	280,099	308,863	357,011	387,789	374,968	324,618	15.89%

Sources: Arizona Department of Revenue (2003–2009).

Note: Utah severance taxes are not redistributed to counties and municipalities, therefore, no data are presented here.

Utah

In Utah, transient room tax (also known as a lodging tax) is imposed at the county and local government level and reported to the State. Counties may impose a county-wide tax on temporary lodging of up to 4.25%, whereas cities and towns may impose an additional tax on temporary lodging of up to 1%. Table 3.16-15 shows the bed and sales taxes for the study area. According to the Hotel Travel Index, Kane County has 66 hotels, motels, and bed-and-breakfasts, San Juan County has 36, and Washington County has 55. The numbers of Utah properties (see Table 3.16-15) are estimates only. Bed tax collections for counties in the study area increased between FY 2000–2001 and FY 2005–2006. Washington County experienced the most growth during this period (64.24%).

Table 3.16-15. Lodging/Transient Room Tax Rates and Collections in the Study Area

	Number of Properties	Tax Rate	Room Tax Collections FY 2000–2001	Room Tax Collections FY 2005–2006	Room Tax Collections % Change
Arizona*			–	–	–
Flagstaff	83	2.00%	$1,161,825	$1,430,215	23.10%
Williams	41	1.25%	$340,111	$614,679	80.73%
Page	15	3.00%	$299,435	N/A	N/A
Utah	–	n/a	–	–	–
Kane County	66	4.25%	$270,451	$372,200	37.62%
San Juan County	36	4.25%	$230,996	$267,499	15.80%
Washington County	55	4.25%	$1,174,808	$1,929,554	64.24%

* Arizona lodging taxes are collected by the State and cities (not counties).

Note: N/A = Not applicable.

FEDERAL LAND PAYMENTS TO COUNTIES

Payment in Lieu of Taxes

In 1976, Congress directed federal land management agencies, with the exception of the Forest Service, to allocate income to states and counties with federal lands to provide a PILT program to help offset lost tax revenues. Because the BLM is the largest federal land owner and land manager, the BLM was chosen by the Secretary of the Interior to administer the PILT program. Federal lands are not subject to property taxes that support county governments and education, although local communities play an important role in supporting the management of federal lands. Congress appropriates PILT payments each year. The formula used to compute the payments is contained in the PILT Act and is based on population, receipt-sharing payments, and the amount of federal land within an affected county (BLM 2010g).

Since 2000, PILT payments received by Arizona and Utah have increased significantly; Arizona PILT increased by 188% between 2000 and 2009, while Utah PILT increased by 218% for the same period. Both states received similar PILT for each period. PILT to each county in the five-county study area also showed a dramatic increase during this time. Table 3.16-16 provides a breakdown of annual PILT received by each county during the study period.

Table 3.16-16. History of PILT in the Study Area

	2000	2009
Arizona	$11,005,635	$31,662,123
Coconino County	$820,879	$1,548,284
Mohave County	$1,052,149	$3,148,076
Utah	$10,411,528	$33,063,034
Kane County	$292,000	$955,611
San Juan County	$441,379	$1,334,042
Washington County	$885,447	$2,620,215

Source: BLM (2010g).

Note: No data available prior to 2000.

Secure Rural Schools and Community Self-Determination Act of 2000

In place of the PILT program, the Secure Rural Schools and Community Self-Determination Act of 2000, reauthorized as part of PL 110-343, was enacted on October 3, 2008. According to the Forest Service website, the Secure Rural Schools Act was established to restore stability and predictability to the annual payments made to states and counties containing National Forest System and public domain lands managed by the BLM for use by counties for the benefit of public schools, roads, and other purposes. In addition, the act provides for investments in providing employment opportunities through projects that improve the maintenance of existing infrastructure, implement stewardship objectives, enhance forest ecosystems, and restore and improve land health and water quality.

Recreation Economics

Recreational activities (nonconsumptive and hunting) have economic value both in terms of the satisfaction provided to local residents and visitors and the economic activity they generate for the regional economy. Recreation generates additional spending in the local economy that supports jobs and income. Economic stimuli occur as nonresidents visit the area and spend money in the local economy, which in turn generates additional spending by local residents. For the purpose of this study, it is assumed that if local residents were not participating in recreation, they are spending their money on something else in the region's economy. Thus, expenditures by local residents are seen as a shifting of dollars from one sector to another within the local economy and not a net gain to the region. However, dollars that remain within the community when local residents have satisfactory recreation opportunities are important. Keeping dollars within the local economy helps maintain jobs, thus reducing employment and income fluctuations that may result if those dollars are spent outside the local economy.

NONCONSUMPTIVE RECREATION

Information on the economic value of recreation opportunities on federal lands, including BLM, national forest, national parks, etc., can be difficult to determine because recreation experiences are not directly observed in market transactions. As a result, valuation methodologies have evolved to estimate the non-market value of recreation. Data presented and summarized in Table 3.16-17 include valuation for recreation activities, estimated using the Travel Cost Method or Contingent Valuation Method. These methods estimate the consumer surplus, or net willingness to pay (WTP), that visitors receive from their recreation experience. For a full discussion of both methods, see Loomis and Walsh (1997). Both recreation valuation methods have been used for over 30 years by federal agencies such as the USACE and U.S. Bureau of Reclamation (U.S. Water Resources Council 1979). The USFWS has also used these valuation methods since the 1980s.

In economics, the net economic benefit or value of a good or service is measured by the summation of producer and consumer surpluses. Intended behavior is the foundation of the Contingent Valuation Method, used for measuring the net WTP. The Travel Cost Method uses the relationship between the rate of visitation to a site and the return costs of traveling to the site to develop a demand curve for the recreation use of some resource. The value of a visit, or consumers' surplus, is the WTP for the recreation use of some resource.

Visitor Data and Value per Visitor Day

The volume of non-consumptive recreational use within the region of the proposed withdrawal is taken from visitor data provided by BLM, Forest Service, and NPS. Table 3.16-17 summarizes recreation visitor days (where available), per recreation site, located within and adjacent to the proposed withdrawal parcels. There are 23 recreation sites within the proposed withdrawal parcels; these include campsites, trailheads, scenic vistas, and overlooks, etc. Values per visitor day are also included in Table 3.16-17. An additional 17 sites are located in areas outside the proposed withdrawal parcels; these recreation sites were identified through consultation with BLM, Forest Service, and NPS staff.

Based on known visitor data and estimated value per visitor day, the total annual benefit of recreation sites in the total study area is $450 million (see Table 3.16-17). Total known visitor days are 4.77 million. Of the total visitor days, 92% can be attributed to visitor use of the Grand Canyon Gateway. Of the estimated annual benefit of recreation sites in the study area, 97% can be attributed to the gateway.

In terms of the annual benefit of each proposed withdrawal parcel, based on known data, the annual benefit of recreation in the North Parcel is $17,652. However, no visitor data are available for four recreation sites in this parcel. The estimated annual benefit of the South Parcel is $601,056. As with the North Parcel, visitor data are lacking for several sites in the parcel (see Table 3.16-17). The annual benefit of recreation in the East Parcel is $661,526; no visitor data are available for several recreation sites in this parcel (see Table 3.16-17).

Table 3.16-17. Inventory of Recreation Sites within the Study Area

Proposed Withdrawal Parcel	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)	Recreation Activity	Value Per Visitor Day	Annual Benefits[j]
North	BLM	Hack Canyon	Trailhead	402	Hiking[f]	$43.91	$17,652
North	BLM	Swapp Trail	Trailhead	Not available	Hiking[f]	$43.91	–
North	Forest Service	Gunsight Point	Overlook	Not available	Sightseeing[d]	$18.07	–
North	Forest Service	Hatch Cabin	Cabin	Not available	Sightseeing[d]	$18.07	–
North	BLM	Rock Canyon	Trailhead	Not available	Hiking[f]	$43.91	–
East	Forest Service	House Rock Valley Overlook	Overlook	Not available	Sightseeing[b]	$18.07	–
East	Forest Service	House Rock Overlook Interpretive Site	Interpretive site	5,371	Interpretive[c]	$21.66	$116,335
East	BLM	Navajo Trail	Trailhead	Not available	Hiking[d]	$43.91	–
East	BLM	Soap Creek	Trailhead	338	Hiking[f]	$43.91	$14,841
East	BLM	Rider Canyon	Trailhead	36	Hiking[f]	$43.91	$1,580
East	BLM	North Canyon Creek	Trailhead	36	Hiking[f]	$43.91	$1,580
East	BLM	Badger Creek	Trailhead	120	Hiking[f]	$43.91	$5,269
East	BLM	Dominquez-Escalante Interpretive Site	Historic site	10,635	Interpretive[e]	$21.66	$230,354.
East	BLM	Condor Interpretive Site	Wildlife/Overlook	4,200	Wildlife viewing[e]	$69.42	$291,564
South	Forest Service	Ten-X Family Campground	Family campground	25,300[i]	Camping[f]	$20.87	$528,011
South	Forest Service	Charlie Tank Group Camp Ground	Group campground	3,500[i]	Camping[h]	$20.87	$73,045
South	Forest Service	Bike Trail	Trailhead	Not available	Mountain biking[e]	$210.26	–
South	Forest Service	Arizona Trail	Trailhead	Not available	Hiking[f]	$43.91	–
South	Forest Service	Red Butte	Trailhead	Not available	Hiking[f]	$43.91	–
South	Forest Service	Russell Tank Fishing Parking Area	Fishing site	Not available	Fishing[g]	$92.91	–
Outside withdrawal parcel	Forest Service	Snake Gultch	Trailhead	Not available	Hiking[f]	$43.91	–
Outside withdrawal parcel	Forest Service	Saddle Mountain Wilderness	Wilderness area	Not Available	Hiking[f]	$43.91	–
Outside withdrawal parcel	Forest Service/ NPS	South Canyon	Trailhead	54	Hiking[f]	$43.91	$2,371
Outside withdrawal parcel	NPS	Camper Village	Campsite/tent/trailer/ recreational vehicle	Not available	Camping[h]	$20.87	–
Outside withdrawal parcel	NPS	Bass Trail	Trailhead	243	Hiking[f]	$43.91	$10,670
Outside withdrawal parcel	NPS	Kanab Point	Overlook	16	Sightseeing[d]	$18.07	$289

Table 3.16-17. Inventory of Recreation Sites within the Study Area (Continued)

Proposed Withdrawal Parcel	Land Manager	Recreation Site	Site Type	Visitor Counts (2009)	Recreation Activity	Value Per Visitor Day	Annual Benefits[j]
Outside withdrawal parcel	NPS	150 Mile Canyon	Trailhead	Not available	Hiking[f]	$43.91	–
Outside withdrawal parcel	NPS	SB Point	Overlook	Not available	Sightseeing[d]	$18.07	–
Outside withdrawal parcel	NPS	Grand Canyon Gateway	Park Entrance	4,418,773	General recreation[11]	$99.34	$438,960,909
Outside withdrawal parcel	NPS	Lees Ferry	Historic Site	Not available	Interpretive[e]	$21.66	–
Outside withdrawal parcel	NPS	Point Sublime	Overlook	Not available	Sightseeing[d]	$18.07	–
Outside withdrawal parcel	NPS	Swamp Point	Overlook/Picnic area	Not available	Picnicking[e]	$32.22	–
Outside withdrawal parcel	NPS	Grandview Point	Overlook	Not available	Sightseeing[d]	$18.07	–
Outside withdrawal parcel	NPS	Yaki Point	Overlook	250,088	Sightseeing[d]	$18.07	$4,519,090
Outside withdrawal parcel	NPS	Tiyo Point	Overlook	Not available	Sightseeing[d]	$18.07	–
Outside withdrawal parcel	NPS	Cape Royal	Overlook	Not available	Sightseeing[d]	$18.07	–
Outside withdrawal parcel	NPS/BLM	Tuckup Point	Overlook	2	Sightseeing[d]	$18.07	$36
Outside withdrawal parcel	BLM	Toroweap	Campground/ Overlook	3,859	Camping[h]	$20.87	$80,537
Outside withdrawal parcel	BLM	Vermilion Cliffs National Monument	National monument	26,080[a]	General recreation[h]	$99.34	$2,590,787
Outside withdrawal parcel	BLM	Grand Canyon Parashant National Monument	National monument	29,674[a]	General recreation[11]	$99.34	$2,947,815
Outside withdrawal parcel	BLM	Kanab Creek Wilderness	Wilderness area	Not available	Hiking[f]	$43.91	–

Sources: BLM (2010h); Forest Service (2009f); NPS (2009b).

[a] BLM (2005) Arizona Strip Field Office Traffic Counts.

[b] Haspel and Johnson (1982).

[c] Loomis et al. (2005).

[d] Loomis (2005).

[e] Connelly and Brown (1988).

[f] Data from Brown et al. (1989); Richards and Brown (1992); Sublette (1975).

[g] USFWS (2006b).

[h] Duffield et al. (2009).

[i] Annual estimates received from the Forest Service.

[j] Annual benefit estimate included only when visitor counts are available.

In terms of the annual benefit of recreation sites based on agency ownership, recreation sites in the study area on BLM lands amount to an estimated $6.1 million; of this, $562,842 can be attributed to the withdrawal parcels, and the remainder can be attributed to recreation sites in the overall study area, outside the proposed withdrawal parcels. Recreation sites in the study area on NPS lands amount to an estimated $443 million; none of the NPS recreation sites are located within proposed withdrawal parcels. There are very few Forest Service visitor data; therefore, it is difficult to estimate the benefit of recreation sites on Forest Service lands. However, using the data that are available, Forest Service recreation sites in the study area contribute an estimated $719,763 each year.

Hunting

Hunting is a popular activity within the study area; this activity occurs on both BLM and Forest Service lands. Large areas of undeveloped lands in northern Arizona provide habitat for many species, including big and small game. Big-game hunting use was estimated from AGFD data by GMU, as this agency regulates the sport and records data on hunting use by animal and by area throughout Arizona (Table 3.16-18). In Table 3.16-18, deer hunting was used as a proxy for estimating economic values from this activity in the study area.

Table 3.16-18. Big Game Hunting Use, Success Rate, and Economic Values in the Three GMUs (Averages 2004–2008)

AGFD GMU	Average Success Rate	Deer Average Annual Hunter Days	Elk Average Annual Hunter Days	$ Value/ Hunter Day	Annual Value for Each Entire GMU	% GMU in Study Area	Annual Value for % GMU in Study Area
9	29%	2,205	4,361	$81.00	$531,814.00	47.70%	$253,675.00
12A	59%	4319	21.8*	$165.76	$719,531.00	11%	$79,148.00
12B	69%	1,213	0	$192.00	$232,896.00	38.80%	$90,364.00
13A	74%	258	0	$204.00	$52,632.00	35%	$18,421.20
State Average	**45%**	**–**	**–**	**$125.00**			
Total					**$1,536,873.00**		**$441,608.00**

Sources: AGFD (2008b); USFWS (2006).

* AGFD only provides elk hunter days for GMU 12 for the whole unit; data are not split between GMU 12A and 12B. For this document, all GMU 12 data for elk hunting are summarized in GMU 12A. Additionally, there were only data for GMU 12 for 2004 (109 hunter days), but averaged over 5 years it equals 21.8 days.

Four GMUs in Arizona overlap the three proposed withdrawal parcels (GMUs 9, 12A, 12B, and 13A). Based on available data for deer hunting, the value per hunter day is tailored to the hunting quality of each GMU, using the percent harvest success rate of the unit relative to the state average success rate. The state average value of hunting is $125 per day, according to USFWS (2006). This statewide average value is associated with the statewide average success rate of 45%. Thus, GMU 9, with a success rate of 29%, has about two-thirds (0.64, to be exact) of the state average success rate. Using this ratio, the state average hunter day of $125 is adjusted downward for GMU 9 to reflect its lower success rate. Likewise, GMUs 12A, 12B, and 13A have higher success rates than the state average, so the implicit quality of the hunting trip would be higher than the state average, at $192 and $204, respectively. No data on the value per hunter day for elk hunting are available for Arizona; however, for this analysis, we are assuming that the value per hunter day for elk hunting is at least the same as for deer hunting.

Table 3.16-18 summarizes big-game hunting use, success rates, and values per day for each GMU in the study area. Based on the average success rates, average annual hunter days, and values per hunter day presented in Table 3.16-18, the total estimated annual value for GMUs 9, 12A, 12B, and 13A is $1.53

million. Hunting within the proposed withdrawal area accounts for 28%, or $4 of the economic value of hunting in these four GMUs.

Existence and Use Value

Values for goods traded in the market and for on-site recreation use are called “use values” and are considered the traditional measure of value for the economic implications of policy or management decisions (Harpman et al. 1994) (see “Recreation Economics” discussed above). In addition to the economic value of recreation activities and mineral development, there is also the value that people place on the sheer existence of a unique resource, or the preservation of the resource (also known as existence, nonuse, or bequest value). That is, people value a resource even if they have never visited it, just because it exists. Research indicates that existence value of a resource is most likely to be greater when the resource is unique (e.g., Grand Canyon National Park or Old Faithful Geyser in Yellowstone National Park) (Harpman et al. 1994).

Air Quality and Impacts to Recreation

Deterioration of the region’s visual quality could affect recreationists’ choices and levels of visitorship. Two studies have looked at the value that visitors get from the current visibility conditions at Grand Canyon National Park (the Park is a Class I airshed) and how much they would pay to avoid a reduction in visibility.

One study (conducted by McFarland et al. in 1983) surveyed visitors at Grand Canyon National Park to estimate how much they would pay to avoid a reduction in visual range. This study found that the WTP is $2.61 per visitor day. A second study (by Brookshire and Schulze, also in 1983) asked households that visited Grand Canyon National Park what they would pay in higher daily admission to the park to avoid a decrease in visibility from current conditions to poor conditions. These per-day visitor values range from $5.72 in Albuquerque, New Mexico, to $9.72 in Los Angeles, California. These values and references are summarized in Table 3.16-19. These values reflect adjustment using the Consumer Price Index from the original study year dollars to 2008 dollars.

In addition to these WTP values, the McFarland et al. (1983) study also asked whether visitors would change their length of stay at Grand Canyon National Park as a result of deterioration of visual range or visibility. About 80% of visitors said they would shorten their length of stay at the Park. A reduction in visitation would have the effect of reducing visitor spending, thereby changing the input and output of the regional economy.

Table 3.16-19. Summary of Values to Visitor to Prevent a Decrease in Visibility (Visual Range) at Grand Canyon National Park

Study	Sample	WTP per Visitor Day ($2008)
McFarland et al. (1983)	On-site visitors	$2.61
Brookshire and Schulze (1983)		
Albuquerque, New Mexico	Visiting households	$5.72
Denver, Colorado	Visiting households	$6.61
Los Angeles, California	Visiting households	$9.22

Sources: Brookshire and Schulze (1983); McFarland et al. (1983).

Energy Resources

The major commodity of interest in the proposed withdrawal area continues to be uranium. Other precious metals could be recovered from breccia pipe deposits concurrent with uranium mining, including gold, silver, copper, and vanadium. However, recovery of these metals is assumed to not be significant enough to drive mine development and thus is not considered in this study as part of the mineral economics discussion.

Economically viable uranium deposits can be found in Arizona and in several other western states, including Utah, Colorado, New Mexico, and Wyoming (EIA 2003). In the United States, the highest-grade uranium deposits are thought to be located in northwestern Arizona. Statewide, an estimated 13% to 16% of U_3O_8 is thought to be located in Arizona (EIA 2003). According to the EIA (2003), Wyoming uranium deposits have the most potential in terms of U_3O_8 output (approximately 40%) (Table 3.16-20). The current market price of U_3O_8 was U.S. $44.04 per pound in December 2009 (Index Mundi 2009).

Table 3.16-20. U.S. Forward-Cost Uranium Reserves by State, December 31, 2003*

State(s)	$30 per pound Ore (million tons)	$30 per pound Grade[†] (% U_3O_8)	$30 per pound U_3O_8 (million pounds)	$50 per pound Ore (million tons)	$50 per pound Grade[†] (% U_3O_8)	$50 per pound U_3O_8 (million pounds)
Wyoming	41	0.129	106	238	0.076	363
New Mexico	15	0.28	84	102	0.167	341
Arizona, Colorado, Utah	8	0.281	45	45	0.138	123
Texas	4	0.077	6	18	0.063	23
Other[‡]	6	0.199	24	21	0.094	40
Total	**74**	**0.178**	**265**	**424**	**0.105**	**890**

Notes: Table reproduced from EIA (2003). Uranium reserves that could be recovered as a by-product of phosphate and copper mining are not included in this table. Reserves values in forward-cost categories are cumulative; that is, the quantity at each level of forward-cost includes all reserves at the lower costs. Totals may not equal sum of components because of independent rounding.

* From EIA (2003).

† Weighted average percent U_3O_8 per ton of ore.

‡ Includes California, Idaho, Nebraska, Nevada, North Dakota, Oregon, South Dakota, and Washington.

The uranium reserve estimates from the EIS (2003) summarized in Table 3.16-20 are provided as a context for the relative importance of uranium deposits within the proposed withdrawal area, as a portion of national uranium reserves. It should be noted that these estimates were compiled using a fundamentally different methodology than those used in the RFD (see Appendix B) for this analysis. The EIA estimates reflect a region including Arizona, Colorado, and Utah. Within this region, data on uranium reserves were compiled from industry surveys, information from previous estimates, and information from other government agencies. The EIA estimate includes known uranium deposits, such as those for which borehole data or geochemical sampling have confirmed the presence of uranium ore. Furthermore, the EIA estimate assumes a uranium price ranging from $30 to $50 per pound; at higher prices, uranium of lesser grade can be recovered, thus increasing the estimate of uranium reserves.

Alternatively, the amount of uranium considered in the RFD (see Appendix B) is restricted to only the proposed withdrawal area, rather than a three state area (Arizona, Colorado, and Utah). The amount of uranium resource considered in the RFD includes both known deposits as well as estimates of undiscovered uranium resources. The total amount of uranium resources considered to be mineable in the RFD under Alternative A is 33,155 tons U3O8 (see also Table 3.3-1); the proportion of this that would likely to have been included in the 2003 EIA estimate is 4,147 tons U3O8, with the remainder of the RFD estimate representing undiscovered uranium resources or breccia pipes that have been discovered but not yet quantified for uranium reserves.

As outlined in Appendix B, the economics of mining in the proposed withdrawal area is driven by the relationship between uranium production costs and market price. Whereas production costs can be controlled or anticipated, through management and technology, the significant unknown factor will be the price of uranium. The overall profitability of an operation—and hence the level of activity at the prospecting, exploration, and mining phases for development of breccia pipes—is closely related to the price of uranium. Uranium mining is subject to constant variations in price, supply, and demand over the past half-century.

The amount of uranium mined as a percentage of known domestic resources, domestic demand, and domestic production and as a percentage of known global demand and production is discussed in Section 3.3. Like oil and lumber, uranium mined in the U.S. can be sold to consumers domestically or 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 in the United States would not necessarily move the United States toward energy independence.

The following discussion and Table 3.16-21 are based on known reserves, estimated uranium resources in undiscovered pipes not yet quantified, and undiscovered uranium endowment (see Table 3.3-1). A total of 33,155 tons of economically viable U3O8 is estimated to be located within the proposed withdrawal area. Using a flat rate of $40.00/pound, the total estimated value of available uranium resources in the proposed withdrawal area is $2.97 billion. Over 60 percent of this estimate is located within the North Parcel ($1.77 billion).

Table 3.16-21. Estimated Value of Estimated Total Available Uranium Resources in the Proposed Withdrawal Area

Parcel	Estimated Total Available Uranium Resources (tons U_3O_8)*	Total Estimated Value**
North	20,177	$1,775,576,000
East	3,339	$293,832,000
South	9,639	$848,232,000
Totals	**33,155**	$2,917,640,000

* See Table 3.3-1 of this EIS for known reserves, estimated undiscovered resources, and undiscovered uranium endowment. This figure represents the estimated amount of economically viable uranium in the withdrawal area.

* Using estimated $40/pound; assuming price stays flat (would account for indefinite market fluctuations), using 2010 dollars (does not adjust for inflation).

In terms of industrial output in the study area, mining of locatable minerals ranks in the top 10 industries in Kane and San Juan counties in Utah. Locatables most commonly mined in these two counties include uranium, copper, and placer gold (BLM 2008d). Denison is also considered a leading employer in San Juan County, Utah (see employment discussion above [Utah Department of Workforce Services 2009]); jobs in the mining sector accounted for 9.81% of area employment in 1990 and dropped to 6.24% in 2007. This is likely the result of a decline in activity at the White Mesa Uranium Processing Mill near Blanding. In Washington County, mining accounted for 0.61% of county employment in 1990 and dropped to 0.54% in 2007. In terms of overall employment in Arizona, jobs in the mining sector accounted for less than 0.5% of area employment in Coconino and Mohave counties between 1990 and 2007. Of all study area counties, San Juan County appears to benefit from mining the most in terms of employment and industrial output over the other study area counties.

Road Condition and Maintenance

Access routes to the proposed withdrawal area along with average daily traffic volume are discussed in Section 3.15.1.4 under Transportation Conflicts. On BLM lands on the Arizona Strip, paved roads are rare and account for less than 3% of the transportation system (including roads, primitive roads, and trails) (BLM 2008b). Of the total transportation system (8,032 miles), 6,675 miles (84.5%) consist of primary, secondary, and tertiary unpaved roads. Various federal, state, and/or county agencies and private groups or individuals maintain these roads. The road network provides access to area destinations, including mining and livestock operations, utility and communication facilities, and range and wildlife developments, etc. (BLM 2008b). The road network is also valuable to the recreating public for access.

In terms of Forest Service lands, nationally, most of the existing roads on Forest Service lands were built over the past 50 years for harvesting timber. As with BLM roads, forest roads provide access for recreation, research, fish and wildlife habitat management, grazing, resource extraction, fire protection, insect and disease control, and private land use, among other things. There are more than 900 miles of roads, including unauthorized routes, on the Tusayan Ranger District. Of these, 740 are open to motorized travel. Annually, an average 100 miles of road are maintained, at a cost of approximately $487,000 each year (Forest Service 2008e).

Both the BLM Arizona Strip Field Office and Tusayan Ranger District are currently revising their respective route designations through separate NEPA processes. These route designations will likely result in changes to the existing route network and mileages discussed above.

Estimates for current use include approximately 6,326 haul trips per mine over a 4- to 5-year period (an annual average of 24–30 trips per week, or 5–6 trips per day per mine) (see RFD scenarios, Appendix B). Mining companies would be responsible for paying for the maintenance of unpaved public roads used to haul ore. The Arizona and Utah Deparments of Transportation would be responsible for managing and funding maintenance on state highways. The Federal Highway Association would be responsible for managing and funding maintenance on interstates.

3.16.2 Economic Condition Indicators

Mineral exploration and construction, operation, and maintenance of proposed uranium mine facilities and/or the proposed withdrawal of mineral estates and the associated reduction in mineral exploration and development have the potential to impact economic conditions resources within the study area. Resource condition indicators include those listed below (Table 3.16-22).

Table 3.16-22. Economic Condition Indicators

	Description of Relevant Issue	Resource Condition Indicator(s)
Effects on economic activity from mineral development	Mineral exploration and development represents a large component of the economic activity for many communities in the region. The manner and degree to which the proposed withdrawal could directly change the economic activity in the area, particularly in smaller communities, is an issue.	*Indicator:* Number of persons in the region directly and indirectly employed by the uranium mining industry. *Indicator:* Local and state revenue from property and income taxes directly tied to uranium mineral exploration and development.
Effects on economic activity from tourism	Tourism represents a large component of the economic activity for many communities in the region and for the states. The manner and degree to which continued mining could change the nature and quality of the natural resources that attract tourism is an issue.	*Indicator:* Visitor user days and value per visitor user days to tourist destinations, primarily Grand Canyon National Park but also National Forest System and BLM lands.

Table 3.16-22. Economic Condition Indicators (Continued)

	Description of Relevant Issue	Resource Condition Indicator(s)
Energy resources available	The withdrawal of uranium deposits in the study area would remove a potential source of energy production, which would then be replaced by energy produced from other sources, either additional mining elsewhere, imports of uranium from foreign sources, or production from equivalent amounts of other sources like coal, petroleum, natural gas, wind power, or solar.	*Indicator:* Value of energy produced from study area. *Indicator:* Equivalent amount of other energy-producing commodity represented by uranium production.
Road condition and maintenance	The use of road systems to service mine operations requires increased maintenance of the transportation infrastructure. This includes use for ore transport and employee access. Increased mineral exploration and development could presumably increase funding from property and use taxes at the same time at which maintenance needs increase. Conversely, decreases in activity mean less maintenance, along with less potential revenue.	*Indicator:* Number of haul trips anticipated on major public use roads over the next 20 years. *Indicator:* Required maintenance level on public roads systems used for mineral operations. *Indicator:* The net change in funding available for road maintenance.

Economic Activity

Indicators used to determine the economic condition in the study area include the amount of industry output. IMPLAN 2008 software and data will be used to model potential changes in economic activity under different mineral exploration and development and development scenarios. In IMPLAN, industry output changes are estimated by measuring changes in direct value of local production, plus the additional inter-industry transactions that result from local production, plus any additional household spending that results from inter-industry production (the multiplier effect).

Employment, Personal Income, and Unemployment

Indicators used to determine the economic conditions in the study area include employment, personal income, and unemployment for all industries.

Taxes and Revenues

Indicators used to determine the economic conditions in the study area include taxes and revenues in terms of the amount of severance taxes, sales and use tax, lodging taxes, and PILT.

IMPLAN 2008 software and data will be used to model potential changes in taxes (excluding PILT[4]). Industry output measures (as described above in Section 3.16.1) can demonstrate contributions to the study area (county and state level) through production taxes, royalties, and fees on potentially exported ore.

Recreation Economics

Indicators used to determine the economic conditions in the study area with respect to recreation economics include the estimated value of non-consumptive and consumptive recreation activities, tourist spending levels, total output, income, and/or employment resulting from tourist spending.

Benefits to tourists/recreationists will also be estimated by referring to existing literature on people’s WTP for existence and use values in the proposed withdrawal area and how that WTP might change under different alternatives.

[4] Because no change in federal land ownership is expected, no impacts to PILT collections are anticipated.

Energy Resources

Indicators used to determine conditions regarding the availability of energy resources include the amount of undiscovered uranium resources or uranium reserves remaining at existing mines and the energy equivalent of those uranium resources.

Road Condition and Maintenance

Indicators used to determine conditions regarding road condition and maintenance include the number of haul trips for existing mines over the next 20 years, required maintenance level on public roads systems used for mineral operations, and the net change in funding available for road maintenance.

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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 nonpoint 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* (μg/m³)	Background Concentration (μg/m³)	Total Concentration (μg/m³)	NAAQS (μg/m³)	% 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.

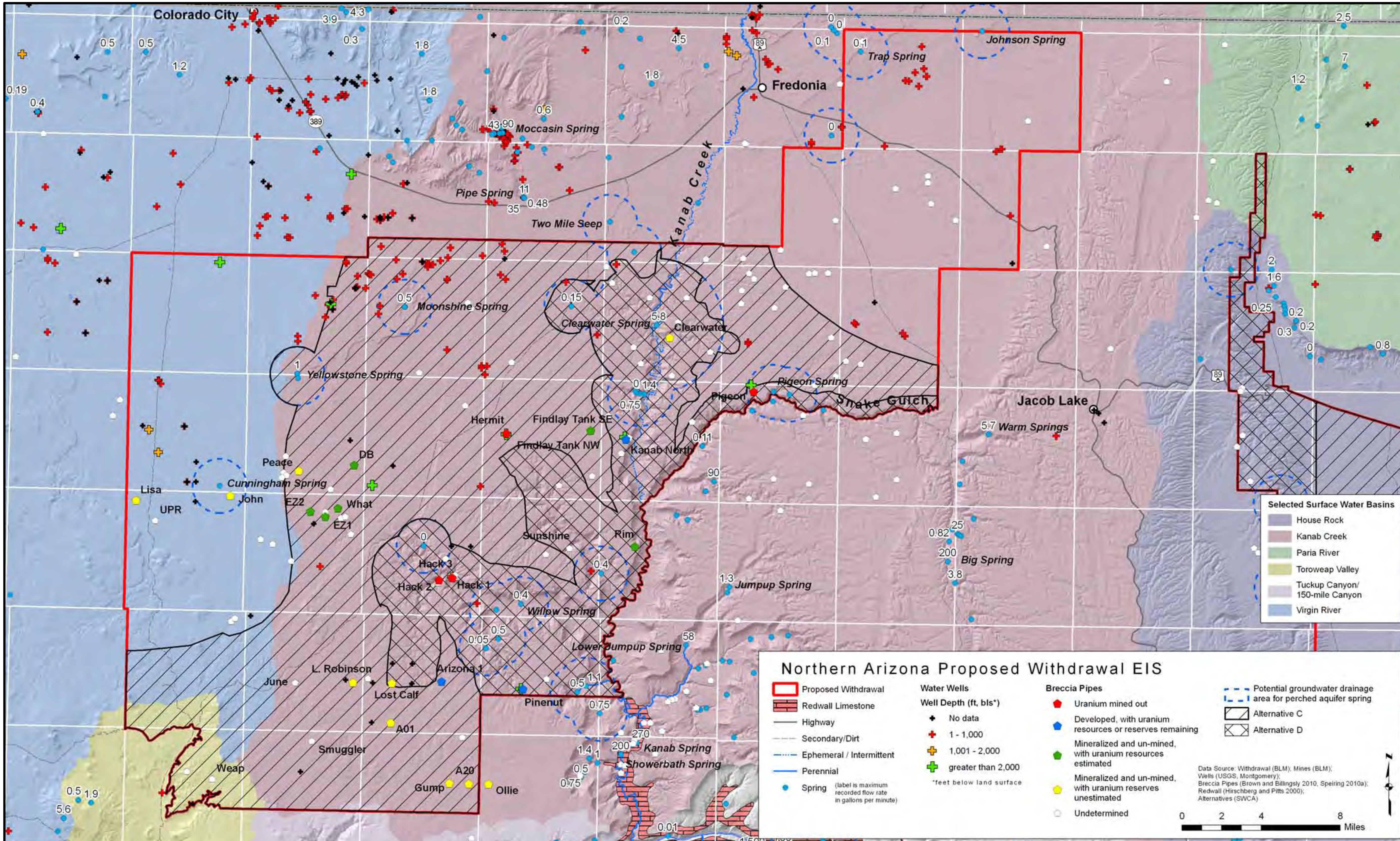

Figure 4.4-1. North Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

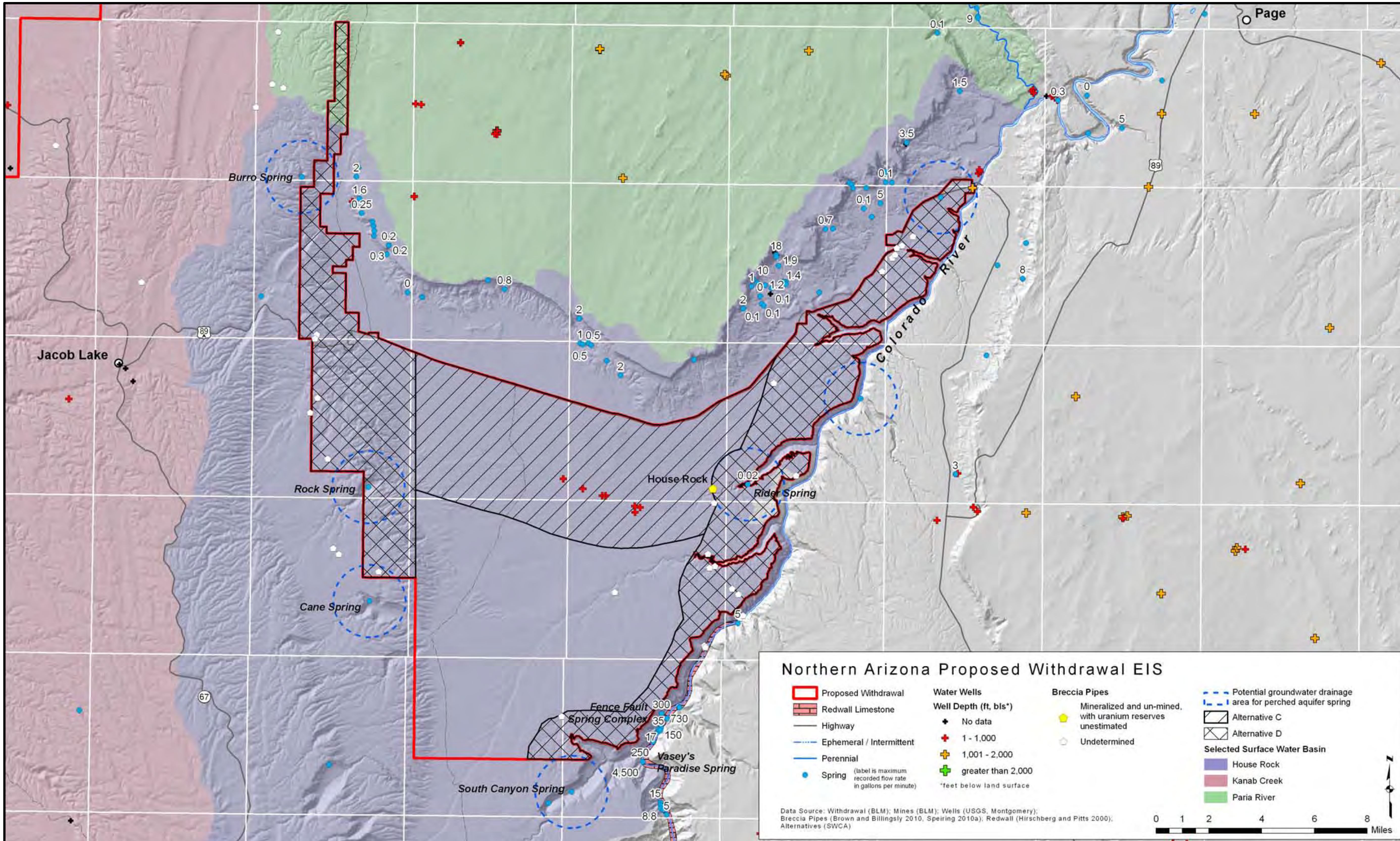

Figure 4.4-2. East Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

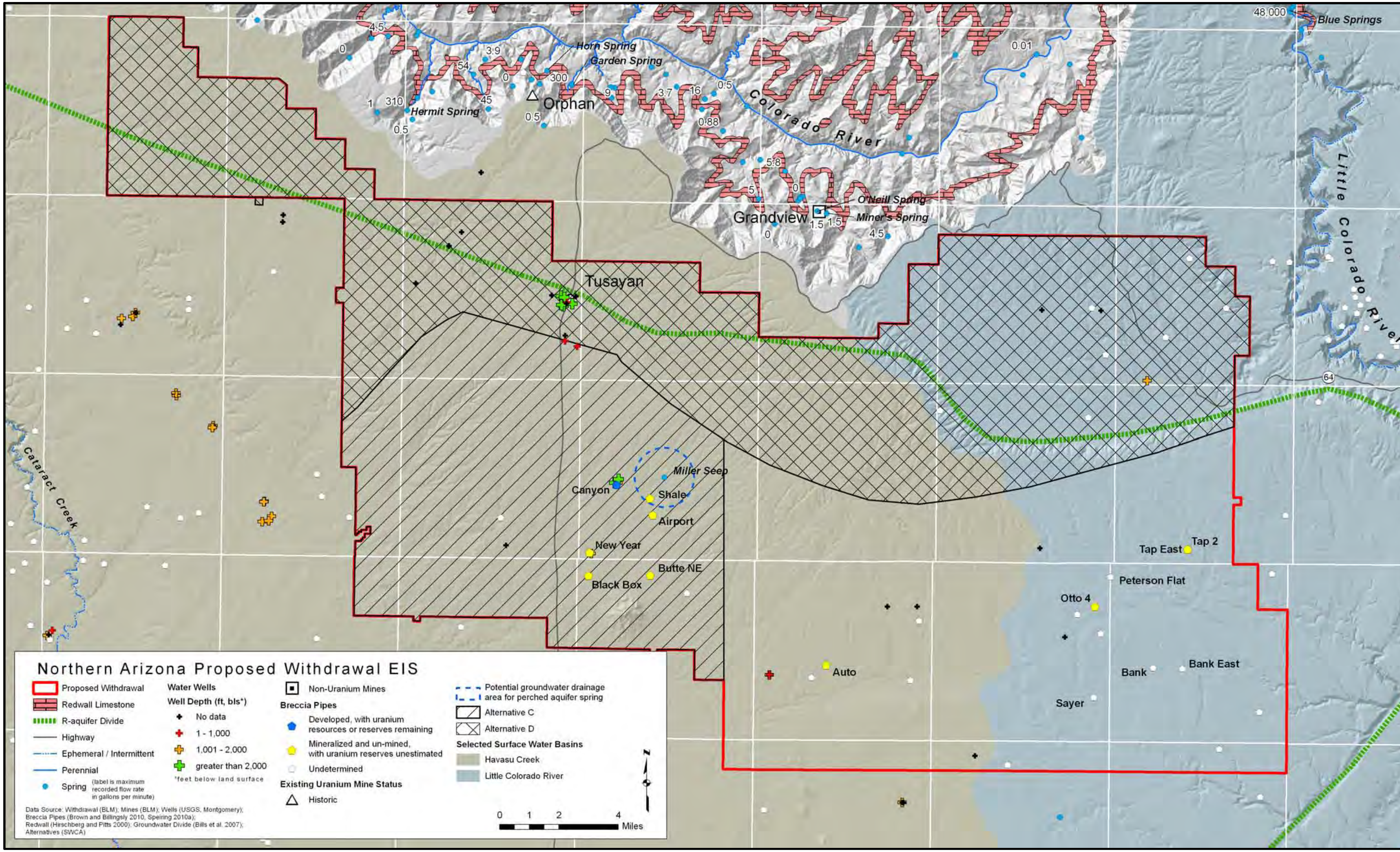

Figure 4.4-3. South Parcel locations of alternative withdrawal areas, protective spring buffers, springs, and water wells.

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:

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

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.

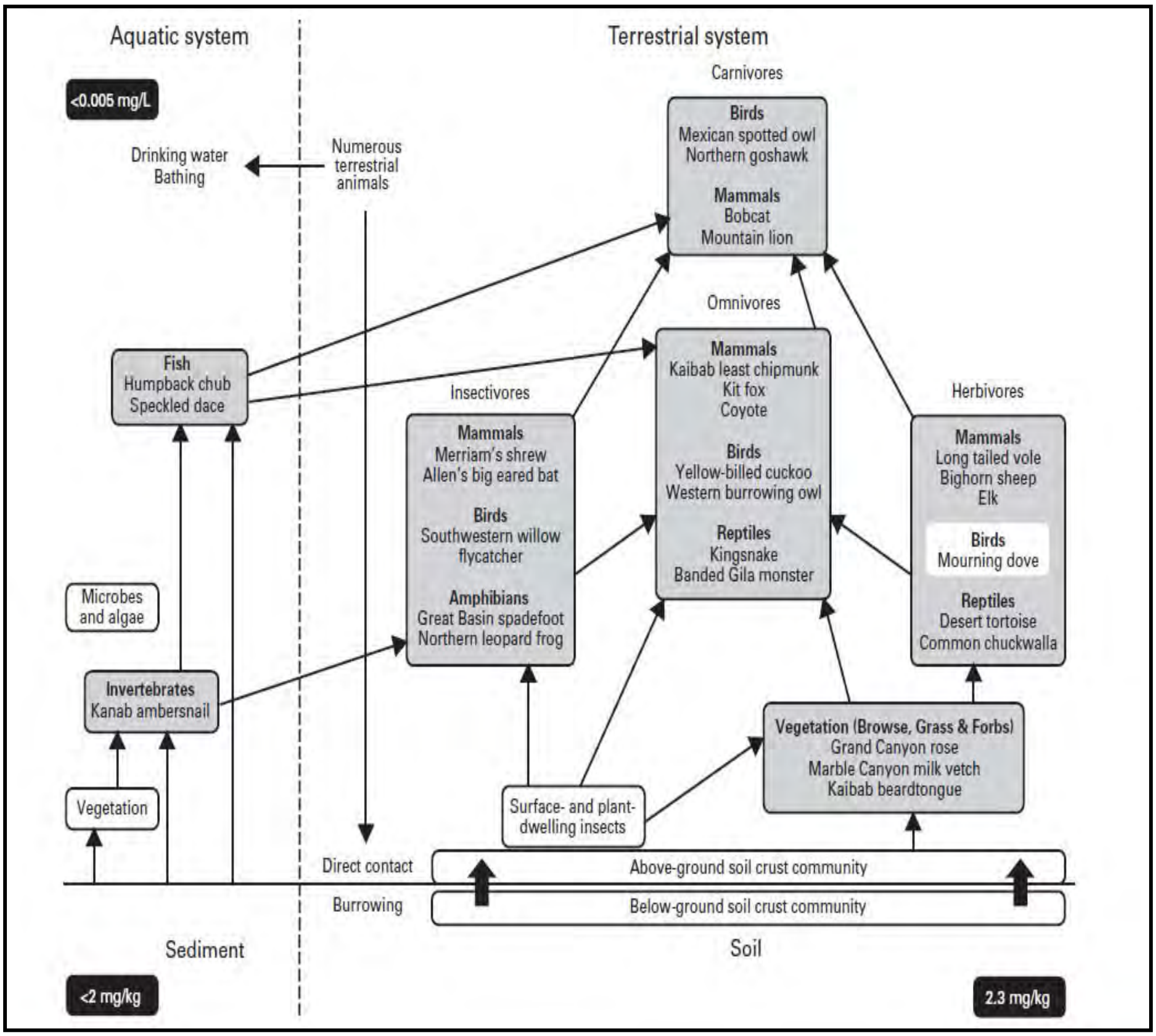

Figure 4.7-1. Potential linkage between chemical and radiation hazards associated with mining operations and biota (from Hinck et al. 2010).

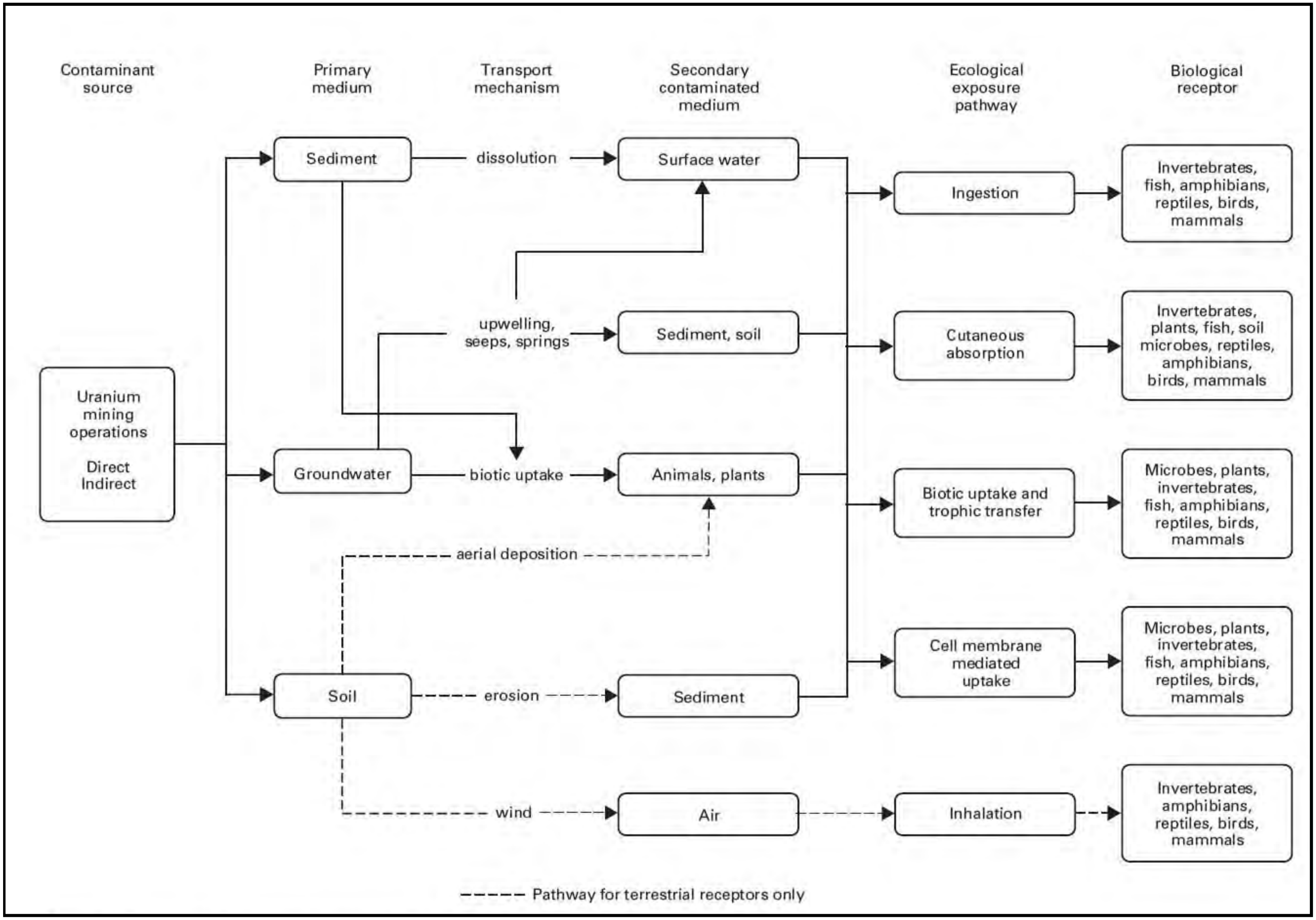

Figure 4.7-2. Exposure Pathways among generalized terrestrial and aquatic habitats (from Hinck et al. 2010).

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.

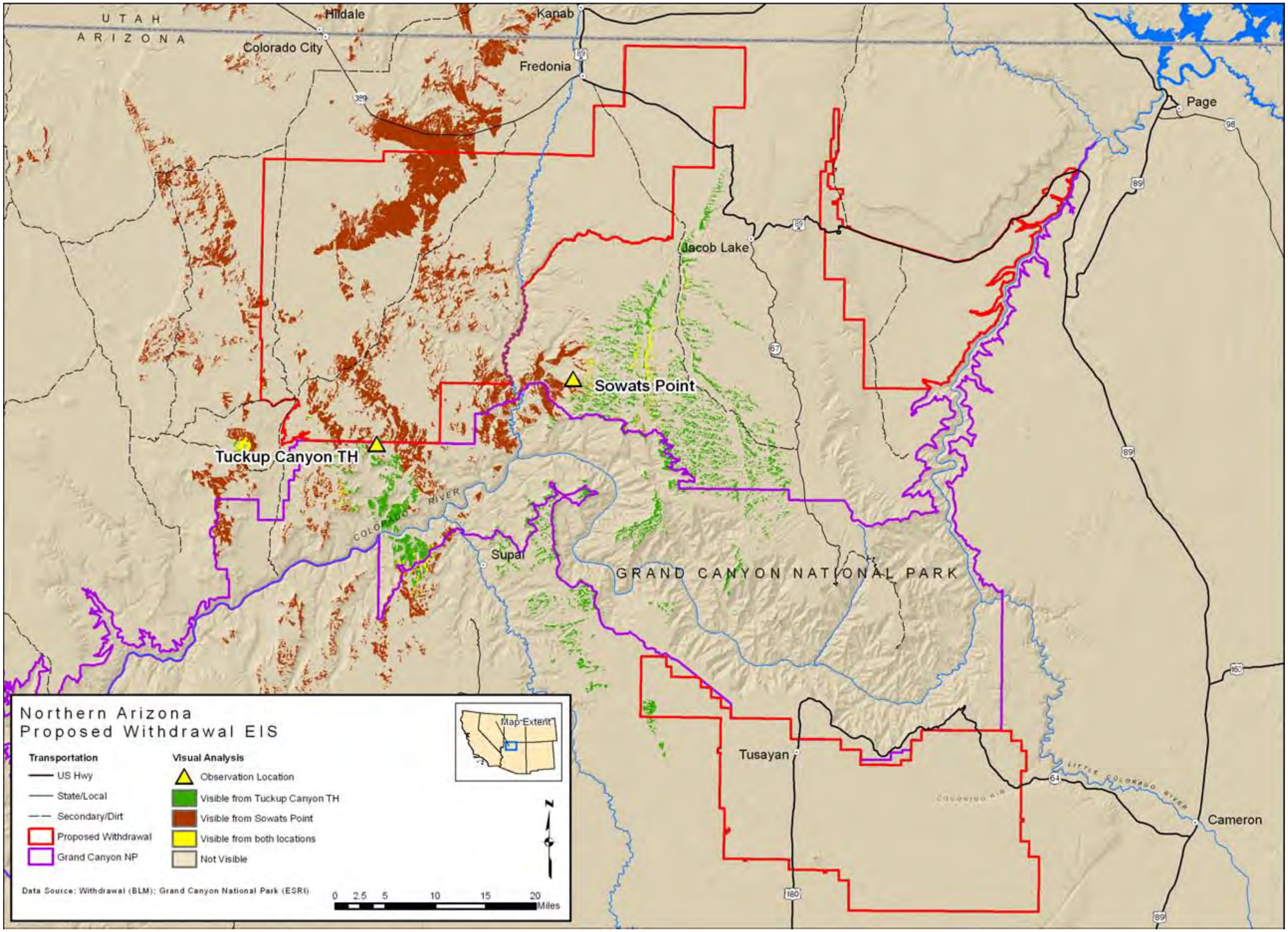

Figure 4.9-1. Viewshed analysis for Tuckup Canyon TH and Sowats Point.

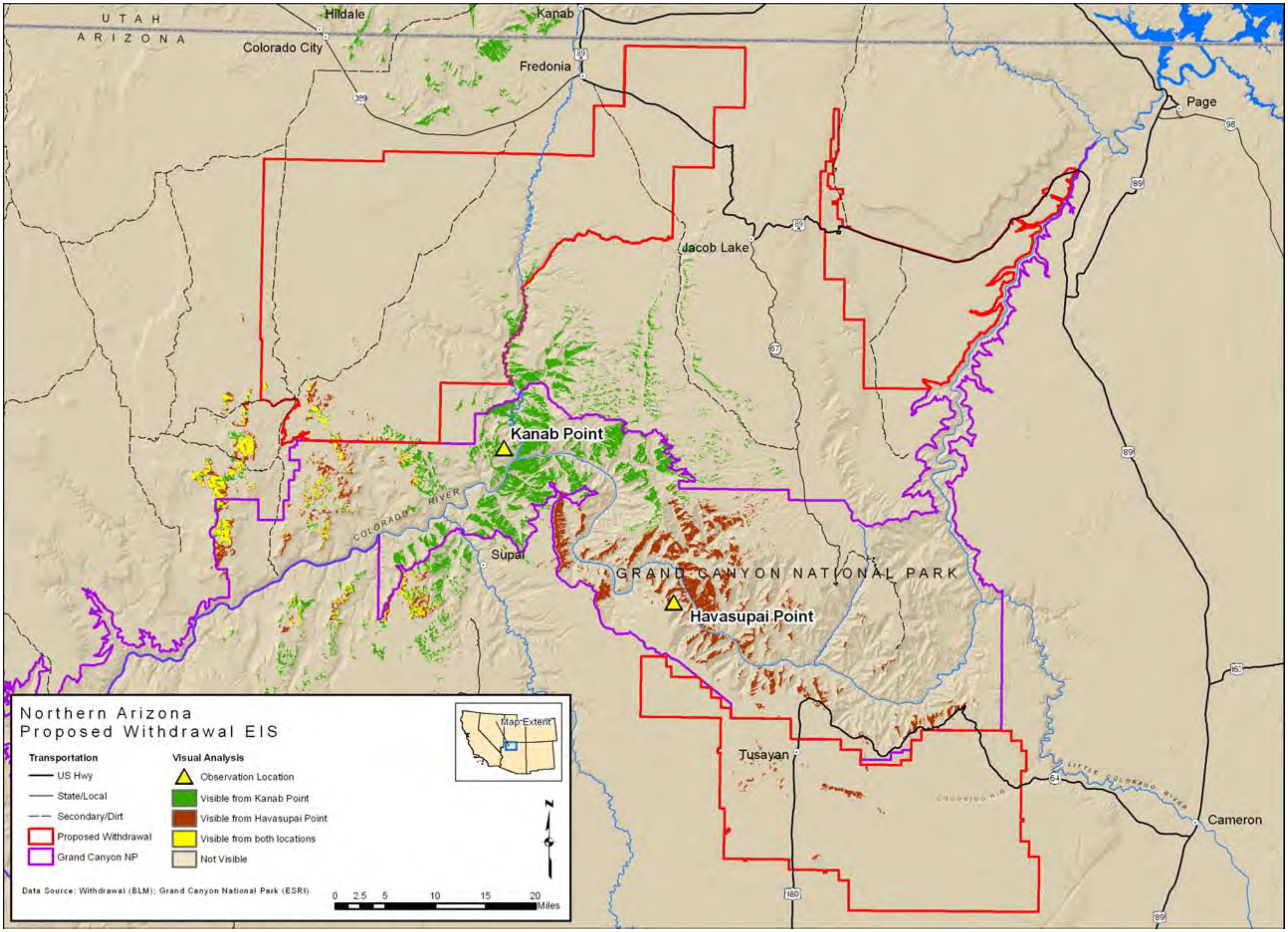

Figure 4.9-2. Viewshed analysis for Kanab Point and Havasupai Point.

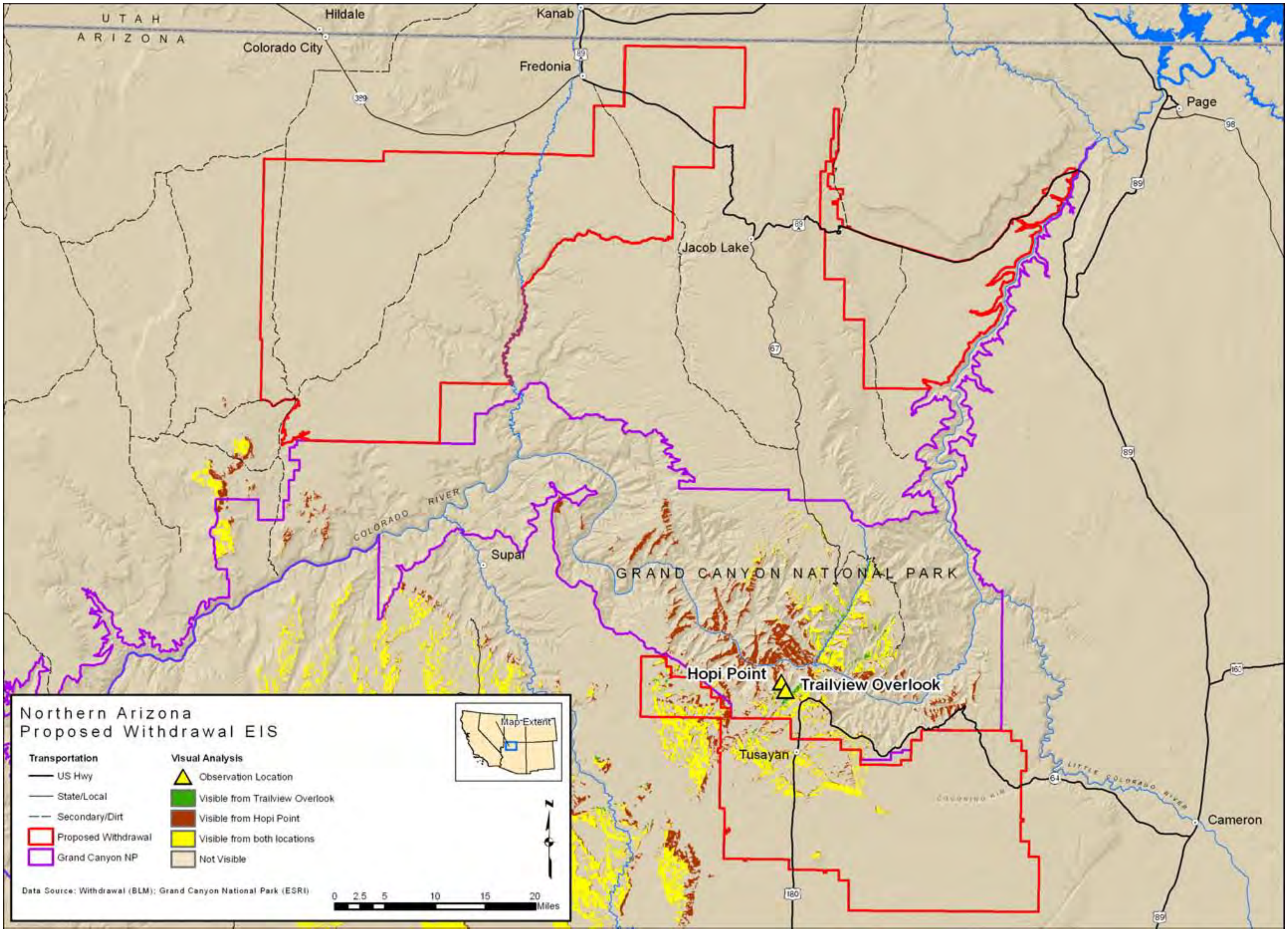

Figure 4.9-3. Viewshed analysis for Cape Final and Cape Royal.

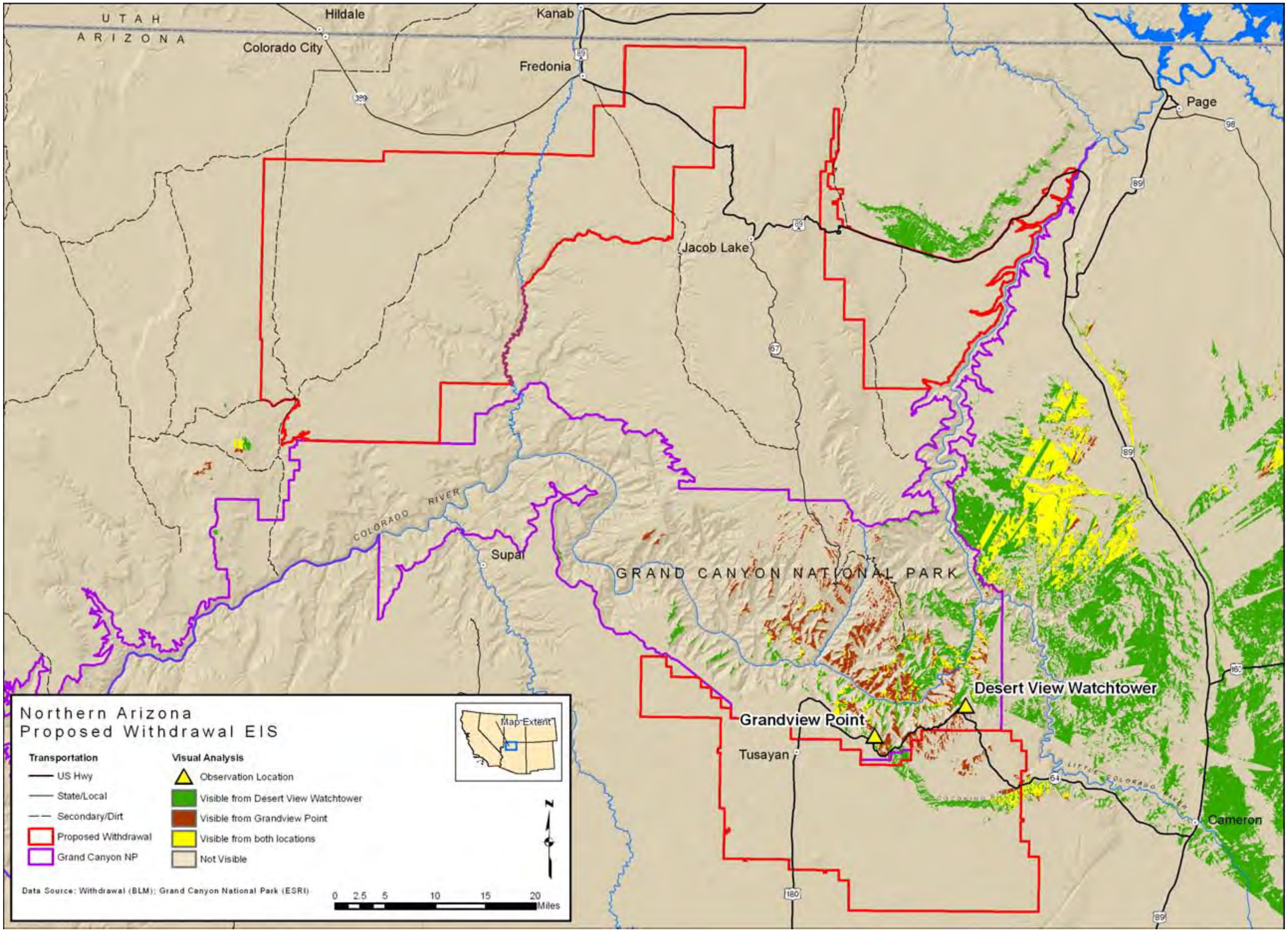

Figure 4.9-4. Viewshed analysis for Point Imperial and Bright Angel Point.

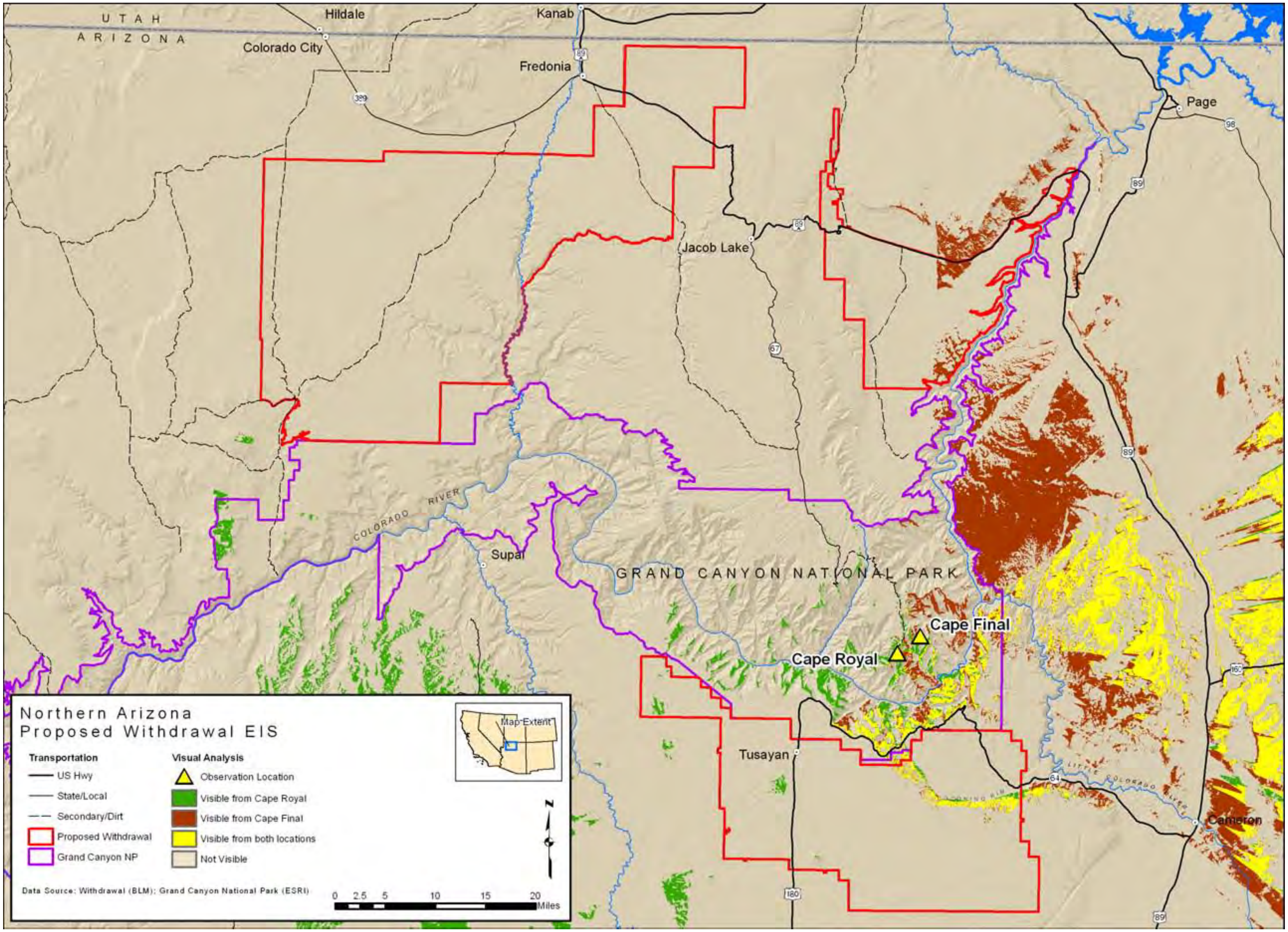

Figure 4.9-5. Viewshed analysis for Desert View Watchtower and Grandview Point.

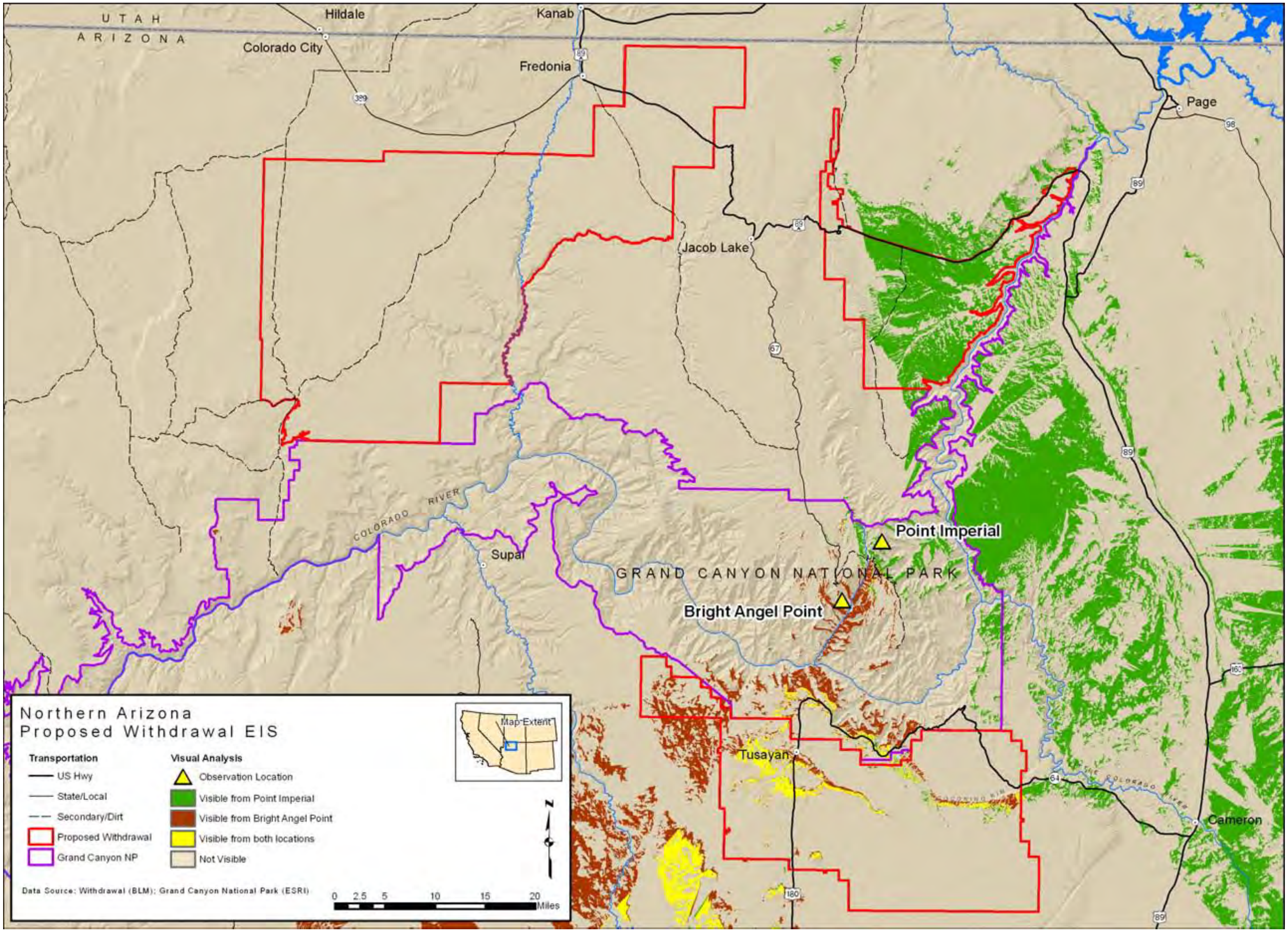

Figure 4.9-6. Viewshed analysis for Trailview Overlook and Hopi Pont.

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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Chapter 5

CONSULTATION AND COORDINATION

An EIS must be prepared when a federal government agency considers approving an action within its jurisdiction that may impact the human environment. An EIS aids federal officials in making decisions by presenting information on the physical, biological, and social environment of a proposed project and its alternatives. The first step in preparing an EIS is to determine the scope of the project, the range of action alternatives, and the impacts to be included in the document.

This EIS has been prepared with input from and coordination with interested tribal governments, agencies, organizations, and individuals. The CEQ regulations [40 CFR 1500–1508] require an early scoping process to determine the issues related to the Proposed Action and alternatives that the EIS should address. The purpose of the scoping process is to identify important issues, concerns, and potential impacts that require analysis in the EIS and to eliminate insignificant issues and alternatives from detailed analysis. Public involvement is a vital component of NEPA for vesting the public in the decision-making process and allowing for full environmental disclosure.

5.1 PUBLIC INVOLVEMENT

The purpose of scoping is to provide an opportunity for members of the public to learn about the proposed withdrawal and to share any concerns or comments they may have. Input from the public scoping process is used to help the BLM identify issues and concerns to be considered in the EIS, as well as to identify potential alternatives. In addition, the scoping process helps to identify any issues that are not considered relevant and that can therefore be eliminated from detailed analysis in the EIS. The list of stakeholders and other interested parties is also updated and generally expanded during the scoping process.

The BLM hosted two scoping meetings in Fredonia and Flagstaff, Arizona, on September 30 and October 15, 2009, to provide the public with an opportunity to learn about the project and provide comments. The meeting in Fredonia was held at the Fredonia Elementary School on East Hortt, and the meeting in Flagstaff was held at the High Country Conference Center on Butler Avenue. An open house format was used to encourage two-way dialogue and to encourage discussions about issues to be addressed in the Northern Arizona Proposed Withdrawal EIS, concerns about the process, and development of the range of alternatives to be analyzed in the Draft EIS. Meeting attendees signed in upon entering, at which time they were provided with handouts and informed about the meeting format and how to comment at the meeting. The handouts and displays provided information about the NEPA process, project background, tentative project schedule, preliminary issues to be analyzed in the EIS, location maps, and how to provide comments. A 30-day scoping comment period was provided in order for the public to submit written comments related to potential issues.

The scoping meetings were advertised 15 days prior to their scheduled dates in the *Federal Register*, the *Southern Utah News*, and the *Arizona Daily Sun*, in an email to the BLM stakeholder mailing list, and on the BLM website at <http://www.blm.gov/az>. The BLM has maintained a link on the website for the Northern Arizona Proposed Withdrawal EIS to provide information to the public regarding the NEPA process, EIS schedule, public scoping, and other information pertinent to the project.

Members of the public were afforded several methods for providing comments during the scoping period. These included multiple comment stations with comment forms at the scoping meeting and the opportunity to send emails or letters to BLM personnel. A total of 83,525 individuals submitted comments.

5.1.1 Newsletters

The BLM has arranged to produce and publish several newsletters on the website <http://www.blm.gov/az> at important milestones during the course of the project. The first newsletter, published in March 2010, announced the publication of the scoping report and USGS report; it also provided a brief summary of the scoping report and project schedule and a technical discussion of what breccia pipes are and how they are mined. The second newsletter, to be published in September 2010, will announce the public availability of the Draft EIS and include information on the alternative development process, maps illustrating the alternatives, and a narrative discussion of each alternative. Other newsletters will coincide with release of the Final EIS and with release of the ROD.

5.1.2 Mailing List

A mailing list identifying individuals (as points of contact) in organizations, agencies, and interest groups was used to provide information about the public meetings, scoping period deadlines, and other key milestones. The BLM mailing list was used as the foundation but was periodically revised, updated, and expanded throughout the scoping period and was further updated throughout the entire NEPA process. Individuals who signed in at either of the public meetings or submitted comments during the scoping period were automatically added to the mailing list unless they stated that they did not want to be added or did not want to receive additional information as the project progressed.

The first direct mailing related to the EIS process occurred on September 10, 2009, included 265 recipients (71 federal, state, and local government entities; 18 non-government organizations; 14 businesses; 25 tribal entities; and 137 media organizations). The mailing provided information about the Proposed Action, announced scoping meetings and locations, and provided information about how to submit comments. A second mailing was sent prior to announcing publication of this Draft EIS. This mailing included a summary of the Draft EIS and the alternatives that were analyzed, along with information about the comment period, how to review the EIS and how to comment, and the dates, times, and locations of all public review meetings. A third mailing at a future date will announce availability of the Final EIS, and a fourth mailing will announce availability of the ROD.

5.2 CONSULTATION WITH TRIBAL GOVERNMENTS

Federal agencies are required to consult with American Indian tribes as part of the Advisory Council on Historic Preservation Regulations, Protection of Historic Properties [36 CFR 800], implementing Section 106 of the NHPA. Accordingly, NHPA outlines when federal agencies must consult with tribes and the issues and other factors this consultation must address. In addition, pursuant to EO 13175, executive departments and agencies are charged with engaging in regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications and are responsible for strengthening the government-to-government relationship between the United States and Indian tribes.

In August 2009, BLM and the Forest Service initiated consultation via letter with the following tribal governments: Chemehuevi Tribe, Colorado River Indian Tribes, Havasupai Tribe, Hopi Tribe, Hualapai Tribe, Kaibab Band of Paiute Indians, Las Vegas Paiute Tribe, Moapa Band of Paiute Indians, Pahrump

Band of Paiutes, Paiute Indian Tribe of Utah, Pueblo of Zuni, San Juan Southern Paiute Tribe, Navajo Nation, White Mountain Apache Tribe, Yavapai-Apache Nation, and Yavapai-Prescott Indian Tribe.

The Havasupai Tribe, Hopi Tribe, and Hualapai Tribe, Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah, Pueblo of Zuni, and Navajo Nation all requested active consultation. The BLM and Forest Service have had one or more project-related meetings with each of these tribes. A summary of the dates of and tribal entity(ies) attending these meetings is provided in Table 5.2-1. Tribes are being provided with a copy of this Draft EIS, and consultation and partnering will continue throughout implementation of the selected action alternative, if approved.

Table 5.2-1. Tribal Meeting Summary

Date	Attendees
November 2, 2009	Southern Paiute Tribal Chair Association*
November 2, 2009	Paiute Indian Tribe of Utah Tribal Council
November 3, 2009	Kaibab Band of Paiute Indians Tribal Council and Staff
November 19, 2009	Hopi Cultural Resources Advisory Task Team/Hopi Cultural Preservation Office
November 23, 2009	Hualapai Tribal Council
December 4, 2009	Navajo Historic Preservation Department
December 17, 2009	Paiute Indian Tribe of Utah Tribal Council
February 9, 2010	Pueblo of Zuni Tribal Council and Staff
February 10, 2010	Hualapai Tribal Council
March 1, 2010	Paiute Indian Tribe of Utah Tribal Council
March 2, 2010	Shivwits Band of Paiute Indians Tribal Council
March 8, 2010	Hualapai Cultural Resources Staff
March 12, 2010	Navajo Historic Preservation Department
March 16, 2010	Kaibab Paiute Tribal Council and Staff
March 26, 2010	Hopi Cultural Preservation Department
April 6, 2010	Havasupai Tribal Council
May 18, 2010	Pueblo of Zuni Tribal Council and Staff
June 1, 2010	Paiute Indian Tribe of Utah Tribal Council
June 9, 2010	Kaibab Band of Paiute Indians Tribal Council and Staff
June 15, 2010	Hualapai Cultural Resource Staff
June 23, 2010	Hopi Cultural Preservation Office
June 23, 2010	Navajo Historic Preservation Department
July 8, 2010	Havasupai Tribal Council
September 14–15, 2010	Intertribal Meeting (Havasupai, Hualapai, and Hopi tribal members)*

* Does not represent official government-to-government consultation.

5.3 LIST OF PREPARERS

This EIS was prepared and reviewed by a team from the BLM and Forest Service. A team associated with SWCA Environmental Consultants (SWCA) assisted the BLM and Forest Service in conducting research, gathering data, and preparing the EIS and supporting documents. Table 5.3-1 identifies team members and their roles.

5.3.1 Interdisciplinary Team Members

Table 5.3-1. List of Preparers

Organization	Name	Qualifications	Project Role
BLM	Scott Haight	B.S. Geology	Project Manager
BLM	Scott Florence	B.S. Range and Wildlife	Arizona Strip District Manager
BLM	Lorraine Christian	B.S. Wildlife and Fisheries Biology	Arizona Strip Field Manager
BLM	Chris Horyza	B.S. Forestry and Range Management	Project Manager/Arizona State Office Planning and Environmental Coordinator
BLM	Todd Calico	B.I.S. Natural Resources and Environmental Studies	Cartographic Technician
BLM	Rody Cox	B.A. Molecular, Cellular, and Developmental Biology M.S. Earth Sciences	Geologist/Mineral Specialist
BLM	Jim Fogg	M.S. Watershed Science	Hydrologist
BLM	Jeff Garrett	B.S. Geology	Mining Law Program Lead
BLM	Diana Hawks	B.S. Archaeology M.S. Archaeology	District Recreation, Wilderness, and Cultural Resources Team Lead
BLM	John Herron	B.A. Archaeology (minor in Ecology and Evolutionary Biology)	Archaeologist
BLM	Lee Hughes	B.S. Fisheries and Range Management	Ecologist
BLM	Tim Hughes	B.S. Wildlife Biology	Threatened and Endangered Species Program Lead, Arizona State Office
BLM	Jon Jasper	M.S. Geosciences	Outdoor Recreation Planner
BLM	Michael Johnson	B.S. Anthropology M.S. Anthropology	Deputy Preservation Officer
BLM	Joel Larson	B.A. Geography M.P.P. Master of Public Policy	Social Science Program Analyst
BLM	Brent Lewis	B.A. Geology B.S. Environmental Science M.S. Geology	Human Toxicologist
BLM	Paul McNutt	B.S. Environmental Science M.S. Economics	Economist
BLM	Craig Nicholls	B.S. Atmospheric Sciences M.S. Atmospheric Sciences	National Air Quality Modeler
BLM	Darla Pindell	B.A. Economics and Accounting M.B.A. Business Administration	Socioeconomist
BLM	Jeff Simms	M.S. Wildlife and Fisheries Science B.S. Fisheries Science	Fisheries Biologist
BLM	Bob Smith	B.S. Plant, Soil, and Water Science Graduate Certificate, Hazardous Waste Land Management	Soil, Water and Air Specialist
BLM	Richard Spotts	B.A. Political Science J.D. Law	Planning and Environmental Coordinator
BLM	Connie Stone	Ph.D. Anthropology	Archaeologist
BLM	Joan Trent	M.S. Environmental Science	Sociologist

Table 5.3-1. List of Preparers (Continued)

Organization	Name	Qualifications	Project Role
Forest Service	Liz Schuppert	B.S. Forest Management	Kaibab National Forest Recreation, Lands and Minerals Staff Officer
Forest Service	Alvin Brown	B.S. Forestry	Kaibab National Forest NEPA Coordinator
Forest Service	Roger Congdon	B.S. Geology M.S. Geology Ph.D. Geology	Groundwater Geologist, Southwestern Region of the Forest Service
Forest Service	Angela Gatto	B.S. Biological Sciences M.S. Forestry	Wildlife Biologist, North Kaibab Ranger District
Forest Service	Margaret Hangan	B.A. Anthropology M.A. Anthropology	Kaibab National Forest Heritage Program Manager
Forest Service	Mike Hannemann	B.S. Wildlife Biology M.S. Forestry	Kaibab National Forest Range and Watershed Staff Officer
Forest Service	Christopher MacDonald	M.S. Forest Science	Kaibab National Forest Soil Scientist
Forest Service	Mark Schwab	B.A. Geological Sciences	Certified Mineral Examiner, Southwestern Region of the Forest Service
Forest Service	Diane Tafoya	B.A. Geology	Zone Geologist and Certified Mineral Examiner, Cibola/Kaibab National Forests
Forest Service	Richard Periman	B.A. Anthropology/History M.S. Anthropology Ph.D. Environmental Science and Technology	Social Science Coordinator, Southwestern Region of the Forest Service
Forest Service	Michael Linden	B.S. Geology M.S. Economic Geology	Certified Mineral Examiner, Regional Liaison for Centralized National Operations, Minerals and Geology Management
Forest Service	Jessica Lopez-Pearce	B.S. Geosciences M.S. Earth and Planetary Sciences	Geologist, Kaibab National Forest
SWCA	Ken Houser	M.A. Geology	Managing Principal
SWCA	Charles Coyle	M.A. English	Project Manager
SWCA	Jill Grams	M.L.A. Landscape Architecture	Assistant Project Manager/Visual Resources Specialist
SWCA	Molly Thrash	B.A. Anthropology	NEPA Planner
SWCA	Chris Garrett	B.S. Hydrology	Geology and Minerals Specialist
SWCA	Tom Furgason	B.S. Ecology and Evolutionary Biology	Senior Biologist
SWCA	Ken Kertell	M.S. Wildlife Biology	Wildlife Biologist
SWCA	Mark Turner	M.S. Biology	Wildlife Biologist
SWCA	Tom Koronkiewicz	M.S. Biology	Wildlife Biologist
SWCA	Amanda Kuenzi	M.S. Forestry	Vegetation Specialist
SWCA	Mark Turner	M.S. Biology	Land Use/Visual Resources Specialist
SWCA	Steve Leslie	B.S. Natural Resource Management	Visual Resources/Land Use Specialist
SWCA	Greg Seymour	M.A. Archaeology	Archaeologist
SWCA	Adrienne Tremblay	Ph.D. Anthropology	Archaeologist
SWCA	Annmarie Kmetz	M.A. Heritage Resources	Archaeologist
SWCA	Victor Villagran	B.A. Anthropology	Archaeologist

Table 5.3-1. List of Preparers (Continued)

Organization	Name	Qualifications	Project Role
SWCA	Megan Robertson	B.S. Public Planning	Land Use/Public Involvement Specialist
SWCA	Ryan Rausch	M.E.L.P. Environmental Law	Recreation Specialist
SWCA	Jeff Connell	M.A. Public Administration	Socioeconomics Specialist
SWCA	Cara Bellavia	M.U.E.P. Master of Urban and Environmental Planning	Socioeconomics Specialist
SWCA	Christina White	M.P.P. Master of Public Policy	Socioeconomics Specialist
SWCA	Glenn Dunno	M.A. Geography	GIS Coordinator
SWCA	Chris Query	B.S. Natural Science and Geography	GIS Specialist
SWCA	Heidi Orcutt-Gachiri	Ph.D. Linguistics and Anthropology	Senior Technical Editor
SWCA	Danielle Desruisseaux	B.A. Anthropology	Technical Editor/Archaeologist
SWCA	Peggy Ford	B.A. English and Chemistry	Technical Editor
SWCA	Paige Marchus	B.A. Journalism	Technical Editor
SWCA	Camille Ensle	B.A. Studio Art (in progress)	Publication Specialist
SWCA	Jessica Maggio	B.A. Anthropology/ Photography	Publication Specialist
SWCA	Elizabeth Slocum	B.A. Sociology	Publication Specialist
SWCA	Michelle Weigman	B.S. Art	Graphic Design Specialist
SWCA	Benjamin Gaddis	M.A.T. General Science M.E.M. Water and Air Resources	NEPAPublic Facilitation Specialist
SWCA	Ryan Van Wormer	N/A	Public Involvement Specialist
SWCA	Donna Morey	B.I.S. Urban Planning (in progress)	Project Administrator
SWCA	Betsy Rattee	B.A.S. Administration (in progress)	Project Administrator
SWCA	David Reinhart	B.A. Anthropology	Website Developer
SWCA	Sarah Wilcox	B.A. Anthropology	Database Specialist
Rozelle Group	Marty Rozelle	Ph. D. Community Education	Public Involvement
Montgomery & Associates	William Victor, P.G.	M.S. Hydrology	Water Resources / Soil Resources
Montgomery & Associates	Andrew Scott, P.G.	M.S. Geology	Water Resources / Soil Resources
Ninyo & Moore	Bill Jamieson	B.S. Zoology	Air Quality / Soundscapes
Ninyo & Moore	Al Ridley	M.S. Geology	Air Quality / Soundscapes
Ninyo & Moore	Bradley Sohm	B.S. Chemical Engineering	Air Quality / Soundscapes
Ninyo & Moore	Sandra Ripplinger	B.S. Occupational and Environmental Health and Safety	Air Quality / Soundscapes
Ninyo & Moore	Mark A. Williams	B.S. Environmental Science and Biology	Air Quality / Soundscapes
N/A	Clark Lantz	Ph.D. Physiology and Biophysics	Environmental Toxicology
N/A	John Loomis	Ph.D. Economics	Economic Valuation of Non-Market Natural Resources

5.4 COOPERATING AGENCY TEAM

In addition to the specialists identified in Table 5.3-1, who were actively engaged in developing the Draft EIS, numerous specialists from the cooperating agencies contributed their expertise by reviewing and submitting comments on the EIS as it evolved. These agencies and individuals are identified in Table 5.4-1.

Table 5.4-1. Cooperating Agency Reviewers

U.S. Forest Service			
Mike Williams	Angela Parker	Charlotte Minor	Jackie Banks
Roy Jemison	Anna Jaramillo		
National Park Service			
Martha Hahn	Jan Balsom	RV Ward	Linda Jalbert
Kirstin Heins	Steve Rice	Shannon Reed	Lori Makarick
Jane Rodgers	Kerry Moss	Chris Turk	Deanna Greco
John Notar	Jerry Mitchell	Cal McCusker	Tim Bowden
U.S. Fish and Wildlife Service			
Brenda Smith	Brian Wooldridge	Bill Austin	
U.S. Geological Survey			
John Hoffman	Andrea Alpine	Don Bills	Jim Otton
Jo Ellen Hinck			
Arizona Game and Fish Department			
Andi Rogers	Ron Sieg		
Arizona Geological Survey			
Lee Allison	Jon Spencer	Jeri Young	
Arizona State Land Department			
Joe Dixon			
Arizona Department of Mines and Mineral Resources			
Madan M. Singh			
Arizona Department of Environmental Quality			
Debra Duerr			
Kaibab-Paiute Tribe			
LeAnn Skrzynski	Glendora Homer		
Hualapai Tribe			
Peter Bungart	Alex Cabilla	Loretta Jackson-Kelly	
Mohave County, Arizona			
Cindy Levesque	Cullin Pattillo	Gary Watson	
Coconino County, Arizona			
Bill Towler			

Table 5.4-1. Cooperating Agency Reviewers (Continued)

San Juan County, Utah			
Rick Bailey	David Gallegos	Jerry McNeely	Bruce Adams
Kane County, Utah			
Daniel Hulet			
Washington County, Utah			
Alan Gardner	Ron Whitehead	Dean Cox	

Chapter 6

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Chapter 7

GLOSSARY

100-year flood. A flood event of such magnitude that it occurs, on average, every 100 years. This equates to a 1% probability of occurring in any given year.

Affected environment. The existing biological, physical, social, and economic conditions of an area that are subject to change, both directly and indirectly, as a result of a proposed human action.

Acre-foot. A measure of volume of water. The amount of water it would take to cover 1 acre of land to a depth of 1 foot; equal to 325,851 gallons or 43,560 cubic feet.

Air quality. The cleanliness of the air as measured by the levels of pollutants relative to standards or guideline levels established to protect human health and welfare.

Ambient concentration. The mass of a pollutant in a given volume of air, typically measured as micrograms of pollutant per cubic meter of air.

Animal unit month. Amount of forage required to sustain a cow/calf unit (one cow and one calf) or equivalent for one month.

Aquifer. A water-bearing body of permeable rock, sand, or gravel. A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to conduct groundwater and yield quantities of water to wells and springs.

Area of Critical Environmental Concern. A Bureau of Land Management designation for an area within public lands in which special management is required in order to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes, or to protect life from natural hazards.

Assessment (environmental). An evaluation of existing resources and potential impacts to those resources from a proposed act or change to the environment.

Attainment area. A geographic region that meets the National Ambient Air Quality Standards for a criteria pollutant under the Clean Air Act.

Background concentration. The existing levels of air pollutant concentration in a given region. In general, it includes natural and existing emission sources but not future emission sources.

Baseline. The initial environmental conditions that form the basis against which the environmental consequences of a proposed action are evaluated.

Best management practices. Structural and operational measures undertaken to reduce erosion and sedimentation before beginning and continuing during ground-disturbing activities. Best management practices are measures that are demonstrated to be the best available for the site for controlling soil loss and protecting water quality, given the site-specific social, economic, and technical constraints.

Breccia pipe. A narrow, vertical geological structure formed by the collapse of a cavity in an underlying limestone formation, typically filled with breccia, which is a rock formed of debris from the overlying geological formation.

Candidate species. Species for which the U.S. Fish and Wildlife Service has sufficient information on file regarding biological vulnerability and threat(s) to support the issuance of a proposed rule to list the species as threatened or endangered but for which issuance of the proposed rule is precluded.

Code of Federal Regulations. The compilation of federal regulations adopted by federal agencies through a rule-making process.

Cooperating agency. A federal, state, or local government entity that provides input for and review of the compliance process required by the National Environmental Policy Act of 1969 but that is not responsible for management of that process.

Core area. A component of natural habitat composed of "contiguous blocks of uniform habitat types away from natural breaks or habitat edges,"[16] used to describe the inner part of the effect zone.

Council on Environmental Quality. An advisory council to the President of the United States established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Criteria pollutants. Air pollutants for which the U.S. Environmental Protection Agency has established National Ambient Air Quality Standards. These include particulate matter, nitrogen oxides, sulfur dioxide, carbon monoxide, and volatile organic compounds.

Cultural resources. Areas, properties, or sites of importance to cultural groups. In addition to areas of importance for traditional uses or products, these include the remains of human activity, occupation, or endeavor, as reflected in districts, sites, buildings, objects, artifacts, ruins, works of art, architecture, and natural features important in human events.

Cumulative effects. The impact on the environment that results from the incremental effect of the Proposed Action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions that take place over a period of time.

Direct effect. See *Direct impact.*

Direct impact. Beneficial or adverse effect that is caused by an action and occurs at the same time and place.

Distance zones. A subdivision of the landscape as viewed from an observer position. The subdivision (zones) includes foreground–middle ground, background, and seldom seen.

Drill site. A location, typically cleared of vegetation, at which a drill rig is placed and a vertical hole is drilled downward in order to collect geological samples and determine the presence of economic minerals.

Ecotone. The transition zone between two major ecological communities in which one does not merge gradually into the other, for example, that between grassland and woodland.

Edge area. The portion of wildlife habitat that forms the borders with nearby non-habitat area and typically provides less value to wildlife.

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[16] Weller, C., J, Thomson, P. Morton, and G. Aplet, 2002. *Fragmenting Our Lands: The Ecological Footprint from Oil and Gas Development—a Spatial Analysis of a Wyoming Gas Field.* Seattle, Washington, and Denver, Colorado: The Wilderness Society. Available at: <http://wilderness.org/files/fragmenting-our-lands.pdf>.

Effect. See *Impact*.

Emission. Discharge of pollutants into the atmosphere, usually specified by mass of pollutant per unit of time.

Endangered species. A plant or animal species that is threatened with extinction or serious depletion in its range and is formally listed as such by the U.S. Fish and Wildlife Service.

Environmental Impact Statement. A document prepared to analyze the impacts on the environment of a Proposed Action and released to the public for review and comment. An Environmental Impact Statement must meet the requirements of the National Environmental Policy Act and the Council on Environmental Quality and the directives of the lead federal agency responsible for the Proposed Action.

Endemic environment. Plants or animals that are native to a particular region; the surrounding conditions, influences, or forces that affect or modify an organism or an ecological community and ultimately determine its form and survival.

Ephemeral stream. A stream or portion of a stream that flows only in direct response to precipitation.

Evapotranspiration. The loss of water from the soil both by evaporation and by transpiration from the plants growing there.

Fault. A fracture or fracture zone in the earth's surface along which there has been displacement of the sides relative to one another and parallel to the fracture.

Federally listed threatened and endangered species. Species afforded protection under the Endangered Species Act. An endangered species is one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered in the foreseeable future.

Floodplain. The portion of a river or stream valley, adjacent to the river channel, that is made up of stream sediments and is inundated with water when the stream overflows its banks.

Forage. All browse and herbaceous foods available to grazing animals for feeding.

Fragmentation. See *Habitat fragmentation*.

Groundwater recharge. Water that infiltrates the land surface and is not lost to evaporation or consumed by plants can percolate downward and replenish groundwater aquifers. This deep percolation is called recharge.

Habitat. The region in which a plant or animal naturally grows or lives. A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

Habitat fragmentation. The disruption (by division) of habitat into smaller habitat patches. The effects of habitat fragmentation include loss of habitat area, increased edge area, and the creation of smaller, more isolated patches of remaining habitat.

Habitat type. A habitat type is the basis of a forest ecosystem classification system. It is an aggregation of all land areas potentially capable of producing similar plant communities at climax. Habitat types are usually named for the most shade-tolerant tree species that will grow on the site and an understory plant that is represented with a high degree of constancy.

Haul road. The route over which mined ore is moved from the mine to a processing location or waste rock is moved to a storage location.

Hazardous waste. Waste that is designated hazardous by the U.S. Environmental Protection Agency or state regulations. As defined under the Resource Conservation and Recovery Act, hazardous waste is waste from production or operation activities that poses a potential hazard to human health or the environment when improperly treated, stored, or disposed of. Hazardous waste that appears on special U.S. Environmental Protection Agency lists or possesses at least one of the four following characteristics: ignitability, corrosivity, reactivity, or toxicity.

Head structure. The frame and equipment built above a vertical mine shaft in order to raise ore from the mine and lower personnel and equipment into the mine.

Human environment. The natural and physical environment and the relationship between people and the environment.

Hydrology. A science that studies the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere.

Impact. The terms "impacts" and "effects" are synonymous as used in National Environmental Policy Act analyses. Impacts may be beneficial or adverse and may apply to the natural, aesthetic, historic, cultural, and socioeconomic resources of the installation and the surrounding communities. Where applicable, impacts may be classified as direct or indirect.

Indicator species. A wildlife species whose presence in a certain location or situation at a given population level indicates a particular environmental condition. Population changes are believed to indicate effects of management activities on a number of other wildlife species.

Indirect effect. See *Indirect impact.*

Indirect impact. An indirect impact is caused by a proposed activity but is later in time or farther removed in distance while still being reasonably foreseeable. Indirect impacts may include land use changes or population density changes and the related effects these changes will have on air, water, and other natural or social systems.

Infiltration. Water that falls on the land surface and does not run off. Some of this water evaporates, some is used by plants, and some percolates downward to the groundwater.

Interim management (a mine under interim management). A mine operating under alternate stipulations under an approved mine plan of operations during periods when ore is not being removed because of temporary changes in economic or regulatory conditions.

Intermittent stream. A stream that flows only at certain times when it receives water from springs or from a surface source.

Leasable mineral. Minerals that may be acquired under the Mineral Leasing Act of 1920, as amended, including coal, oil shale, oil and gas, phosphate, potash, sodium, and geothermal resources.

Listed species. Any species that occurs on a threatened or endangered species list at the state or federal level.

Lithic. Pertaining to stone or a stone tool (e.g., lithic artifact).

Lithic scatter. An archaeological site type characterized by a surface scatter of artifacts that consists entirely of lithic (i.e., stone) tools and chipped stone debris.

Locatable materials. Traditional hardrock minerals, such as gold, silver, lead, copper, and zinc, and industrial minerals, such as fluorspar, barite, and high-calcium limestone, that occur in lode or placer deposits. Lode claims are located on indurated bedrock, whereas placer claims are usually located on loosely consolidated materials, such as mineral-bearing sands and gravels.

Long-term impacts. Long-term impacts are neither temporary nor reversible. They may occur either during the construction or operation phases of an activity. For example, the construction of a new building may create long-term impacts during both the construction and operation phases. Draining of a wetland for the construction of a new building will create long-term and permanent impacts to biological resources. Likewise, once in operation, the new building may create additional long-term impacts such as increased population density, waste generation, etc.

Mine footprint. The land area within which all surface mining activities are conducted, including head structures for underground mines, stockpiles of waste rock or ore, and stormwater or process water basins.

Mine plan of operations. A description of proposed mineral exploration or mining, including the name and address of the operator, location of the operation, access to the operation, period in which the operation would take place, and other information, as required by the Bureau of Land Management in accordance with 43 Code of Federal Regulations 3809.11 and by the U.S. Forest Service in accordance with 36 Code of Federal Regulations 228.4.

Mineral entry. Authority to enter public lands for the purpose of developing minerals in an orderly, organized manner.

Mineral rights. An ownership interest in minerals that may or may not be owned by the person or party having title to the surface estate.

Mineralized breccia pipe. A breccia pipe in which, over time, various minerals have formed in fractures and pores as a result of the presence of mineral-rich groundwater, some of which may be economic to mine for uranium and other metals.

Mitigation. Actions intended to render an action less severe or harmful to environmental resources. Mitigation generally includes the following: avoiding the impact altogether by stopping or modifying the Proposed Action; minimizing impacts by limiting the degree or magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by conducting preservation and maintenance operations during the life of the action; compensating for the impact by replacing or providing substitute resources or environments.

National Ambient Air Quality Standards. Section 109 of the Clean Air Act requires the U.S. Environmental Protection Agency to set nationwide standards for widespread air pollutants. Currently, six pollutants are regulated: sulfur dioxide, carbon monoxide, particulate matter 10, nitrogen dioxide, ozone, and lead.

National Register of Historic Places. A listing of architectural, historical, archaeological, and cultural sites of local, state, or national significance established by the National Historic Preservation Act of 1966 and maintained by the National Park Service.

No Action Alternative. The most likely condition expected to exist in the future if current management direction were to continue unchanged.

No effect. See *No impact.*

No impact. "No impact" implies that a particular activity creates neither a direct nor indirect impact, does not have long- or short-term implications, and is neither beneficial nor negative.

Nonattainment area. An area that has been designated by the U.S. Environmental Protection Agency or the appropriate state air quality agency as exceeding one or more national or state Ambient Air Quality Standards.

Nonpoint source. Source of pollution generally attributed to urban runoff from irrigating landscapes and golf courses, draining pools to streets, washing vehicles in streets, and hosing down driveways.

Notice of Intent. A notice published in the *Federal Register* to announce the intent to prepare an Environmental Impact Statement.

Noxious weed. An undesirable weed species that typically moves into disturbed areas, grows aggressively, and outcompetes desirable or native species for resources.

Off-highway vehicle. Any motorized vehicle designated for cross-country travel over any type of natural terrain.

Ore. Naturally occurring material from which a valuable mineral or minerals can be economically extracted.

Overburden. Rock and soil cleared away prior to mining.

Ozone (ground level). A major ingredient in smog. Ozone is produced from reactions of hydrocarbons and nitrogen oxides in the presence of sunlight and heat.

Particulate. Fine liquid or solid particles, such as dust, smoke, mist, fumes, or smog, found in air or emissions.

Particulate matter. Particulate matter is regulated under the Clean Air Act. Particulate matter 10 is particulate matter that is 10 microns or less in effective diameter (also called fine particulate matter). Particulate matter 2.5 is particulate matter that is 2.5 microns or less in diameter.

Patent. A document by which the United States conveys, to those entitled thereto, legal title to some portion of the public lands (Glossaries of Bureau of Land Management Surveying and Mapping Terms).

Patented claims. Private land that has been secured from the U.S. government by compliance with laws relating to such lands.

Percent grade (of uranium). The total amount of processed uranium that can be extracted from a given amount of ore, typically given as percent U_3O_8.

Perennial. Lasting or active throughout the entire year.

Perennial stream. A stream or reach of a stream that flows throughout the year, fed by springs or groundwater.

Permeability. The measure of the ease with which a fluid can diffuse through a particular porous material.

Petroglyph. Literally, a rock carving; petroglyphs usually exclude writing and are of prehistoric or protohistoric age.

Physiographic. Describing the shape and features of the land's surface.

Physiographic province. An area characterized by distinctive topography, geological structure, climate, drainage patterns, and other features and phenomena of nature.

Plan of operations. See *Mine plan of operations.*

Point source. Any discernible, confined, and discrete conveyance, including any pipe, ditch, channel, tunnel, or conduit, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

Preferred Alternative. The alternative recommended for implementation by the project proponent based on the evaluation completed in the planning process.

Prevention of significant deterioration. A regulatory program based not on the absolute levels of air pollution allowable in the atmosphere but on the amount by which a legally defined baseline condition will be allowed to deteriorate in a given area. Under this program, geographic areas are divided into three classes, each allowing different increases in nitrogen dioxide, particulate matter, and sulfur dioxide concentrations. Prevention of significant deterioration above legally established levels includes the following, used to classify a region:

- Class I—minimal additional deterioration in air quality (certain national parks and wilderness areas).
- Class II—moderate additional deterioration in air quality (most lands).
- Class III—greater deterioration for planned maximum growth (industrial areas).

Primacy state. A state of the United States that is authorized by the U.S. Environmental Protection Agency to administer portions of the Clean Water Act; Arizona is a primacy state.

Project alternatives. Alternatives to the proposed project developed through the National Environmental Policy Act process.

Quaternary. The geological period following the Tertiary in the Cenozoic Era, beginning about 1.8 million years ago, composed of the Pleistocene and Holocene epochs, characterized by the evolution of hominids into modern humans.

Rangeland. Land used for grazing by livestock and big-game animals on which vegetation is dominated by grasses, grass-like plants, forbs, or shrubs.

Reasonably foreseeable development scenario. Predicts the level and type of reasonably foreseeable future locatable mineral exploration and development that could occur in the proposed withdrawal area.

Reclamation. The process of contouring, stabilizing, and/or vegetating to convert disturbed land to its former use or other productive uses.

Record of Decision. A public document that explains which alternative will be selected for the area of concern. In addition to the decision, the Record of Decision states the alternatives considered, environmentally preferable alternative or alternatives, factors considered in the agency's decision, and mitigation measures that will be implemented and identifies any applicable enforcement and monitoring programs.

Right-of-way. Strip of land acquired by legal means over which, for example, power lines and access roads would pass.

Riparian. Typically refers to vegetation that requires the continual presence of water and therefore tends to grow near streams, springs, or lakes.

Riparian area. Land areas that are directly influenced by water. They usually have visible vegetative or physical characteristics that show water influence. Stream sides, lake borders, and marshes are typical riparian areas.

Road density. The number of miles of road per square mile.

Runoff. Precipitation that is not retained on the site where it falls and that is not absorbed by the soil or lost to the atmosphere.

Salable minerals. Common-variety mineral materials, such as sand, gravel, cinders, and building stone, that are sold on a permit basis. Also referred to as mineral materials.

Scope. The range of actions, alternatives, and impacts to be considered in an Environmental Impact Statement.

Scoping. A term used to identify the process for determining the range of issues related to a Proposed Action and for identifying significant issues to be addressed in an Environmental Impact Statement. Scoping may involve public meetings, field interviews with representatives of agencies and interest groups, discussions with resource specialists and managers, and comments received by the lead federal agency in response to news releases, direct mailings, articles, and Internet postings about the Proposed Action.

Sediment. Soil or mineral particles transported by moving water, wind, gravity, or glaciers and deposited in streams or other bodies of water or on land.

Sedimentary rock. Rock formed from consolidation of loose sediment that has accumulated in layers and become cemented.

Seepage. The discharge of water from an unlined facility or mine.

Sensitive species. Species whose populations are small and widely dispersed or restricted to a few localities; species that are listed or candidates for listing by the state or federal government.

Short-term impacts. Short-term impacts are temporary and either direct or indirect. Short-term impacts usually occur during the construction phase of the activity.

Significance. Significance requires consideration of the context and intensity of the impact under consideration. Significance can vary in relation to the context of the Proposed Action. Both short- and long-term impacts may be relevant. Impacts may also be evaluated in terms of their intensity or severity.

Soil productivity. The capacity of a soil to produce a plant or sequence of plants under a system of management.

Soil texture. The relative proportions of sand, silt, and clay particles in a mass of soil. Basic textural classes, in order of increasing proportion of fine particles, are as follows: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, silty clay loam, clay loam, sandy clay, and clay.

Species. A group of individuals of common ancestry that closely resemble each other structurally and physiologically and in nature interbreed, producing fertile offspring.

Stand. A community of trees possessing sufficient uniformity of composition, constitution, age, spatial arrangement, or condition as to be distinguishable from adjacent communities, forming a silvicultural management entity.

Stratigraphy. The arrangement of rock strata, especially as relates to geographic position and chronological order of sequence.

Subsidence. The gradual settling or sinking of an area, usually as a result of the withdrawal of large amounts of groundwater.

Subsurface. A zone below the surface of the earth whose geological features are principally layers of rock that have been tilted or faulted and are interpreted on the basis of drill hole records and geophysical (seismic or rock vibration) evidence. Generally, it is all rock and solid materials lying beneath the earth's surface.

Tertiary. The older of the two geological periods, from 62 million to 2 million years ago, that form the Cenozoic Era; also, the system of rock strata deposited during that period.

Threatened and endangered species. Animal or plant species that are listed under the Federal Endangered Species Act of 1973, as amended.

Ton. A short ton (2,000 pounds).

Tonne. A metric tonne (2,204.6 pounds).

Total suspended particulates. All particulate matter less than 70 microns in effective diameter that is suspended in a water body.

Traditional Cultural Property. A location that is valued by a group, such as an ethnic group, because it is a place of cultural patrimony and an important place in the traditional cultural landscape.

Uranium. A metallic element naturally occurring in the earth's surface. Uranium is present in water, soil, and rock and is always found combined with other elements to form a variety of common minerals.

Uranium endowment. The uranium occurring in rock that exceeds 0.01% U_3O_8 (see *Percent grade*).

Viewshed. The visible portion of the specific landscape seen from a specific viewpoint, normally limited to landform, vegetation, distance, and existing cultural modifications.

Visual quality objectives. The degree of acceptable alteration of the characteristic landscape.

Visual resources. The visible physical features of a landscape (topography, water, vegetation, animals, structures, and other features) that constitute the scenery of an area.

Waste rock. Non-ore rock that is extracted to gain access to ore. It contains no ore metals or contains ore metals at levels that are below the economic cutoff value and that must be removed to recover the ore.

Water table. The elevation of water at saturation in subsurface materials, whether permeable, porous, or not. Typically, it is the level of the groundwater in a given location.

Waters of the United States. A jurisdictional term typically associated with Section 404 of the Clean Water Act that refers to water bodies such as lakes, rivers, streams (including intermittent and ephemeral streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds with defined bed and bank, the use, degradation, or destruction of which could affect interstate or foreign commerce.

Watershed. The entire land area that contributes water to a drainage or stream.

Wetlands. An area that is regularly saturated by surface water or groundwater and subsequently supports vegetation that is adopted for life in saturated soil conditions. To qualify as a U.S. Army Corps of Engineers jurisdictional wetland, it must have hydric soil, be saturated to the surface sometime during the growing season, and contain wetland plant species.

Wildfire. Any fire on wildlands that was not intentionally set for management purposes and confined to a predetermined area.

Wind rose. Any one of a class of diagrams designed to illustrate the distribution of wind direction experienced at a given location over a given period. Wind roses may also give information concerning stability, distribution of wind speed, and other meteorological parameters.

Withdrawal. An action that withdraws federal public domain land from entry and location of new mining claims.

Chapter 8

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