National Park Service

U.S. Department of the Interior

Grand Canyon National Park

Grand Canyon, Arizona

North Rim and Roaring Springs Canyon Water System Improvements

Environmental Assessment

March 2026

NPS-117319

The National Park Service (NPS) has considered the factors mandated by the National Environmental Policy Act (NEPA). This environmental assessment represents the NPS's good-faith effort to fulfill NEPA's requirements by prioritizing documentation of the most important relevant considerations within the statutorily mandated page limits and timeline. This prioritization reflects the NPS's expert judgment, and any considerations addressed briefly or left unaddressed are, in NPS's judgment, comparatively non-substantive and would not meaningfully inform NPS's consideration of environmental effects and the decision to be made. The environmental assessment is substantially complete, considers the factors mandated by NEPA, and, in the decisionmaker's judgment, contains analysis adequate to inform NPS's decision regarding the proposed action.

If you wish to comment on this Environmental Assessment (EA), you must submit your comments online at https://parkplanning.nps.gov/NorthRimWaterSystem. This EA will be available for public review for a minimum of 30 days.

Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. Although 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. Comments will not be accepted by fax, email, or in any other way than those specified above. Bulk comments in any format (hard copy or electronic) submitted on behalf of others will not be accepted.

Contents

Figures

Tables

Acronyms & Abbreviations

ABA	Architectural Barriers Act
ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effect
BGS	Below Ground Surface
BA	Biological Assessment
BMP	Best management practice
BO	Biological Opinion
CFR	Code of Federal Regulations
CLI	Cultural Landscape Inventory
CLR	Cultural Landscape Report
dB	Decibel
dBA	A-weighted Decibel
DM	Departmental Manual
DO	Director's Order
DOE	Determination of Eligibility
DOI	Department of Interior
EA	Environmental Assessment
ERT	Electrical Resistivity Tomography
EMS	Emergency Medical Services
ft	Foot/Feet
HD	Historic District
HABS	Historic American Buildings Survey
HAER	Historic American Engineering Record
HVAC	Heating, Ventilation, and Air Conditioning
L_{eq}	Equivalent sound level
L_{max}	Instantaneous sound pressure level
MSO	Mexican spotted owl
NEPA	National Environmental Policy Act
NHLD	National Historic Landmark District
NRWL	North Rim waterline
PA	Programmatic Agreement
PAC	Protected Activity Center
Park	Grand Canyon National Park
PM	Procedural Manual
RSPH	Roaring Springs Pumphouse
SCADA	Supervisory Control and Data Acquisition
SHPO	State Historic Preservation Officer
SPL	Sound pressure level
SR	State Route
UAS	Unmanned Aircraft Systems
USFWS	United States Fish and Wildlife Service
VUE	Visitor Use and Experience
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
HDD	Horizontal Directional Drilling

VDD	Vertical Directional Drilling
TCWL	Transcanyon Waterline
UF	Ultrafiltration

Chapter 1: Introduction, Background, and Purpose and Need

Introduction

The National Park Service (NPS) has prepared this Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA), the Department of the Interior's (DOI) NEPA Regulations (43 Code of Federal Regulations [CFR] Part 46) and DOI's Implementing Procedures at 516 Departmental Manual (DM) 1 to evaluate proposed improvements to the North Rim water system. The proposed action includes replacing the North Rim Water Pipeline, also known as the North Rim waterline, between Roaring Springs Pumphouse and the North Rim developed area; rehabilitating the waterline between Roaring Springs Cave and Roaring Springs Pumphouse; constructing a new waterline between the North Rim and Supai Tunnel; constructing a new water treatment plant (WTP) and additional water storage on the North Rim; and rehabilitating Roaring Springs Pumphouse. The project location is depicted on *Figure 1*.

Background

The North Rim developed area is located on the Bright Angel Peninsula, approximately 40 miles south of Jacob Lake, Arizona. It is remote, with the only paved access provided via Arizona State Route 67 (SR-67). The North Rim features various lodging options, a campground, multiple trails, park and concessioner residences, food services, and other visitor service and park operations facilities, all located within a mixed Ponderosa pine forest. The North Rim is primarily a seasonal operation, with all facilities and services open from mid-May to mid-October annually[1].

Roaring Springs Canyon, located on the east side of Bright Angel Peninsula, generally extends southeast from the North Rim to its confluence with Bright Angel Canyon. It is most easily accessed via the North Kaibab Trailhead at the North Rim. Roaring Springs Canyon features the upper segment of the North Kaibab Trail and the Supai Tunnel facilities. Roaring Springs Canyon also contains vital park infrastructure, including the Roaring Springs Cave water intake, Roaring Springs Pumphouse, North Rim waterline, and powerlines.

Of note, a lightning strike ignited the Dragon Bravo Fire, which burned from July to September 2025 across the North Rim, and destroyed portions of the developed area and inner canyon. The fire substantially altered the North Rim landscape, burning approximately 71,130 acres of park-managed land[2] and associated infrastructure, including roughly 110 buildings (NPS 2025c). The alternatives presented in this environmental assessment (EA) were already well into the design and pre-National Environmental Policy Act (NEPA) phase when the fire occurred; however, the fire warranted reassessment of these alternatives. Upon reassessment, the alternatives remained largely unchanged and were determined to still be viable and warranted, as water continues to be needed to support staff, operations, and visitors at the remaining North Rim facilities.

[1] The North Rim is open for day use only from mid-October to December 31. North Rim roads are closed to all vehicles between December 31-May 14; however, non-motorized use of the North Rim is still allowed during the offseason. Visitor services are not provided from mid-October to mid-May.
[2] The Dragon Bravo fire burned a total of approximately 149,399 acres on lands managed by GRCA, USFS, and BLM.

The alternatives presented in this EA are not a response to the Dragon Bravo Fire, are not directly related to or influenced by post-fire redevelopment needs, and are not connected actions to any future redevelopment efforts. Redevelopment of the North Rim in response to the fire will be evaluated through separate planning and NEPA processes in the future. Lastly, any redevelopment efforts resulting from the fire are not considered reasonably foreseeable actions for purposes of NEPA because the concept, timing, and scale of any such efforts are currently unknown and are unable to be analyzed in meaningful detail.

Purpose and Need

The purpose of the water system improvements is to provide a reliable water system to meet water supply needs at the North Rim developed area[3] and in the inner canyon corridor zone[4] from Supai Tunnel to Cottonwood Campground for a project lifespan of up to 75 years. The improvements are needed because the existing North Rim water system, particularly the waterline from the North Rim to Roaring Springs, has exceeded its design life, resulting in frequent failures, extended service outages, and the need for continual repairs in a hazardous environment.

Project objectives include:

- Improve the reliability and resiliency of the North Rim water system, including delivery, treatment, and storage.
- Reduce high-hazard operations and maintenance of the water system.
- Provide infrastructure that meets current and future visitor and operational needs.

North Rim Waterline

The North Rim waterline, initially constructed in 1928 and 1929[5], plays a vital role in supporting park operations on the North Rim. The waterline conveys water from Roaring Springs Cave – the source of all potable water for the park's North Rim[6] – to the North Rim, where it supports approximately 200,000 to 300,000 visitors annually and about 350 residents during the five-month operating season (mid-May to mid-October), as well as 30 residents during the offseason. The waterline also supplies drinking water at Supai Tunnel Rest Area and supports fire suppression capabilities for the North Rim. Currently, about 130,000 gallons per day are pumped through the North Rim waterline during its operational season.

[3] The development zone for the North Rim includes the entire Bright Angel Peninsula, from the WWTP south, plus CC Hill and the North Kaibab Trailhead areas (NPS 2005). Unless otherwise noted, references to the "North Rim" are to the North Rim developed area/development zone.

[4] The inner canyon corridor use area, or corridor zone, are the areas immediately adjacent to the Bright Angel and Kaibab Trails. It is characterized by permanent structures, trails maintained to safe standards for livestock use, and the potential for constant human contact (NPS 1988).

[5] Approximately one mile of the pipeline was replaced in the late 1960s.

[6] Currently, Roaring Springs also supplies all potable water to Supai Tunnel Rest Area, Manzanita Rest Area, Cottonwood Campground, Phantom Ranch, Havasupai Gardens, Bright Angel Trail Resthouses, and the South Rim via the Transcanyon Waterline (TCWL) and Havasupai Gardens Pump Station. However, as part of the TCWL project, which is currently under construction, the water intake for the TCWL will be relocated to Bright Angel Creek near Phantom Ranch; therefore, Roaring Springs will no longer supply water to those locations south of and including Phantom Ranch. Likewise, the new TCWL water system will not supply water to sites north of Phantom Ranch as the segment of TCWL between Phantom Ranch and Cottonwood Campground will be abandoned. The TCWL intake relocation and associated improvements were addressed in a previous Environmental Assessment (NPS 2018a) and are not included in this project or evaluated in this document. The TCWL project is expected to be completed in 2027.

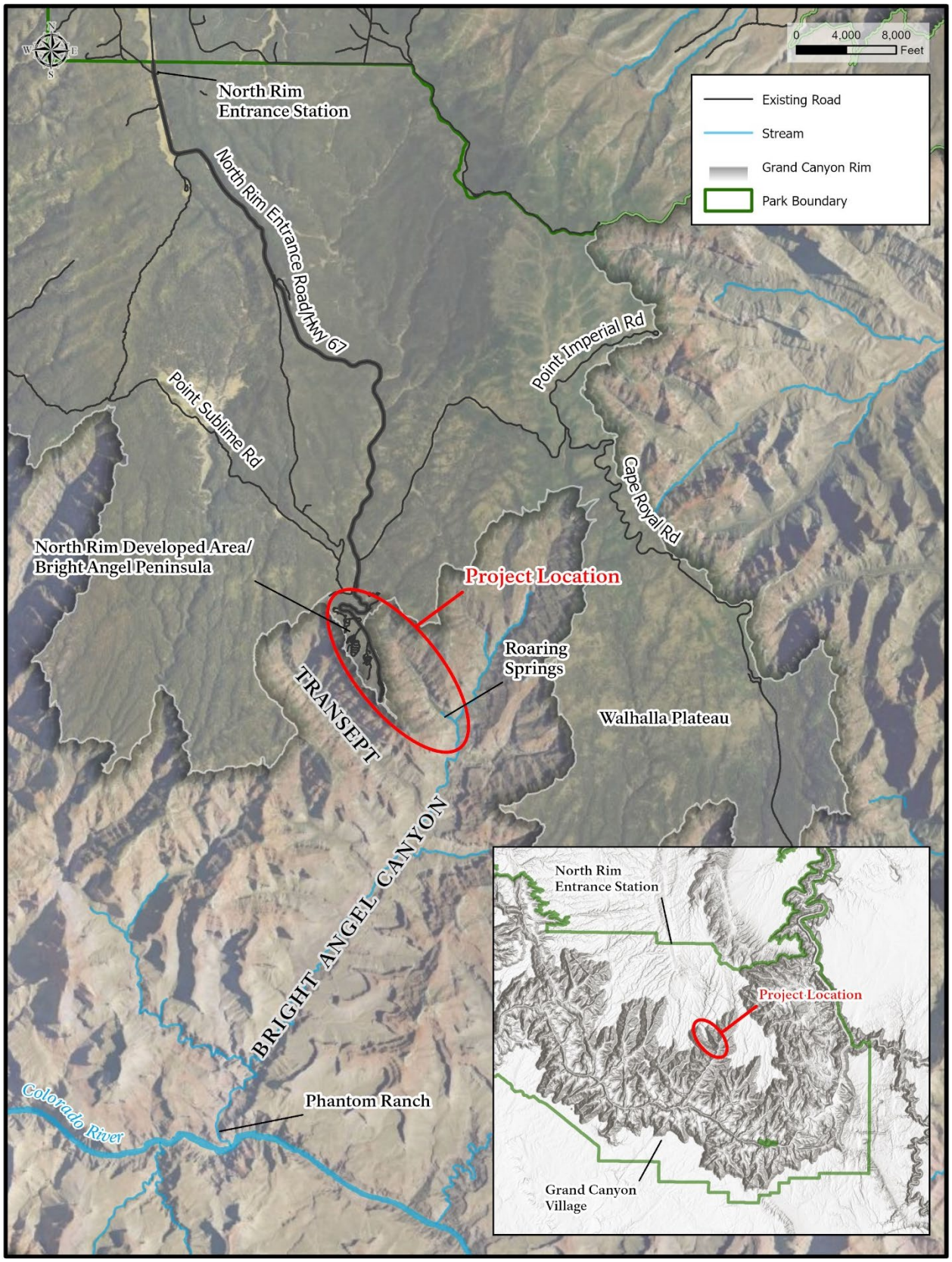


Figure 1: Project Location

Water is collected from an intake in Roaring Springs Cave (elevation 5,210 feet), located approximately 3,000 feet below the North Rim at the junction of Roaring Springs Canyon and Bright Angel Canyon. It flows by gravity through a roughly 750-foot-long section of pipe to the Roaring Springs Pumphouse, where it is treated and then pumped up the 12,500-foot-long (2.4-mile-long) North Rim waterline to two water storage tanks on the North Rim (elevation 8,320 feet). From there, potable water is routed to the North Rim distribution system via the North Rim Pumphouse. See *Figure 2* for the locations of the existing waterline and associated facilities.

The North Rim waterline is susceptible to freezing because of it being surface-mounted and exposed; therefore, water is not pumped to the North Rim from approximately January through March. As a result, the water tanks are filled prior to winterizing the waterline, and this stored water must last until the following spring when pumping can resume. The inability to pump water and refill the tanks during winter limits the number of park and concessioner staff that can overwinter at the North Rim.

The nearly 100-year-old North Rim waterline has exceeded its 50-year design life and requires an average of two repairs per year due to pipe failures such as failing joints, inadequate anchoring and supports, damage from falling rocks, and freezing. A typical failure stops the flow of water to the North Rim for about 7 to 10 days. A failure longer than two to three weeks could disrupt the North Rim's water supply. The North Rim has four million gallons of water storage, which provides an approximately two- to four-week supply during the five-month operating season, after accounting for the minimum amount of water that must remain in storage for fire suppression needs[7]. If the water in the tanks falls below 10 feet or 1 million gallons, Stage 4 water restrictions are implemented, and the park closes overnight hotel lodging at the North Rim. Stage 5 water restrictions—the most severe level—are implemented when the water storage level in the tanks is below 7 feet or 700,000 gallons, resulting in the closure of all North Rim visitor services. If the North Rim waterline completely fails, the North Rim could run out of water for staff use, fire suppression, and other operational needs.

Waterline repairs are challenging and hazardous due to the steep, rugged terrain and difficult access, which can require technical climbing and rappelling. At the break sites, repair personnel must often work in suspended, exposed conditions under tight time constraints to restore water service and minimize costs. Additionally, helicopter support is typically needed to transport personnel, materials, and equipment to or near the repair site. Generally, a waterline repair takes seven days and requires two flights[8] per day (K. Brown, GRCA Water Utilities Supervisor, personal communication, February 6, 2025b). Based on an average of two repairs per year, approximately 28 flights are needed annually to perform pipeline repairs. Furthermore, pipeline breaks that occur during winter are often unable to be repaired until the snowpack melts. For example, record snowfalls in the winter of 2022-2023 caused nine pipeline breaks, most of which could not be repaired until spring. This delay postponed de-winterizing the water system and resuming water pumping operations, which in turn delayed opening the North Rim in 2023[9].

[7] The four-million-gallon storage capacity was originally sized for winter operations while the pumps at Roaring Springs Pumphouse are shut down for winter.
[8] One helicopter flight is defined as one helicopter flying from the South Rim Helibase to the pipeline repair site and back to the South Rim Helibase. If the helicopter needs to stop briefly at the North Rim or another inner canyon site, for example, to pick up personnel, this is considered as part of the one flight and is not counted as an additional flight.
[9] The North Rim typically opens on May 15 each year. In 2023, the North Rim opened for day use only with limited visitor services on June 2, and full opening with full visitor services was delayed until July 23 (NPS 2023a).

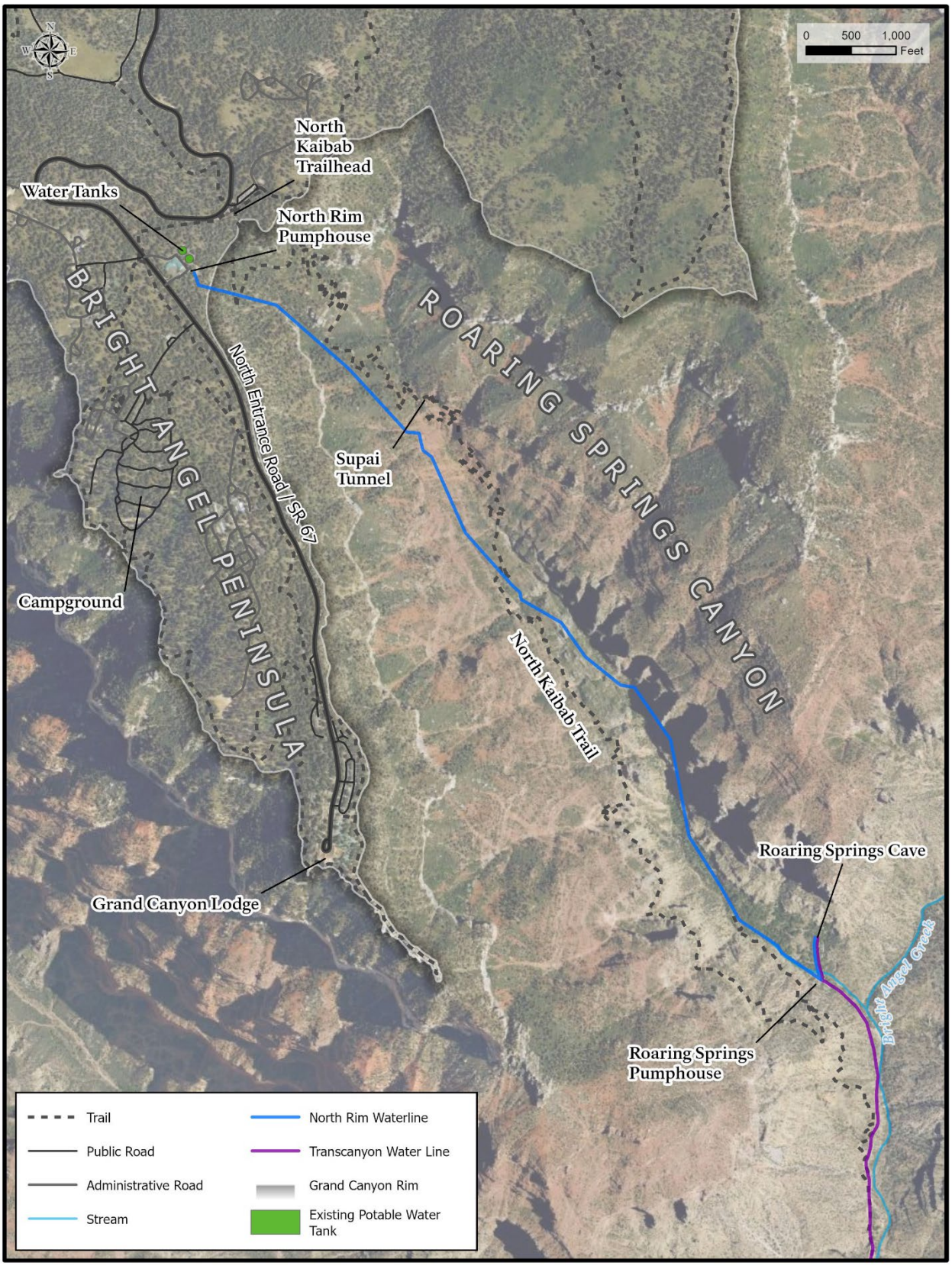


Figure 2: Approximate Locations of Select Water System Facilities at North Rim and Roaring Springs Canyon

These factors slow repair times, leading to extended service outages and increased repair costs, which average about $25,000 to $35,000 per incident. Prolonged repair times could even necessitate water hauling, another costly stopgap measure. As the waterline continues to age, the frequency and severity of failures are expected to increase.

Lastly, vegetation losses caused by the Dragon Bravo Fire have increased slope instability and the risk of erosion events around certain segments of the surface-mounted waterline, particularly those situated in drainages, increasing the likelihood of future damage. The fire also damaged the pipeline coating in areas where the fire burned at a higher severity, leaving bare metal exposed to the elements and increasing the risk of corrosion.

Roaring Springs Pumphouse

Roaring Springs Pumphouse, constructed in 1979, is a critical component of the current North Rim water system. The pumphouse is located in the inner canyon along Roaring Creek and at the base of Roaring Springs. Raw water from Roaring Springs Cave is treated at the pumphouse by removing sand and grit and disinfecting it with chlorine, with the resulting potable water pumped to the North Rim water tanks for storage prior to distribution. The pumphouse water system includes settling tubes for large particles such as sand and grit to settle out of the water, de-sanders to remove finer particles, chlorine gas for disinfection, and pumps to deliver the water to the North Rim.

As part of the Transcanyon Waterline (TCWL) replacement project[10], which is scheduled for completion by the end of 2026, Roaring Springs Cave will no longer be used as the water source for Phantom Ranch, Havasupai Gardens, Bright Angel Trail resthouses, and the South Rim; therefore, the amount of water passing through Roaring Springs Pumphouse would drop substantially, making its components oversized for the lower demand and thereby impacting their performance. The park has also had frequent issues with the pumps, requiring continual repairs or replacements, that often results in only one pump being operational at a given time. If the single operational pump were to fail, the water system would be shut down for an extended period. This would impact park operations and could require water restriction measures or potentially closing the North Rim to visitation.

Using chlorine gas is the most efficient way to haul and store the quantity of chlorine needed to disinfect the volume of water that flows through the pumphouse. The chlorine gas cylinders must be transported to the pumphouse by helicopter due to their weight, contributing to increased helicopter traffic within the park. However, chlorine gas presents safety risks as it is hazardous, combustible, and toxic if inhaled. Detected gas leaks have resulted in closure of inner canyon trails as a safety precaution. Additionally, the pumphouse disinfection system routinely fails because of equipment malfunctions and SCADA[11] communication issues, resulting in unsuccessful disinfection leading to public boil-water notices.

Due to its remote location, the park conducts approximately 65 helicopter flights annually to support operations, maintenance, repairs, and water quality sampling at the pumphouse (K. Brown, GRCA Water Utilities Supervisor, personal communication, February 6, 2025b).

[10] The Environmental Assessment and Finding of No Significant Impact for the TCWL replacement project can be accessed at https://parkplanning.nps.gov/projectHome.cfm?projectID=52237. Current information on TCWL project construction can be viewed here https://www.nps.gov/grca/getinvolved/tcwl.htm.

[11] SCADA, which stands for supervisory control and data acquisition, is a computerized system that is capable of gathering and processing data and applying operational controls over long distances (https://csrc.nist.gov/glossary/term/supervisory_control_and_data_acquisition).

The pumphouse also experiences structural and slope stability issues because it is situated on a steep slope. Riprap that was placed upslope (west) of the building to provide slope stabilization has migrated downslope over time and now bears against the pumphouse's settling tubes, which are part of the water treatment system that allows sediment to settle out of the water. This loose riprap has the potential to damage the building and its equipment in the event of a rockslide. On the downslope (east) side, a concrete deck is supported by a timber retaining wall that wraps around the building. The wall, approximately 13 feet tall at its highest point, is over 40 years old and has structural deficiencies. The deck lacks safety railings or fall protection for staff.

Chapter 2: Alternatives

Two alternatives, the action and no action, are carried forward for analysis in this EA. Alternatives considered but dismissed from detailed analysis are described in Appendix A.

Alternative A: No Action

Under the No Action Alternative, water pumping, conveyance, and treatment would continue as described in the *North Rim Waterline* and *Roaring Springs Pumphouse* sections above. The existing water system infrastructure and facilities would keep serving their current functions and would continue to be operated and maintained as they are currently. No new water system infrastructure or facilities would be constructed and no substantial changes to the existing system would occur. Water restrictions at the North Rim and Supai Tunnel could continue to be required during water system failures or when the water level in the storage tanks is low and pumping is suspended, potentially resulting in delayed seasonal openings of the North Rim or other restrictions or closures. Under this alternative, the current conditions described in the *North Rim Waterline* and *Roaring Springs Pumphouse* sections would be expected to persist, and in some cases worsen over time, due to the age, limited capacity, and ongoing vulnerabilities of the existing water system.

Under the No Action Alternative, no major improvements, upgrades, or new construction would occur to the North Rim waterline and repairs would continue to occur as needed for leaks or breaks. On average, two repairs are needed each year, and the number and cost of repairs is expected to increase as the waterline continues to age. Since the waterline has already exceeded its useful life, it would be expected to eventually fail or otherwise reach a point where major rehabilitation and expenditures would be required to continue functioning.

The No Action Alternative would install additional anchors and supports along the existing waterline for stabilization, particularly between the North Rim and Supai Tunnel. This work is needed because vegetation losses from the Dragon Bravo Fire have reduced slope stability in areas around the surface-mounted waterline, which greatly increases risk of erosion events that could damage the pipeline in its current condition. While these maintenance actions may temporarily reduce the risk of failure, they would not address the underlying vulnerabilities of the aging waterline system.

While no major rehabilitation would occur to Roaring Springs Pumphouse under the No Action alternative, replacement of existing pumps may be required over time as a routine maintenance action to maintain operational capability, as they would be oversized for the reduced water flowing through the pumphouse as a result of the TCWL replacement project.

Helicopter flights to support ongoing operation, maintenance, and repairs of the water system would continue to be required under the No Action Alternative, and the number of flights needed would remain highly variable based on the extent and location of the water system failure. As described in

the *North Rim Waterline* and *Roaring Springs Pumphouse* sections, approximately 28 flights per year are currently needed to perform waterline repairs and about 65 additional flights per year are required to operate and maintain Roaring Springs Pumphouse, totaling approximately 95 flights per year. Based on historic flight data, which varies year to year, and using best professional judgement, it is estimated that an average of 70-120 flights per year would continue to be needed to operate, maintain, and repair the North Rim water system, and more flights could be required as the infrastructure continues to age.

The Roaring Springs Cave water source is currently classified as groundwater but may be reclassified in the future as being influenced by surface water. If the water source is reclassified, there would be additional treatment requirements, such as providing filtration and increased disinfection and monitoring. Under the No Action Alternative, the current treatment system at Roaring Springs Pumphouse would not be equipped to deal with the change in treatment requirements, and a future project would need to be developed to improve the water treatment system to meet new source classification requirements.

Under the No Action Alternative, the TCWL improvements to provide water to Manzanita Rest Area and Cottonwood Campground would continue to be implemented, including slip-lining the waterline between Roaring Springs Pumphouse and Cottonwood Campground and installing point-of-use water treatment systems at Manzanita Rest Area and Cottonwood Campground.

Alternative B: Improve the North Rim and Roaring Springs Canyon Water System (Proposed Action and Preferred Alternative)

Water System

Overview

This subsection provides an overview of the water system under the Proposed Action Alternative. The subsequent subsections provide more detailed descriptions of each component of the water system under the Proposed Action.

The Proposed Action would replace the use of the existing North Rim waterline by installing two new waterlines, one for raw water and one for finished (potable) water, from the North Rim to Roaring Springs Pumphouse. Most of the pipe for the raw and finished waterlines would be installed in two new parallel boreholes, each of which would be approximately 9 to 26 inches in diameter and 9,320 feet long, extending from the North Rim to a location near Roaring Springs Pumphouse. About 5,600 feet of the new waterlines would be installed underground in trenches on the Rim and about 60 feet would be trenched in the inner canyon. Some short sections in the inner canyon (roughly 100 linear feet) would be surface mounted where trenching or other underground installations are not practicable.

The waterline between Roaring Springs Cave and Roaring Springs Pumphouse would be improved by stabilizing the existing pipeline with new anchors, replacing short sections of pipe that are deteriorated or do not meet needed hydraulic profiles, and replacing the overflow box with pipes.

Water from Roaring Springs would continue to be pumped and conveyed to storage tanks on the North Rim via the Roaring Springs Pumphouse and the new raw-water pipeline in the borehole. However, instead of being treated at the Roaring Springs Pumphouse, as currently occurs, the raw

water would be treated at a new WTP that would be located near the existing water tanks on the North Rim. After treatment at the new WTP, the potable water would be pumped to the existing adjacent water storage tanks. From these tanks, potable water would be distributed to North Rim facilities through the existing distribution piping and to the inner canyon locations of Supai Tunnel, Roaring Springs Pumphouse, Manzanita Rest Area, and Cottonwood Campground via the new potable water pipeline.

At Roaring Springs Pumphouse, potable water would be stored in a new 5,000-gallon tank, providing water for consumption and fire suppression at the pumphouse, and for distribution to Manzanita Rest Area and Cottonwood Campground via the slip-lined TCWL. Under the Proposed Action, potable water would be able to be supplied to the pumphouse, Manzanita Rest Area, and Cottonwood Campground year-round without risk of freezing.

A new 2-inch-diameter potable-water pipeline would be surface-mounted parallel to the existing North Rim waterline to convey potable water from the North Rim water storage tanks to Supai Tunnel. Water to Supai Tunnel would continue to be provided seasonally, approximately April through December, since the surface-mounted waterline would remain subject to freezing during low temperatures.

Since raw water would be treated at the new North Rim WTP instead of Roaring Springs Pumphouse, it would be necessary to provide storage for both raw and potable water on the North Rim. Only potable water is currently stored on the North Rim in two existing 93-foot-diameter, two-million-gallon water storage tanks, both of which would remain and be rehabilitated under the Proposed Action. Two additional 32-foot-diameter, 150,000-gallon tanks would be constructed near the existing tanks to store raw water and increase overall storage capacity.

Roaring Springs Pumphouse would be rehabilitated to remove full water treatment operations, including the use of chlorine, and to optimize pumping operations. Although primary water treatment would be relocated to the new North Rim WTP, limited water treatment, such as pretreatment to remove sand and disinfection using liquid sodium hypochlorite (or another appropriate alternative), would still occur at the pumphouse to meet inner canyon potable water needs. Replacement of HVAC, electrical, local controls for SCADA communications, and water system (e.g., water pumps) components, as well as structural and safety improvements would also occur.

A new, short section of pipe would be installed between the new water tank at Roaring Springs Pumphouse and the TCWL to supply potable water to Manzanita and Cottonwood Campground. Additionally, implementation of the Proposed Action would eliminate the need for the point-of-use treatment systems at the Manzanita and Cottonwood areas that are planned under the TCWL replacement project; therefore, these systems would be removed.

See *Figure 3* for an overview of the Proposed Action.

The elements of this alternative are described in more detail below. A summary table outlining the elements of this alternative and acreage of potential impact by location is provided at the end of this chapter (*Table 2*).

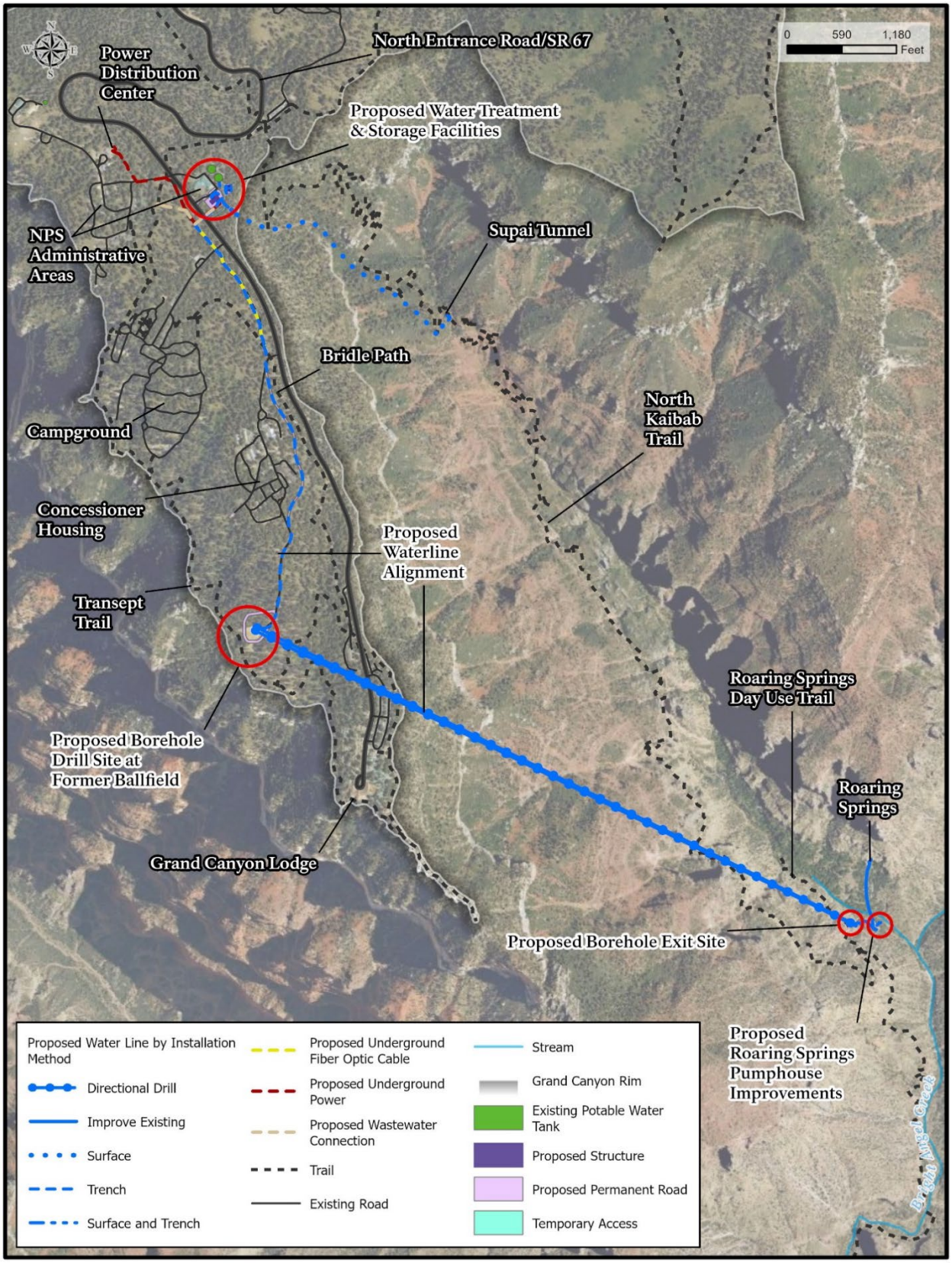


Figure 3: Proposed Action Overview

Water Pipelines

The existing North Rim waterline (approximately 2½ miles long), from the North Rim water storage tanks to Roaring Springs Pumphouse, would be abandoned and left in place. Two new waterlines, one for raw and one for finished water, would be installed in parallel using various methods, including vertical directional drilling (VDD, drilling, or boring), open cut (trenching), and surface mounting. Additionally, the pipeline between Roaring Springs Cave and Roaring Springs Pumphouse would be rehabilitated, and a new potable water pipeline would be installed between the North Rim and Supai Tunnel to maintain water availability at Supai Tunnel. For ease of discussion, the Proposed Action associated with the North Rim waterline alignment has been organized into four "Waterline Areas" based on the proposed primary waterline installation method, as follows:

- Waterline Area 1: North Rim Water Storage Tanks to North Rim Former Ballfield Bore Entry Site[12] (herein referred to as ballfield) bore entry site (open cut installation)
- Waterline Area 2: North Rim Ballfield Drill (Bore Entry) Site to Roaring Springs Pumphouse (VDD, surface mount, open cut installation)
- Waterline Area 3: Roaring Springs Cave to Roaring Springs Pumphouse (rehabilitate existing waterline)
- Waterline Area 4: North Rim to Supai Tunnel Rest Area (surface installation)

Construction in the four Waterline Areas could occur concurrently or sequentially and would be determined at a later date by the contractor in coordination with the park.

Waterline Area 1: North Rim Water Storage Tanks to North Rim Former Ballfield Bore Entry Site
Two new 4-inch diameter waterlines, one for raw water and one for potable water, would be installed in parallel on the North Rim between the ballfield and the North Rim water storage tanks in an approximately 5,600-foot-long (1.1 mile) shared trench. From the ballfield, the trench would follow the existing Ballfield Road, the proposed extension of Ballfield Road (see *Access* section below), and the Bridle Path before crossing North Entrance Road (State Route 67) and connecting to two new raw water tanks (see *North Rim Water Treatment Plant and Water Storage Tanks* section below for more information on the new raw water tanks), which would be adjacent to the existing water tanks. A 2-inch-diameter conduit for fiber optic cabling would also be installed within the trench. Trenches for the waterlines would be approximately 3½ to 5 feet deep and vary from 3 to 8 feet wide.

Aboveground appurtenances such as manholes, pipe vents, and valves would be incorporated into the waterlines. Up to 10 valve vaults would be installed along the pipeline alignment. The valve vaults, which would be underground and accessed by manholes, would be approximately 10 feet deep, 10 feet wide, and 9 feet long. Each vault would also contain a 6-inch-diameter surface vent mounted to a concrete base. The vents would extend approximately 2 feet above ground.

[12] The former ballfield has not been used as a ballfield for decades. In more recent years, the site has been used for staging but is unused currently.

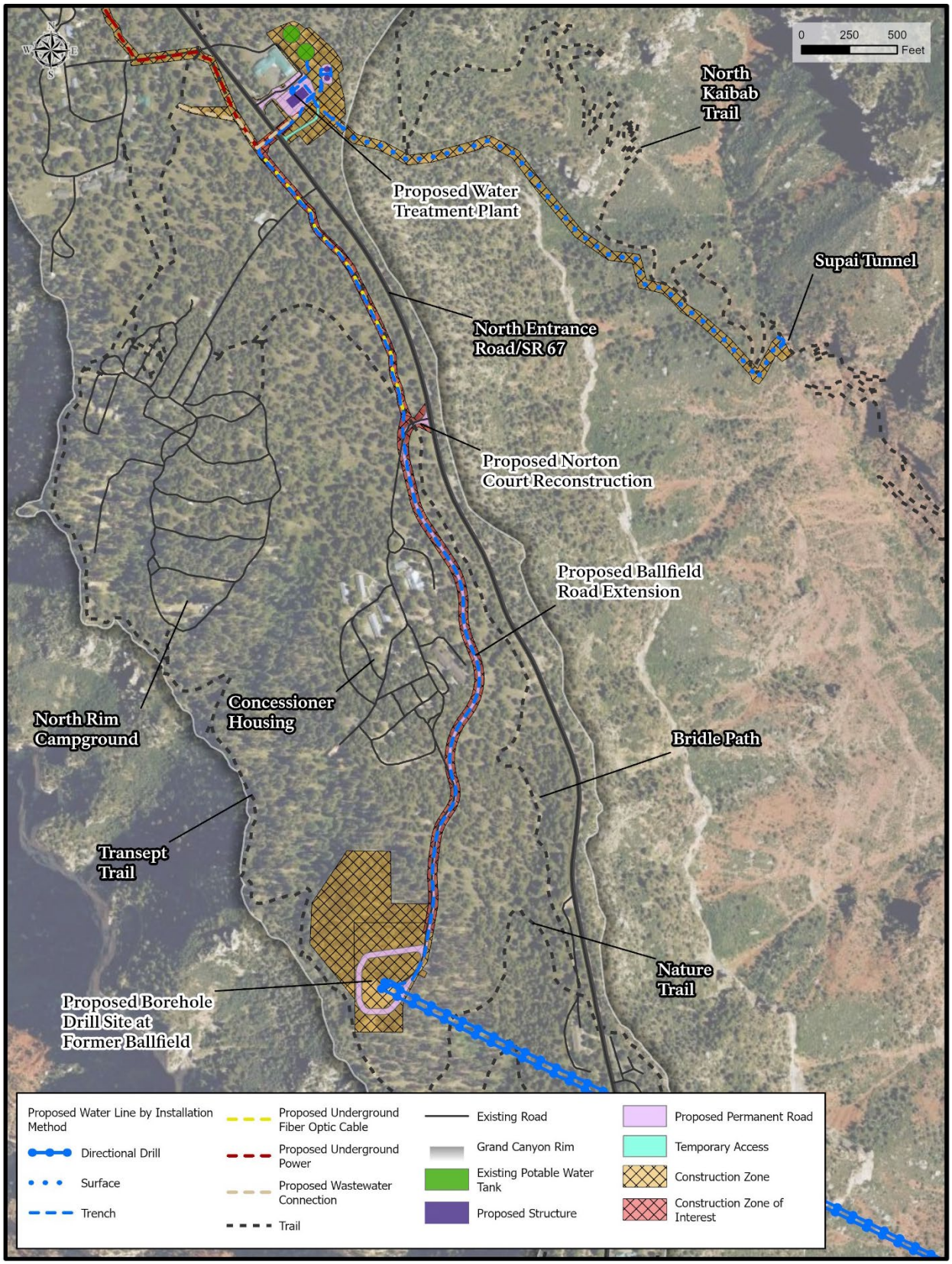


Figure 4: Waterline Area 1 Construction Zone

The construction zones[13] for trenching work and waterline installation would be approximately 40 feet wide north of Norton Court and approximately 50 feet wide south of Norton Court, resulting in a construction zone of about 5.4 acres. The construction zones accommodate tree protections and removals, grubbing, excavated spoils, pipe staging, construction equipment, and the proposed extension of Ballfield Road (see *Access* section below). The construction zone is depicted on *Figure 4*.

Rock excavation may be required at some areas along the trench alignment and would be accomplished by hydraulic hammers, ripping[14], or other nonexplosive rock breaking methods; however, based on geotechnical investigations, rock excavation is expected to be minimal. To the extent feasible, excavated material from the trenches would be used for backfill and pipe bedding or may be stockpiled within the park for future uses. Materials determined unsuitable for reuse would be hauled outside of the park and disposed of properly. Additional needed backfill and bedding originating outside the park would be obtained from park-approved sources.

In places where the waterlines are installed within the Bridle Path alignment, the trail would be restored and any impacted masonry walls, curbing, or similar features would be repaired. Similarly, where waterlines are installed in existing paved areas, those areas would be restored to preconstruction conditions or better. Upon completion of construction, disturbed areas outside of roads, trails, and other surfaced areas would be recontoured and revegetated using native plant species.

The Bridle Path would be closed during tree removal and trenching/pipe installation operations. This trail is expected to be closed for up to approximately eight months. During the closure, detours would be provided using existing trails and paths on the North Rim, including the Transept Trail, as shown on *Figure 5*. Minor improvements, such as minimal widening, grading, placing crushed rock surfacing, and vegetation trimming or removal, could occur to the Transept Trail and other existing unnamed trails/paths that would be used as detour routes. The construction zone along these detour routes would be approximately 5 feet wide on each side of the trail/path centerline with an overall width of 10 feet. Temporary signage would be installed to identify closed areas and to aid in wayfinding along the detour. The duration and extents of trail closures may be revised during construction. If this occurs, the public would be notified of the revised closures. Trail closures are discussed further in *Chapter 3 – Visitor Use and Experience*

Constructing the Waterline Area 1 portion of the project, including the proposed extension of Ballfield Road, is expected to take approximately eight months, which may be nonconsecutive.

[13] Throughout this document, the construction zone typically consists of the limits of construction plus a 5- to 10-feet buffer, unless otherwise noted in the text or depicted on the accompanying figure(s). The construction zone generally indicates the land areas/ground that would be disturbed by construction activities. The term "project area" may also be used interchangeably with "construction zone" throughout this EA.
[14] Ripping generally consists of using excavation machinery (e.g., excavator, backhoe) to scrape and pull, or rip, the rock to the appropriate excavation depth.

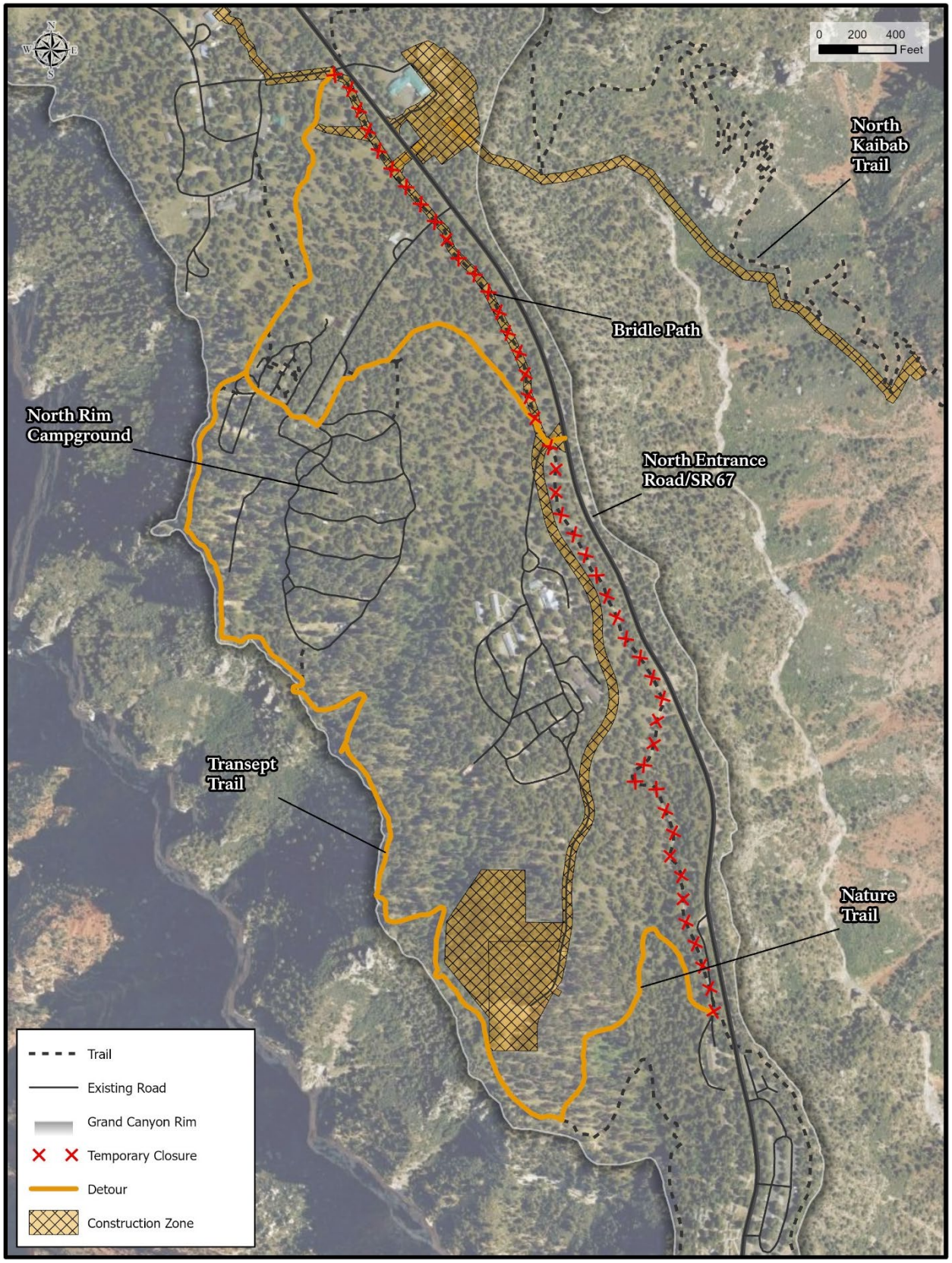


Figure 5: Trail Detours on Bright Angel Peninsula

Waterline Area 2: North Rim Ballfield Drill (Bore Entry) Site to Roaring Springs Pumphouse

Overview

Two parallel boreholes, each approximately 9 to 26 inches in diameter and 9,320 feet long, would be drilled sequentially using vertical directional drilling, and would extend from the drill site (i.e., bore entry site) at the North Rim ballfield to the bore exit site just west of Roaring Springs Pumphouse in the inner canyon, where the borehole would daylight, or emerge from the ground (*Figure 6*). As drilling progresses, casing would be installed in the borehole to aid with borehole stability and protect the installed utilities. Upon completion of borehole drilling and casing, the waterlines would be installed in the borehole. From the bore exit, the waterlines would be surface mounted and trenched to Roaring Springs Pumphouse.

Directional drilling techniques, which are commonly used for oil and gas wells, are often applied when the drill rig cannot be located directly above the target, in this case, the bore exit in the inner canyon[15]. As shown in *Figure 6*, directional drilling involves deviating a borehole from the vertical plane along a predetermined course to a target located at some depth and horizontal distance away from the drill site. Directionally drilled boreholes often have significant vertical and horizontal relief and are often greater than 10,000 feet long.

Ballfield Drilling/Bore Entry Site

Drilling operations would occur from the bore entry site (drill site) at the North Rim ballfield. The former ballfield is located on Bright Angel Peninsula south of the concessionaire residential area and is accessed by the paved Norton Court and unimproved Ballfield Road. The ballfield site is approximately 1.2 acres, but it would be expanded to approximately 4.3 acres (roughly 330 feet by 570 feet) to accommodate drilling activities. These 4.3 acres constitute the construction zone (*Figure 7*).

The drill site would consist of a drill rig with a derrick that is 150 to 175 feet tall; support machinery and equipment; several office trailers; and a gravel loop road to allow vehicles to maneuver around the site. The entire drill site would be fenced during construction. The ballfield was chosen as the drill site in part because it is largely clear of trees and has an existing dirt road providing access; however, some tree removals and grading at the ballfield would be required, and access improvements would be made to minimize disruptions to the concessioner housing area and allow for better circulation of support vehicles around the drill site. Access to the drill site is described in the *Access* section below. See *Figure 7* for the general layout of the drill site.

The two parallel boreholes would be drilled sequentially. Drilling would occur 24/7 until both boreholes are completed to maintain borehole integrity and reduce risk of drilling failures; therefore, night work with lights would be required at the drilling site. If drilling operations encounter refusal, failure to advance, or face other unforeseen issues preventing drilling from progressing, a secondary, or contingency, drill site would be established in the vicinity of the ballfield to the north or northwest of the proposed drill site. To account for the possibility of two drill sites in the vicinity of the ballfield, a potential area of impact of approximately 9.1 acres is used for analysis and is shown on *Figure 7*. If refusal is encountered and a borehole needs to be abandoned, it would be abandoned, capped, or decommissioned in a manner that best protects resources and in accordance with NPS subject matter expert input, industry standards, and/or applicable federal and state regulations.

[15] Directional drilling of a borehole and the subsequent installation of a waterline in the borehole was successfully completed at Grand Canyon in 1986. The borehole was drilled from the South Rim and exited in the inner canyon along the Bright Angel Trail. The bore length was approximately 5,075 linear feet. Figure 10 shows the waterline installed in a borehole below the South Rim.

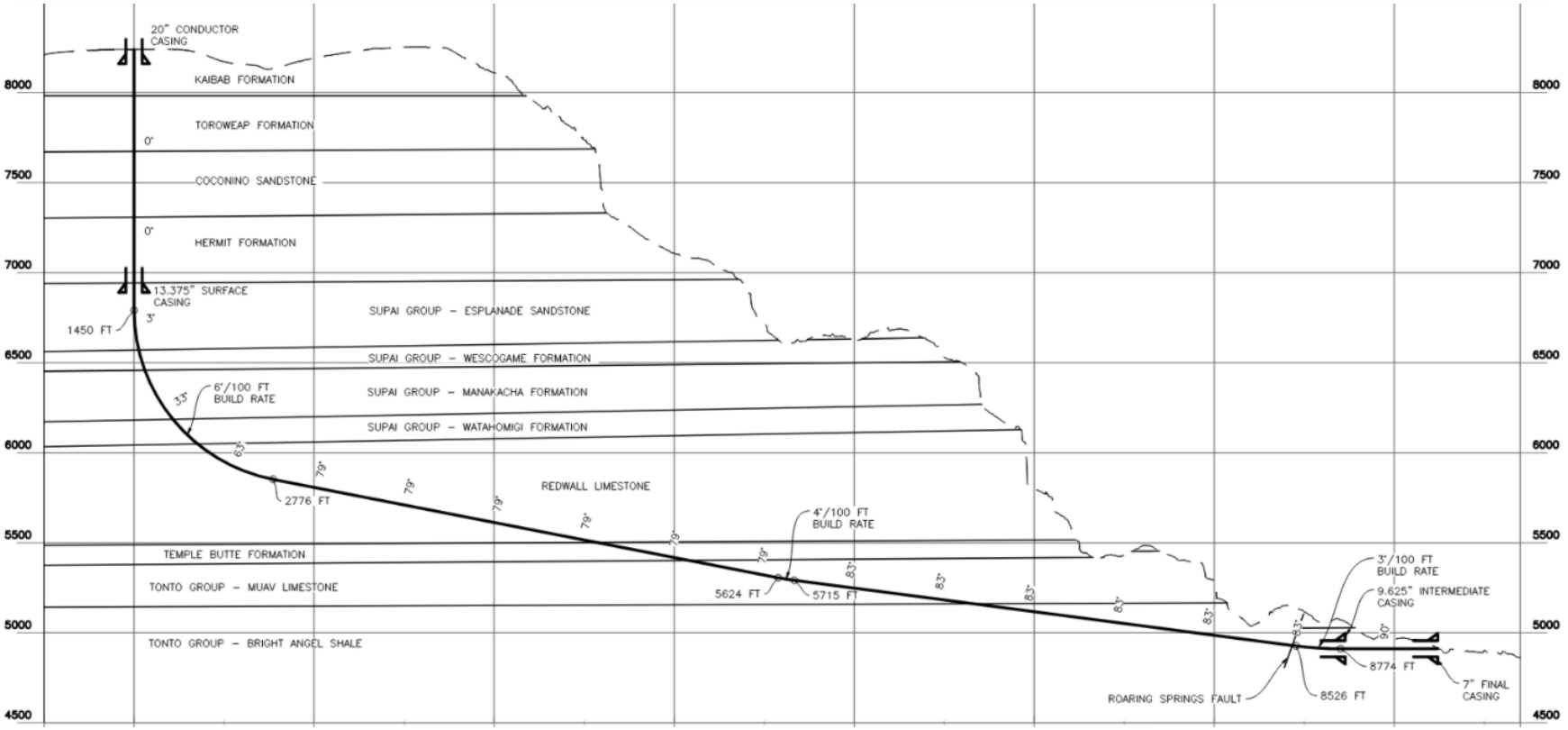


Figure 6: Proposed Drilling Profile

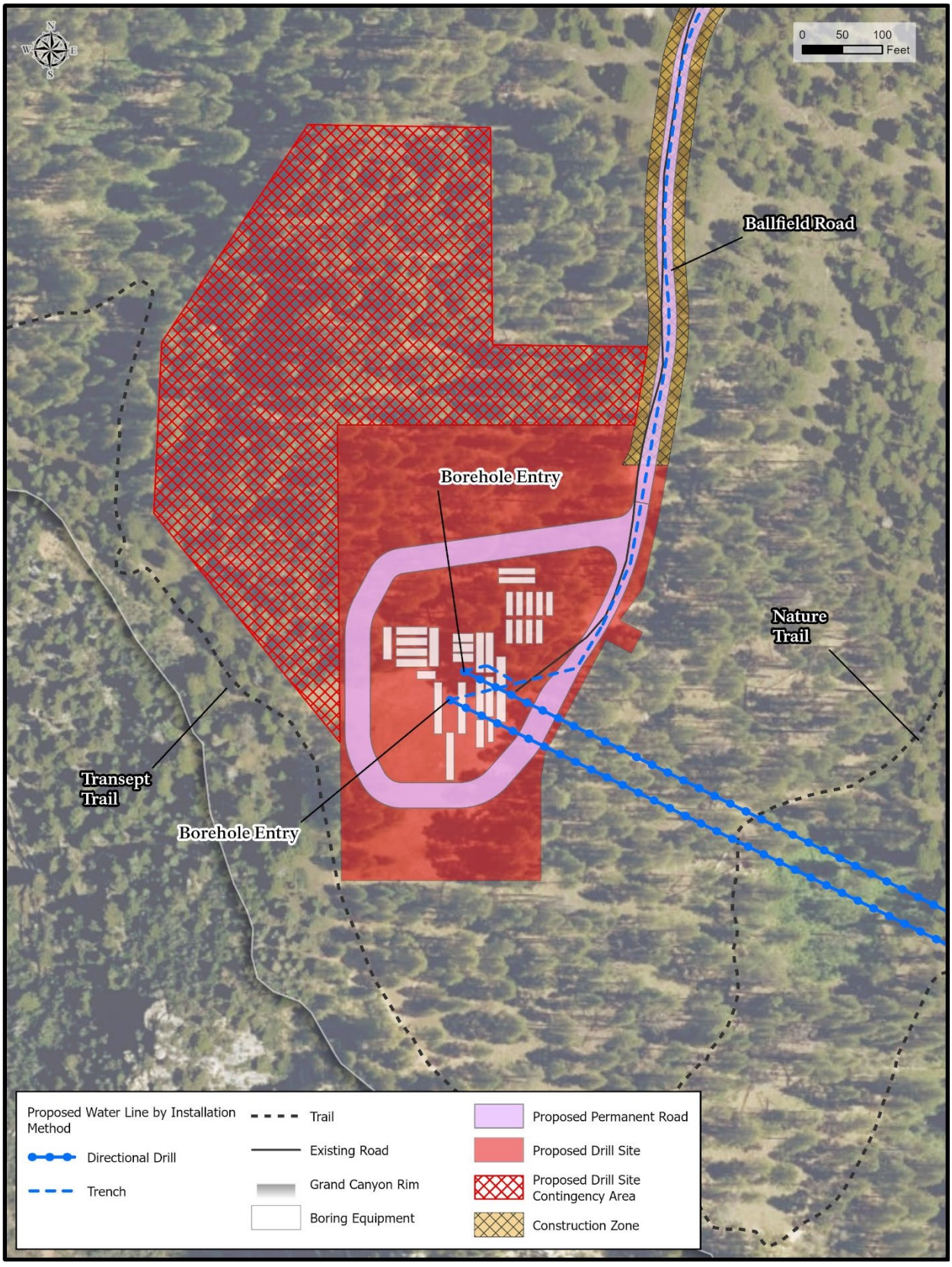


Figure 7: Proposed Borehole Drill Construction Zone and Example Site Layout

Borehole Drilling Specifications

The diameters of the boreholes would vary from approximately 26 inches at the bore entry to 9 inches at the bore exit to accommodate installation of casing pipe, which aids in stabilizing the borehole and protecting the installed utilities. Each borehole would be drilled and cased using progressively smaller bits and casing pipes as the drilling progresses, a process referred to as telescopic casing (*Figure 8*). This technique reduces risk related to borehole instability during drilling. After a casing is installed, it is cemented in place to secure that section of the borehole. Cementing also serves to separate any underground voids from the casing and borehole. The cement would be mixed at the ballfield site using a mobile batch plant.

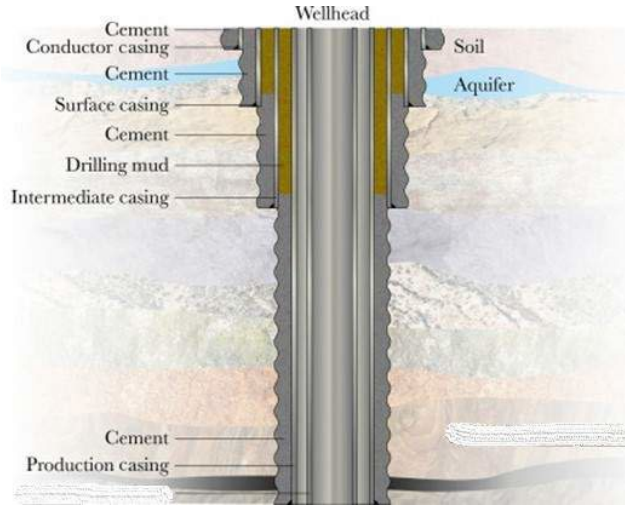


Figure 8: Typical Telescopic Casing

During drilling, a drilling medium is required to return cuttings to the surface, cool downhole tooling, reduce frictional forces, and create a "filter cake barrier" along the borehole wall to aid with borehole stability and fluid containment. The primary drilling medium would be an air, mist, and foam mixture, as it reduces the amount of water needed for drilling operations, requires lower minimum operating pressures to return cuttings, and reduces the potential for drilling fluids entering underground cavities, such as voids, fractures, and caves. However, an air, mist, and foam medium is not as effective at maintaining borehole stability or sealing fractures as drilling fluid, also referred to as drilling mud[16]; therefore, drilling fluid may be used, but only as necessary to aid in stabilizing a borehole, seal fractures and voids, regain lost circulation, and control downhole pressure. It is expected that drilling mud would be required for the first several hundred feet of drilling. All drilling fluid would be non-toxic and would require NPS approval prior to use.

Drilling media and spoil cuttings would be collected and processed at the drill site throughout the drilling process. The soil cuttings would be placed in a containment device or stockpiled and then hauled out of the park. After being separated from the spoil cuttings, the drilling medium can be recycled and pumped back into the drill rig.

Bore Exit Site

The bore exit site, where the drill bits and boreholes would daylight, or emerge from the ground, would be located approximately 200 feet west (upslope) of Roaring Springs Pumphouse in the inner canyon. At the bore exit site, a temporary receiving pit would be constructed to capture and contain cuttings and drilling media/fluids that may exit the boreholes once they daylight. The bore exit site requires a construction zone of about 12,500 square feet (0.29 acre) to accommodate the receiving pit; temporary equipment, machinery, and materials storage; fluid containment tanks; and a helicopter drop zone. See *Figure 9* for the bore exit site. Grading, clearing, grubbing, and minor excavation would be required to create the receiving pit and allow for equipment access. Blast matting would be placed at the bore exit site to capture debris when the drill emerges from underground. The receiving pit would be located downslope of the blast matting and would be lined

[16] The components of mud drilling fluids would generally consist of water, bentonite, and non-toxic additives such as barite, chalk, xanthan gum, and natural fibers.

with erosion control blankets and a protective impermeable membrane/barrier, such as a reinforced polyethylene liner, and bordered with a sandbag embankment to contain drilling media/fluids. Any fluids from the borehole would be collected, tested, and discharged onsite after receiving approval from NPS. Any fluids not approved to be discharged on site would be pumped into water tanks, flown out of the canyon, and discharged at a suitable location.

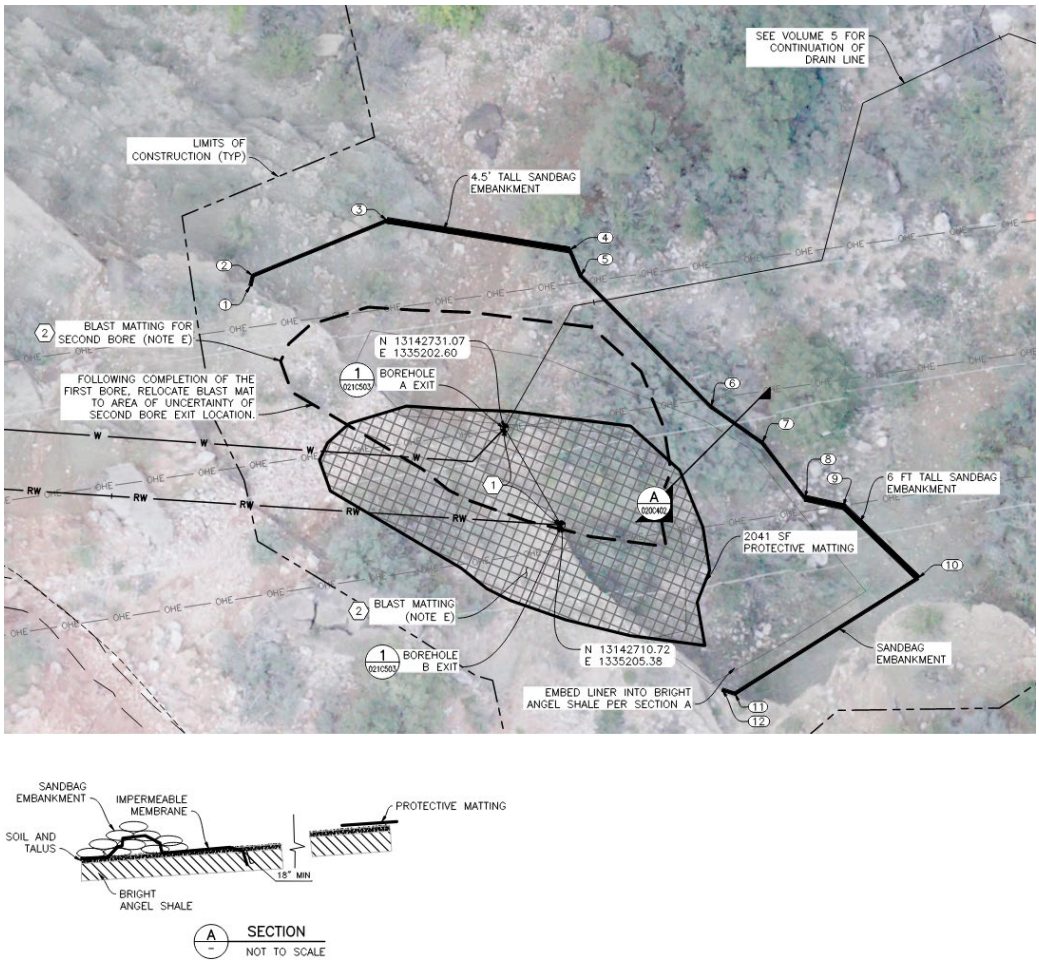


Figure 9: Borehole Exit Site

Borehole Waterline Installation

Upon completion of drilling and casing the boreholes, two 4-inch-diameter steel pipelines, one for raw water and one for potable water, would be installed in their respective borehole by using the drill rig to lower the pipes into place. For reference, *Figure 10* shows an example of a pipeline installed in a borehole at the South Rim.

Once the pipes are installed, 14-foot-tall by 10-foot-wide wellheads would be constructed at the top of each borehole to hold the pipes and to connect them to the trenched waterlines in Waterline Area 1. The wellheads would be buried below the surface on a two-foot-thick reinforced concrete footing, approximately 16 feet below ground surface, and would not be visible at the surface except for the entryway cover.

Bore Exit to Roaring Springs Pumphouse Waterline Installation

From the bore exit site to Roaring Springs Pumphouse, the pipelines would be installed by surface mounting and trenching due to topography. Surface mounted sections of the pipeline would be anchored, insulated, and placed in casing to protect the pipe from freezing and rockfall damage. Temporary access improvements, such as ladders or scaffolding may be installed with anchors between Roaring Springs Day Use Trail and the Roaring Springs Pumphouse to accommodate contractor access.

Figure 10: Existing waterline exiting a borehole below the South Rim along the Bright Angel Trail

Trail Closures

About 2½ miles of the North Kaibab Trail between the Redwall Bridge and Manzanita Rest Area would be closed for approximately six weeks total – three weeks for each borehole exit – as the drill bit approaches and emerges at each exit. The closures are needed to minimize risks to visitors should rockfalls occur during the work. The duration and extents of trail closures may be revised during construction. If this occurs, the public would be notified of the revised closures. Trail closures are discussed further in *Visitor Use and Experience*.

Construction Schedule for Waterline Area 2

The overall construction duration associated with Waterline Area 2 is expected to be five to seven months. It is anticipated that drilling and installing the pipelines in the boreholes would take three months to complete but could extend up to five months and could occur at any time of year. Drilling would occur 24/7 until the borehole is completed; therefore, night work with lights would be required. Additionally, it is anticipated that the installation of the waterlines between the bore exit and Roaring Springs Pumphouse would take approximately two months.

<u>Waterline Area 3: Roaring Springs Cave to Roaring Springs Pumphouse</u>

Improvements to the waterline from Roaring Springs Cave to Roaring Springs Pumphouse would include maintenance of the existing waterline for conveyance, providing additional structural support (e.g., anchors), selective replacements of pipe sections that are deteriorated, selective tree pruning and removals, and rehabilitating or replacing the power and communication cables currently attached to the existing pipeline. The section of underground waterline between Roaring Creek and Roaring Springs Pumphouse would also be removed and replaced through a combination of trenched installation and surface mounted on concrete supports. The trench depth for this installation would be approximately 3 feet. Valve vaults would be installed at several locations along the trenched waterline. Additionally, the existing diversion/overflow box near the cave would be removed and replaced with a new segment of pipe and a valve.

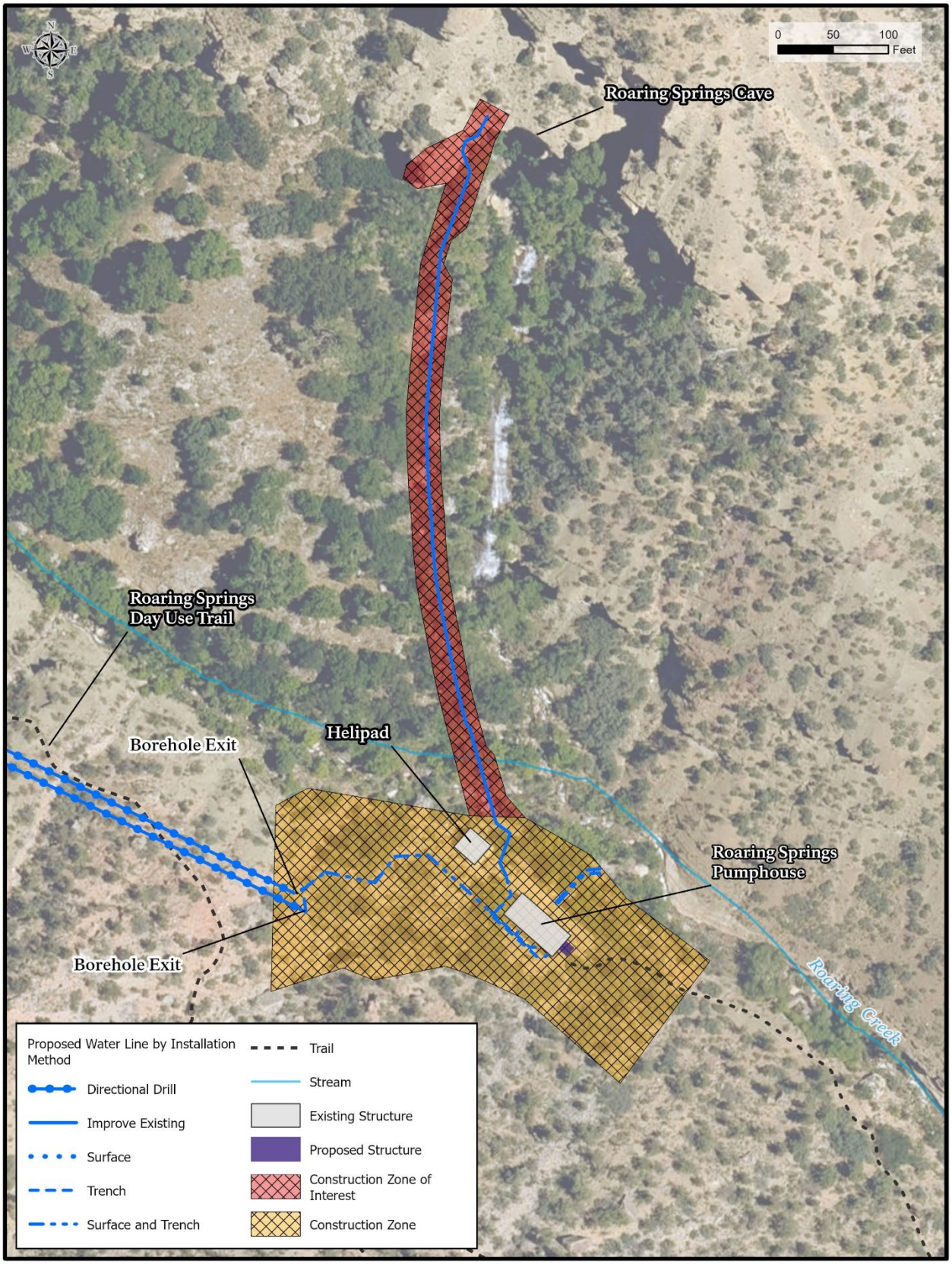


Figure 11: Waterline Area 3 Construction Zone

Upon completion of the TCWL project, there will be less water demand from Roaring Springs Cave, so more water would naturally flow from Roaring Springs Cave to Roaring Springs Falls. Additional water would also flow from the cave when the new valve is closed and water is not being pumped.

Several times a year, water from the pipeline would be discharged into Roaring Creek to flush sediment out of the water system. These discharges would be automated by a turbidity meter. Prior to discharge, water would be dechlorinated.

The construction zone for this work would be approximately 30 feet wide (½ acre), extending from Roaring Springs Cave to near Roaring Springs Helipad, and is depicted on *Figure 11*.

The construction duration for this work is expected to be up to two months. This work would be contractually required to occur during the winter to minimize impacts to water pumping.

Waterline Area 4: North Rim to Supai Tunnel Rest Area

Approximately 3,300 feet (0.6 mile) of new 2-inch-diameter waterline would be installed between the North Rim water tanks and Supai Tunnel. Above the rim, the new waterline would be buried, while below the rim, the waterline would be surface mounted and installed parallel to the existing North Rim and Supai Tunnel lateral waterlines. The North Rim waterline would be abandoned in place or removed if funding is obtained, while the Supai Tunnel lateral waterline would be demolished.

The new waterline would be anchored at least every 275 feet. A pulling winch is anticipated to be needed at various locations along the pipeline alignment to assist in directing the new pipeline during installation and would be transported to and from the inner canyon pulling locations via helicopter.

A vault measuring 9 feet wide by 14 feet deep would be constructed along the waterline alignment on the rim. The vault, which would house the air relief valve, would be buried and built on a footing.

The construction zone for the waterline and vault installation between the North Rim water storage tanks and Supai Tunnel would be approximately 50 feet wide (3.8 acres) and is shown on *Figure 12*.

At Supai Tunnel, a new spigot would be installed near the composting restroom for maintenance of the restroom. The existing filling station would be improved with a new water filling/drinking fixture, and an additional filling station made of steel pipe with two faucets would be installed adjacent to the existing one.

Three vaults housing water valves and appurtenances would be buried near the Supai Tunnel composting toilets. Waterlines would be installed underground between the vaults and water fixtures described above. Each vault would be roughly 4 feet wide, 8 feet long, and 3 feet tall. Drain lines would be connected to the vault boxes, which would allow water to be drained for winterization or maintenance. Due to the new waterline being surface mounted, it would be drained and winterized annually to prevent freezing. The water would drain over a nearby ledge outside of the main Supai Tunnel Rest Area and North Kaibab Trail corridor.

The construction zone at Supai Tunnel is approximately 0.2 acre and shown on *Figure 12*.

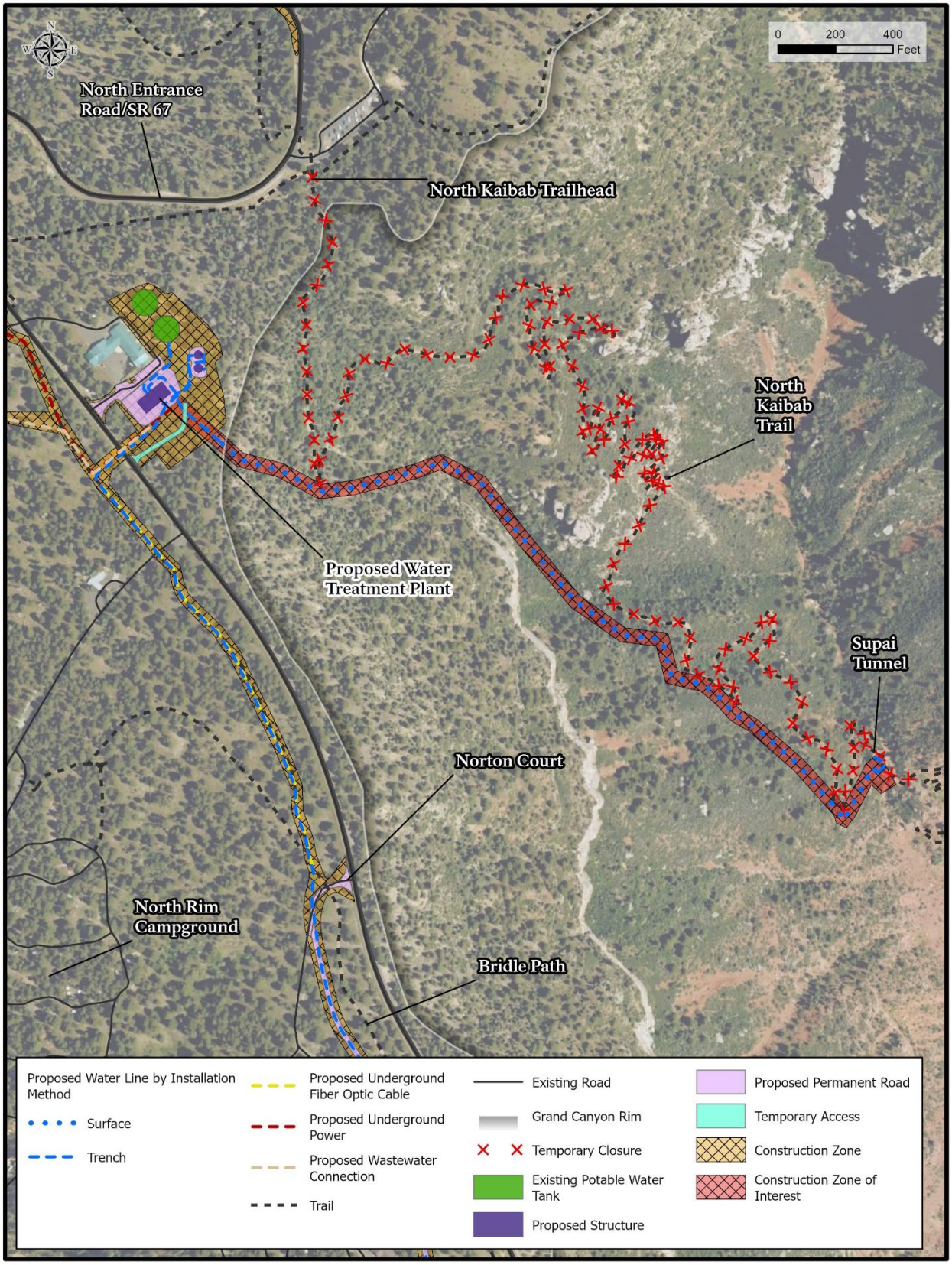


Figure 12: Waterline Area 4 Construction Zone, including Supai Tunnel

Approximately 1.7 miles of the North Kaibab Trail between the trailhead and Supai Tunnel would be closed for approximately five weeks during pipeline installation to minimize risks to visitors. Additionally, Supai Tunnel is expected to be closed for approximately five consecutive months to complete work at this location. These closures are shown on *Figure 12*. To the extent practicable, the North Kaibab Trail and Supai Tunnel closures would occur concurrently to minimize impacts to the public. The duration and extents of trail closures may be revised, and potentially increased, during construction, particularly if warranted due to safety factors. If this occurs, public notifications will be issued for the revised closures. Trail closures are discussed further in *Visitor Use and Experience.*

The construction duration for the Waterline Area 4 work is expected to be five months and is expected to occur at least partly within the North Rim developed area visitor season.

Roaring Springs Pumphouse

The Proposed Action includes interior and exterior improvements at Roaring Springs Pumphouse. As mentioned, full water treatment would no longer occur at Roaring Springs Pumphouse and, because of the TCWL replacement project, the amount of water diverted to and pumped from Roaring Springs Pumphouse would be substantially reduced. Therefore, the interior utility systems within Roaring Springs Pumphouse would be reconfigured to accommodate the proposed water system processes and projected water demands. Stabilization and rehabilitation improvements would be made to the building and its surrounding structures, and the yard piping around the pumphouse would also be replaced to accommodate the new raw and potable North Rim waterlines and associated water systems processes.

Exterior Improvements
The current wood shingle roof would be replaced with a metal roof featuring a weathered steel finish. Any damaged or deteriorated roof components under the shingles, such as sheathing, would be replaced.

Site work at Roaring Springs Pumphouse consists of constructing rockfall protection upslope of the pumphouse and performing various improvements, including:

- Installing anchored rock netting on the upslope (southwest) side of the building to stabilize the existing riprap
- Replacing the concrete decking and repairing the timber crib wall around the pumphouse
- Installing a removable railing system along the concrete deck
- Adding filter fabric and wood slat fencing to the northeast face of the timber crib wall
- Constructing a modular block retaining wall at the northwest side of the building
- Replacing the air-conditioning unit and associated equipment pad on the deck
- Replacing site piping (water and drainage piping) around the pumphouse and installing a drain field
- Upgrading the electrical transformer northwest of the pumphouse
- Installing underground conduit and electrical lines between the upgraded transformer and the pumphouse
- Installing a new approximately 30-foot-long by 17-foot-wide drain field east of the pumphouse
- Constructing a 5,000-gallon water storage tank and associated concrete pad on the southeast side of the building

The tank would be approximately 12 feet tall by 12 feet in diameter and would be fenced as needed in accordance with ADEQ requirements. Piping would be installed from the top and bottom of the

tank into the pumphouse. The tank and pumps would not exceed the height of the pumphouse (approximately 16 feet tall). See *Figure 13* for a rendering of the proposed tank at the pumphouse.

Excavation and grading would be required around the pumphouse to perform the site improvements.

The construction zone at Roaring Springs Pumphouse would be approximately 1.3 acres and is depicted on *Figure 14*. Portions of the Roaring Springs Pumphouse construction zone overlap with construction zones for Waterline Areas 2 and 3.

Construction of the Roaring Springs Pumphouse work is anticipated to take six months, which may be nonconsecutive. Work that could affect current water treatment/pumping operations is planned to occur primarily during the months when water pumping does not occur.

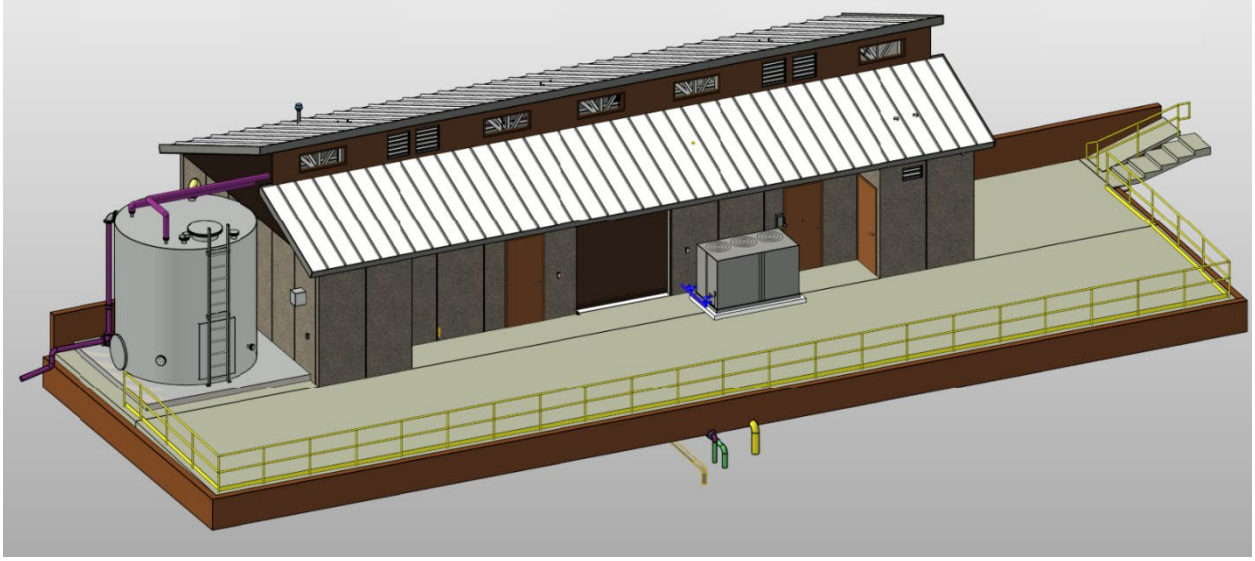


Figure 13: Rendering of Roaring Springs Pumphouse exterior improvements, view facing west

Interior Improvements

All water system process equipment and machinery, such as the pumps, pump pads, and piping, within Roaring Springs Pumphouse would be demolished and the interior reconfigured. The new interior layout would consist of an "electrical area" and "pump area," divided by a removable partition wall or curtain. The room that currently houses the gaseous chlorine and its associated equipment and piping would be converted into an operator's room. The existing partition walls and doors enclosing the storage and office rooms at the southeast elevation of the building would be removed.

New water pumps, pump supports, monorail beams (for moving pumps), truss braces, pipe racks, water piping, filters, and other water systems equipment and appurtenances would be installed in the pumphouse. To install the new equipment and machinery, some areas of the existing concrete floor would need to be cut and replaced. As a result of the new pumps, the existing electrical transformer northwest of the pumphouse would be upgraded (see *Exterior Improvements* above). The current gaseous chlorine disinfection system would be replaced with liquid sodium hypochlorite for secondary disinfection, thereby removing the risks associated with gaseous chlorine while meeting water quality standards.

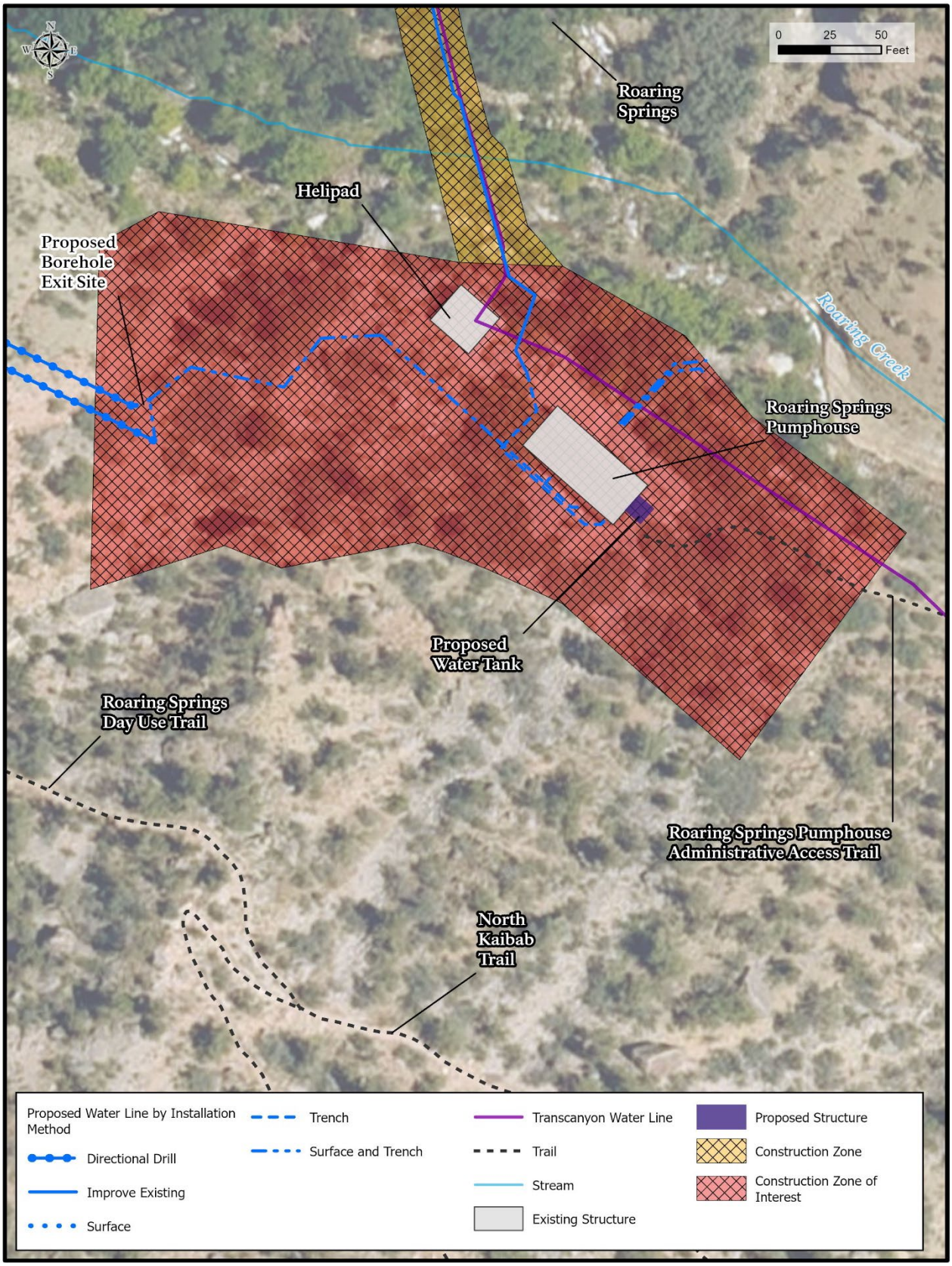


Figure 14: Roaring Springs Pumphouse Construction Zone

The heating, ventilation, and air conditioning (HVAC) systems, including electric unit heaters, air conditioning unit, ductwork, and ventilation louvers and dampers, would be replaced throughout the pumphouse to accommodate the new interior layout. Electrical improvements consist of replacing the motor control center, pump variable force drives, programmable logic controller, wiring (as needed), and light fixtures to accommodate the new interior layout and water system process. Plumbing improvements include installing a new domestic waterline to provide water to a new emergency shower/eyewash station, as well as drinking water at the pumphouse. A water heater and small water softening system would also be installed.

All interior finishes would be refinished, including sealing concrete and painting interior walls.

North Rim Water Treatment Plant and Water Storage Tanks

A new, approximately 6,200-square-foot water treatment plant (WTP) building would be constructed south of the Emergency Medical Services (EMS) building and the existing water tanks. The building would be approximately 55 feet wide, 115 feet long, and 43 feet tall. The building would be compatible with other structures in the area in terms of color, materials, design, massing, and visual scale. It is anticipated that the building would have concrete block walls with a shotblast veneer on the lower elevation and prefinished cement board lap siding on the upper elevation, with both finishes colored a shade of brown. The roof would be a standing metal seam roof colored in a shade of green. See *Figure 15* and *Figure 16* for a rendering of the proposed building.

The WTP would be designed for current needs, with additional space in the building to accommodate more equipment in the future, should it be needed. The treatment system would be designed to meet permitting requirements for surface water and groundwater under direct influence of surface water. The building would also contain pumping equipment to pump water from the potable water storage tanks to the North Rim water distribution system. The existing North Rim Pumphouse, which is adjacent to the proposed WTP, would be decommissioned and reused for other operational purposes (e.g., storage).

The area surrounding the WTP building would be paved with asphalt to provide parking and an access loop around the building. The new pavement on the north side of the WTP building would connect to the existing pavement at the EMS facility, with some of the existing asphalt near the EMS facility being removed and replaced to accommodate the connection. The asphalt access drive to EMS and the WTP would also be replaced in-kind. An outdoor maintenance area with a concrete pad, electrical equipment (e.g., switchbox, transformer), underground treatment process waste tank, and HVAC units would be constructed adjacent to the building.

The two existing 93-foot-diameter, two-million-gallon water storage tanks on the North Rim would remain and be rehabilitated under the Proposed Action. To provide additional water storage, two new tanks — each 32 feet in diameter, 32 feet tall, and with a capacity of 150,000 gallons — would be constructed near the existing tanks. The new tanks are expected to store raw water, while the existing tanks would continue to store potable water. An approximately 10-foot-wide area around each tank would be surfaced with pavement or gravel to allow access and provide defensible space against fire. The fencing around the existing water tanks would be replaced and extended to encompass the two new raw-water tanks. Communications equipment (e.g., antennas) may be mounted atop the tanks as needed.

Figure 15: Rendering of WTP and new water tanks, view facing southwest.

Figure 16: Rendering of WTP, view facing north-northwest.

New site/yard piping for raw and potable water would be installed between the new raw water tanks, WTP, existing potable water tanks, and existing distribution mains via trenching. Sanitary sewer yard piping and electrical and fiber optic lines would also be installed at the WTP site. Trenching methods and trench dimensions would be similar to those described above under the *Waterline Area 1: North Rim Water Storage Tanks to North Rim Former Ballfield Bore Entry Site* section, with trenches being approximately 5 feet deep and varying in width from 3 to 8 feet. Existing site utilities, such as underground water pipes and electrical lines, that are replaced would be removed or abandoned in place.

A temporary gravel road, measuring approximately 16 feet wide by 330 feet long, would be constructed between North Entrance Road and the proposed WTP to provide access during construction. Upon project completion, this temporary access road would be removed and the area restored.

A 40-foot-tall, 1½-foot-wide, self-supporting lattice telecommunications tower would be installed approximately 20 feet northeast of the new water tanks. The tower would be installed on a new concrete pad, measuring seven feet wide and four feet deep, with most of the pad below ground. Electrical and fiber-optic conduit and cabling would be trenched to an existing transformer just west of the northernmost water tank. Fiber-optic lines would also be trenched from the tower to the WTP.

To accommodate construction and staging, one utility shed located within the construction zone would be removed. See *Chapter 3, Historic Districts* section for additional information.

The construction zone for the WTP work described above would be 4 acres and is depicted on *Figure 17*. Site grading, excavation, and vegetation clearing and grubbing would occur to accommodate project construction and staging.

To connect the new WTP to the existing wastewater collection system, a new wastewater pipe would be installed in an approximately 700-foot-long trench between the WTP and an existing manhole behind the former North Rim Administration building/Backcountry Information Center. The trench depth would be a minimum of four feet but may be up to nine feet to allow for optimal gravity flow of wastewater from the WTP. Approximately five new manholes would be installed along this alignment. The construction zone for this work varies from approximately 30 to 80 feet wide (0.7 acres) and is depicted on *Figure 17*.

To provide dedicated standby power to the WTP, a new electrical line would be trenched from the generator building/power distribution center to the WTP (see *Figure 17*). The construction zone for trenching and installing the electrical line would be approximately 40 feet wide. Additionally, the segment of Admin Loop Road between North Entrance Road and the power distribution center would be widened by 2 to 4 feet and resurfaced with new asphalt after the electrical line is installed. The construction zone for widening Admin Loop Road would be 55 feet wide. In total, the construction zone for the electrical alignment and Admin Loop Road widening is approximately 1.7 acres and is shown on *Figure 17*.

The section of Bridge Path between Admin Loop and Campground Roads would be closed for approximately two weeks to install the electrical line and wastewater pipe associated with the WTP.

The construction duration for the WTP and associated work is expected to be approximately 18 to 24 months and may be nonconsecutive.

Construction-related Activities

Helicopter and Unmanned Aircraft System (UAS) Operations

All work in the inner canyon as described in the above sections would require helicopter support to transport equipment, material, and personnel. All project-related helicopter services would be provided by a contractor. All equipment and materials for project components occurring on the North Rim would be trucked directly to the North Rim to minimize helicopter flights.

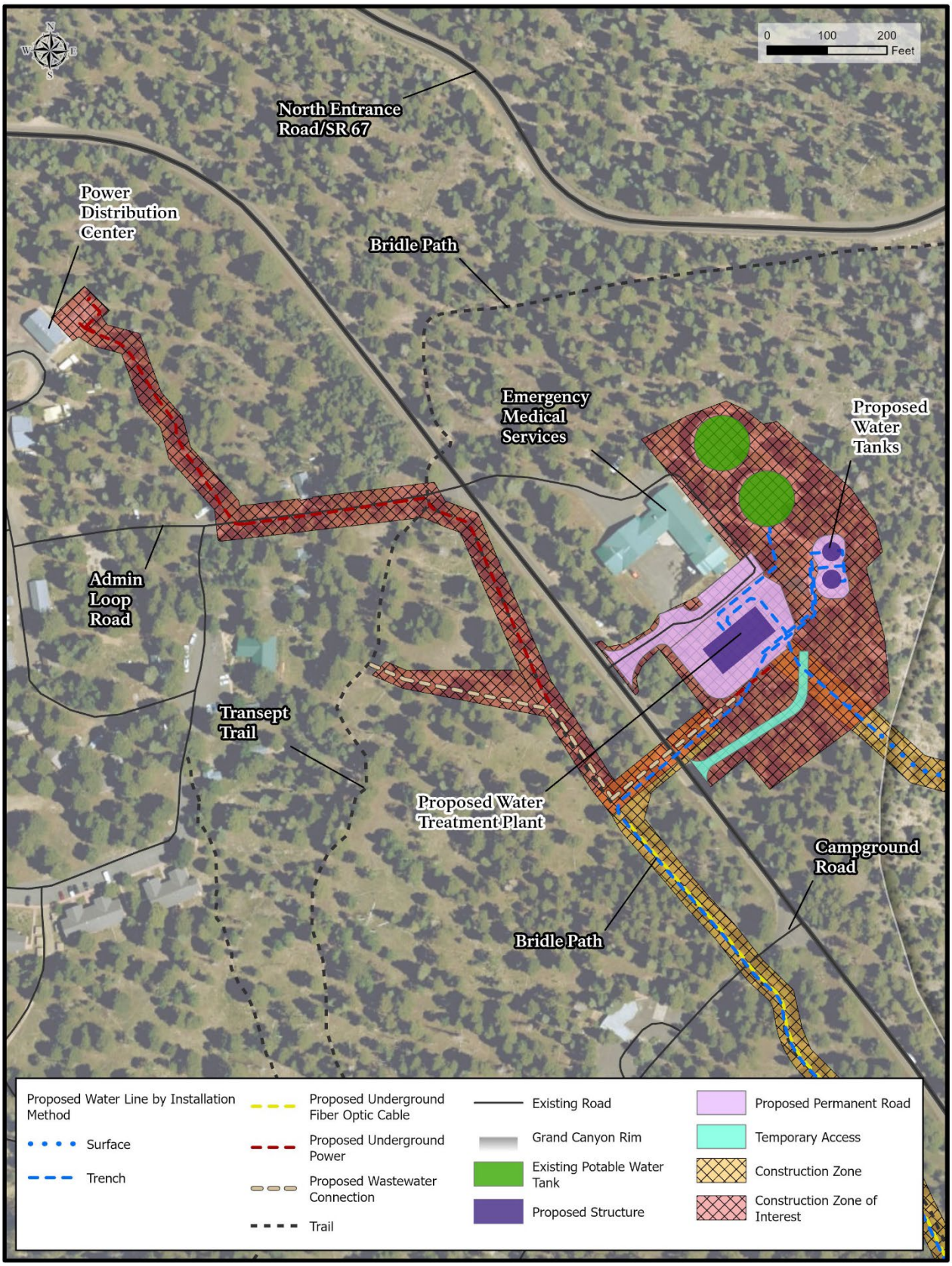


Figure 17: WTP Construction Zone

Most equipment and materials would be flown into the inner canyon from the South Rim Helibase using existing flight paths (see *Figure 18*). The North Rim Helibase would be used primarily for personnel transport, sling-loading smaller loads of materials (e.g., water, food, hand tools), and refueling. The primary inner canyon landing zone would be at the Roaring Springs Pumphouse helipad. Inner canyon sling load locations would occur at Roaring Springs Pumphouse, Roaring Springs Day Use Area, and Supai Tunnel. As necessary, additional sling load sites would be established in or along the construction zone for the North Rim to Supai Tunnel waterline work. Landing and sling-loading may also occur at the Manzanita Rest Area helipad; however, this is anticipated to be infrequent due to its distance from the project areas.

It is expected that aircraft for construction would include two light-lift helicopters with 1,000-pound payloads (Airbus AS350 or similar), one medium-lift helicopter with a 4,000-pound payload, (Bell 305 or similar), and the occasional use of a heavy-lift helicopter with a 14,000-pound payload (Chinook or similar).

A helicopter flight analysis was performed to estimate the number of flights required for the project. The projected flights are included in *Table 1* below (HDR 2025).

As shown in Table 1 below, approximately 1,735 flights are estimated to be needed over the two-year construction period in the inner canyon. Each project component averages about three to five flights per day; however, up to 20 flights per day could occur if construction of any components overlaps in timing. While up to 20 flights per day could occur on busy days, this is expected to be infrequent (a couple times per month). Helicopter flights would only be allowed to occur during the hours of 8 am (power on) to 5 pm (power off), so helicopter activity would typically occur during a nine-hour period each day. However, there may be limited instances when flying outside these times is allowed and flight activity periods exceed nine hours per day.

Under the Proposed Action, helicopter flights required to operate, maintain, and repair the North Rim water system are expected to be reduced by at least half from the current annual total of approximately 70 to 120 flights. This reduction is largely due to changes in water treatment processes at the pumphouse and updated equipment and infrastructure, which should require less maintenance for the foreseeable future, and because most of the waterlines would be protected within boreholes, thereby reducing the risk of breaks. However, some pipe sections in the inner canyon would remain surface mounted and more susceptible to breaks due to natural forces, such as landslides. If breaks occur to these surface-mounted sections, it would be likely that helicopter support would be required.

Due to the difficult terrain in the inner canyon, unmanned aircraft systems (UAS), also known as drones, may be used in Roaring Springs Canyon – generally in the area bounded by Bright Angel Point, North Kaibab Trailhead, and Uncle Jim Point on the Rim and extending from these points down to Manzanita Rest Area in the inner canyon – to perform reconnaissance and survey project areas. For example, UAS may be used to gather route and terrain information and document as-builts, prior to, during, and after construction. Using UAS is anticipated to result in less helicopter flights that may have been otherwise needed to perform reconnaissance and survey project areas in difficult terrain.

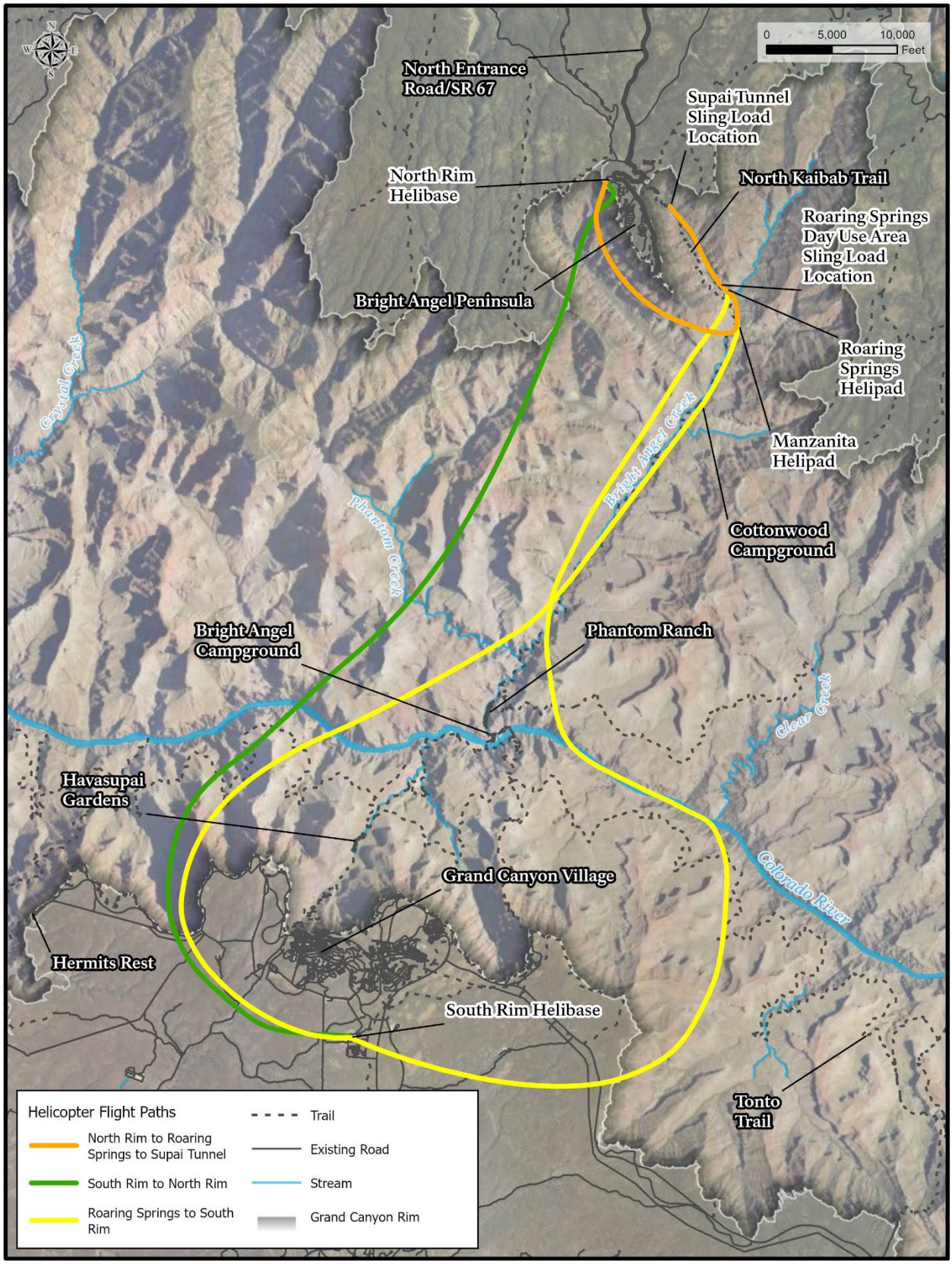


Figure 18: Typical Helicopter Flight Paths

Table 1: Project Areas and estimated helicopter flights

Project Component	Estimated Number of Light-lift Flights[1,2,3]	Estimated Number of Medium-lift Flights[1, 2,3]	Estimated Number of Heavy-lift Flights[1,2,3]	Estimated Total Flights[1,2]	Estimated Days for Construction	Estimated Number of Flights Per Day[1,4]
Waterlines – Bore Exit Site	60	120	2	182	40	4-5
Waterlines – Roaring Springs Cave to Roaring Springs Pumphouse	120	30	2	152	40	3-4
Waterlines – North Rim to Supai Tunnel	315	30	2	347	90	3-4
Roaring Springs Pumphouse	720	330	4	1,054	210	4-5
Total Flight Estimate[2]	1,215	510	10	1,735	-	-

[1] One helicopter flight is defined as one helicopter flying from the South Rim Helibase to the project site and back to the South Rim Helibase. If a helicopter needs to stop briefly at the North Rim or another inner canyon site, for example, to pick up personnel, this is considered as part of the one flight and is not counted as an additional flight. As such, one helicopter flight may involve multiple takeoffs and landings.

[2] Helicopter trip estimates are expected to have an accuracy range between -30% to +50% of the estimated value; therefore, for purposes of this EA, the +50% values are reported in this table and are used for analyses herein as they represent the expected upper limit of number of flights needed, and thus the upper-bound impact scenario.

[3] The helicopter flight analysis used a payload capacity of 1,000 pounds for light-lift helicopters, 4,000 pounds for medium-lift helicopters, and 14,000 pounds for heavy-lift helicopters. Payload capacities, among other factors such as weather, influence the number of flights expected to be required.

[4] Please note that construction of various project components could overlap in their timing, in which case the approximate number of flights per day would be the aggregate of those project components occurring at the same time. For example, if the North Rim to Supai Tunnel and Roaring Springs Pumphouse work occurred concurrently, there could be approximately 9 flights per day.

Access

To access the drill site (bore entry site) at the former ballfield, a new road, measuring approximately 1,830 feet long (0.35 mile) by 20 feet wide, would be constructed between Norton Court and the existing Ballfield Road, effectively extending Ballfield Road. This new road would allow construction traffic to bypass the concessioner housing area. Both the new road and the existing Ballfield Road would be surfaced with gravel, creating a total newly surfaced road length of about 2,900 feet (0.55 mile). The road would remain as a permanent feature upon project completion. Additionally, an approximately 1,200-foot-long gravel loop road would be constructed around the drill site to provide better ingress and egress.

The new waterline segment from the bore entry site to Norton Court (part of *Waterline Area 1*, described above) would follow the new road alignment to limit additional ground disturbance. As such, the construction zone for the new access road is 50 feet wide (3½ acres) and coincides with the construction zone for this segment of waterline installation (see *Figure 19*).

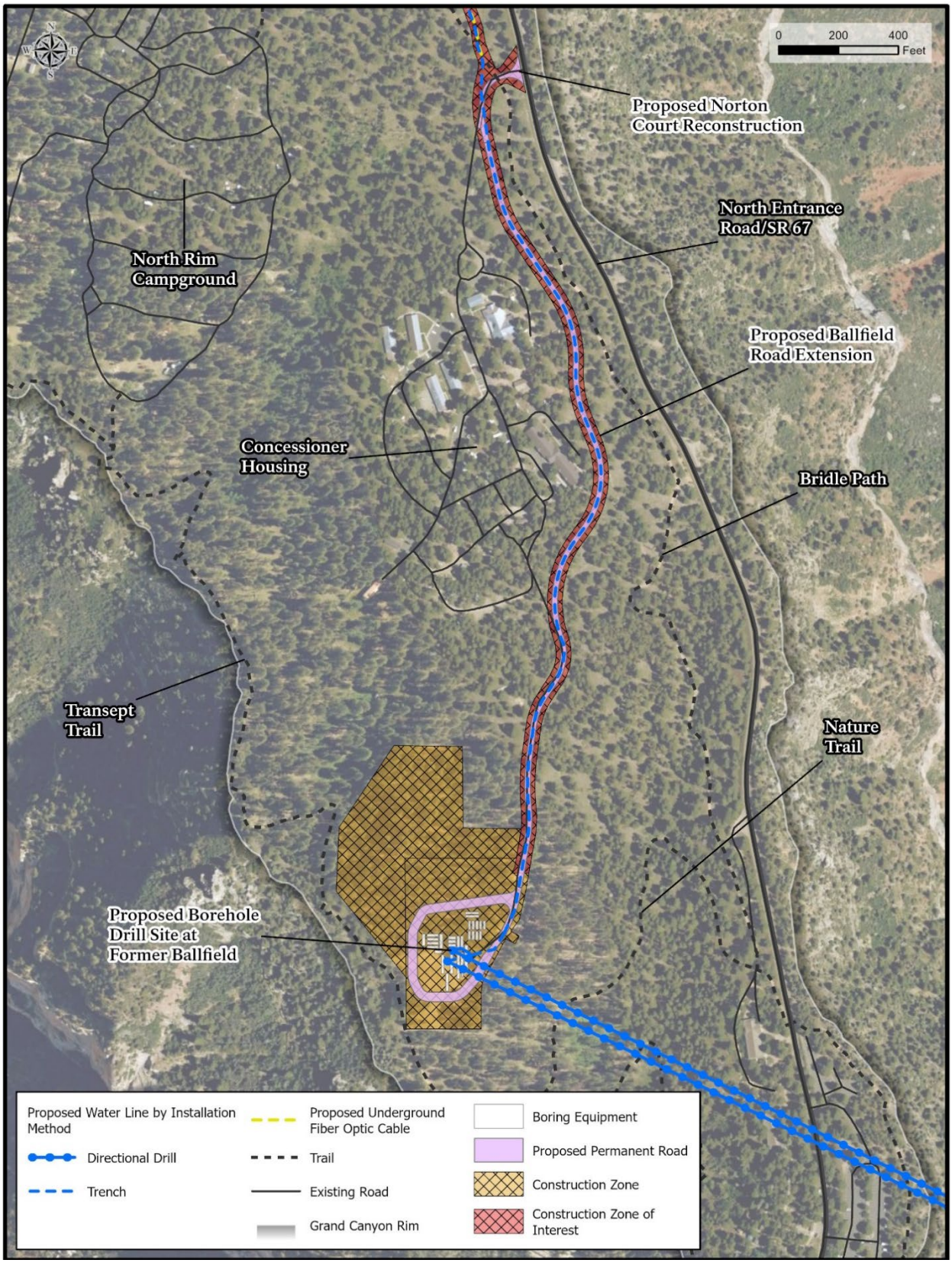


Figure 19: Drill Site Access Road Construction (Ballfield Road Extension) and Norton Court Intersection Reconfiguration

To improve turning radii, cross-slopes, and to connect with the new ballfield access road, approximately 280 linear feet of Norton Court near its intersection with North Entrance Road/SR-67 would be reconfigured (i.e., realigned, regraded, and widened) and paved with asphalt. The construction zone for the Norton Court reconfiguration falls within the construction zone of the Ballfield Road extension and Waterline Area 1installation and is shown on *Figure 19*.

Transporting the drill rig into and out of the park would require temporarily widening and reinforcing the road shoulders along North Entrance Road (SR-67) at two locations near the North Kaibab Trailhead. The construction zones for this work total 0.8 acre. Pilot vehicles and local traffic control would be used on SR-67 during transport of the drill rig to and from the drill site. To minimize traffic disruptions, the drill rig may be transported in the early morning or late evening, as practicable.

Additionally, due to trenching across North Entrance Road, temporary restrictions to vehicular traffic would be required. These restrictions are discussed further in *Visitor Use and Experience*.

As previously described, a temporary road would be constructed between North Entrance Road and the proposed WTP for contractor use during construction (see *Figure 17*). Upon project completion, this temporary access road would be removed and the area restored.

Hazardous Trees

As a result of the Dragon Bravo Fire, standing trees within or adjacent to the construction zones may have sustained heat damage sufficient to cause eventual instability or death. Therefore, prior to project commencement, a hazard tree analysis would be conducted, and any trees identified as posing a hazard to people or property would be removed. Downed trees and brush would also be cleared from the construction zone as needed.

Staging and Contractor Lodging

Staging and contractor housing would be required at the North Rim to construct the project. Staging and laydown would occur both within the construction zones identified above (onsite) and in designated areas outside of the construction zones (offsite). Contractor lodging would be outside of the construction zones. This section primarily addresses staging and contractor lodging outside of the project construction zones identified above.

Offsite staging at the North Rim would occur at the administrative area on the peninsula, Lindbergh Hill, and at an area immediately south of the wastewater treatment plant (WWTP). As noted previously, the former ballfield would serve as the drill site for installing new waterlines in a borehole; however, when drilling activities are not underway, the ballfield would be used for offsite staging for other project components. Similarly, the construction zone at the WTP may be used as offsite staging for other project components.

Additionally, some offsite staging of materials and equipment would occur at the South Rim before being transported by helicopter to the inner canyon project areas. South Rim staging areas are in operational administrative areas away from visitor use areas. The areas include South Gate, near the intersection of State Route 64 (SR-64) and Center Road, and the Contractor Support Facilities area, which is adjacent to the South Rim Helibase and Facilities and Maintenance Division complex. Staging in the inner canyon would occur within the construction zone at Roaring Springs Pumphouse. The staging areas are shown on *Figure 20*.

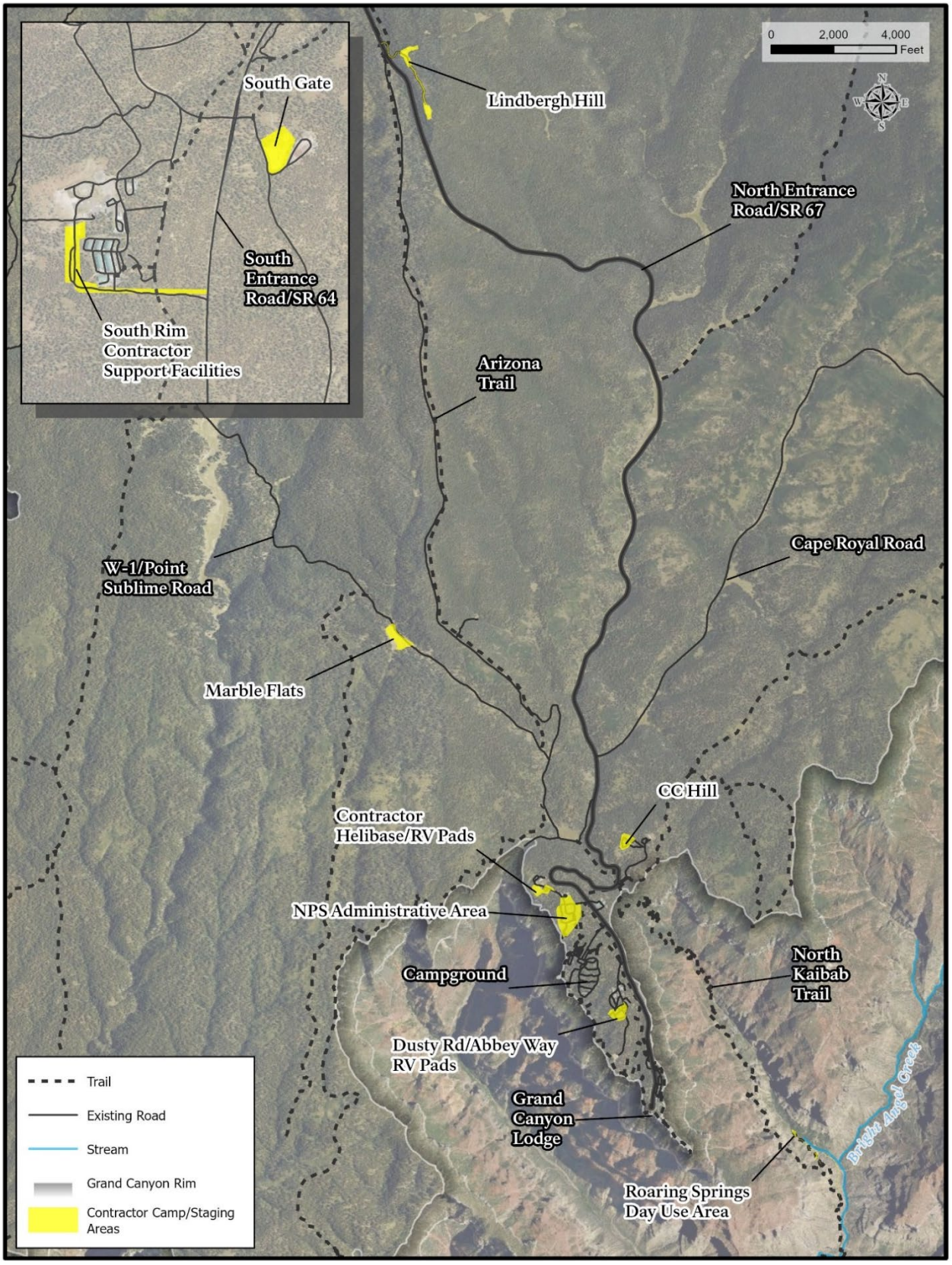


Figure 20: Overview of Contractor Camp and Staging Areas

Construction activities that may occur at staging areas include grading and leveling; limited vegetation removals/grubbing; removing trash and debris; adding gravel, mulch, or similar surfacing; installing permanent or temporary power supply systems, including cabling, pull boxes, and pedestals; operating generators; installing permanent or temporary water supply systems; rock crushing, seining/sorting, and stockpiling; erecting temporary storage and fabrication structures (e.g., sheds, shelters); installing temporary toilets; and installing and operating temporary asphalt and/or concrete batch plants. Installing power and water supply systems may require trenching.

In addition to staging, lodging on the rim would be needed for contractors. Existing RV pads and lodging or housing units at the North Rim would be used, as feasible, for contractor accommodations. However, due to limited lodging and housing availability on the North Rim, temporary contractor lodging, also referred to as construction or contractor camps, would be set up in the administrative area on the peninsula, and at Lindbergh Hill if needed. Depending on the location of the contractor camp, lodging units could consist of modular or flatpack housing units, RVs, wall tents, or similar temporary structures. The contractor camp areas are shown on *Figure 20.*

Construction activities that may occur at these temporary contractor housing areas and existing RV pads include grading; limited vegetation removals/grubbing; removing trash and debris; adding gravel, mulch, or similar surfacing; installing permanent or temporary power supply systems, including cabling, pull boxes, and pedestals; operating generators; installing permanent or temporary water supply systems; and installing temporary toilets. Installing power and water supply systems may require trenching.

Additionally, contractor lodging would be needed in the inner canyon to support the project. The contractor camp in the inner canyon would be at the Roaring Springs Day Use Area.

The staging areas and contractor camps are described further below. A summary table outlining these areas and their acreages is provided at the end of this chapter (*Table 3*).

North Rim NPS Administrative Area

The NPS administrative area, located east of North Entrance Road and north of the North Rim Campground, would be used for staging and contractor lodging. This area formerly consisted of park housing and administrative buildings, such as offices and workshops. However, many of the structures (e.g., buildings, sheds, garages) and numerous trees within this area were destroyed by the 2025 Dragon Bravo Fire. In addition to the trees consumed by the fire, many others were removed to help mitigate and contain the fire's spread. Only about half of the roughly 35 original structures in this area remain. As a result, this area is now a predominantly open, disturbed space that would support project activities, such as staging. Up to 16.5 acres would be used for project support. Remaining structures would stay in place and may be used for project support activities. Additional tree clearing would be minimized to the greatest extent possible, except for hazard trees.

CC Hill

CC Hill is a moderately wooded site with sizable open spaces between interspersed trees. It is accessed from the North Kaibab Trailhead Parking lot and features mule corrals, a volunteers-in-parks program camping area, and multiple debris and detritus piles.

CC Hill would serve as a temporary staging area for materials such as mulch, timber, or salvageable excavated materials for reuse. Some cleanup of the area would be required, including burning or removing slash and woody debris piles and clearing other detritus. Contractor camps would also be allowed at CC Hill.

Former Ballfield

When the former ballfield is not being used for drilling activities, it would serve as a staging area for other project components. As noted previously, the ballfield would be graded and trees removed to expand the site from approximately 1.2 acres to 4.3 acres to accommodate the drill site. No further impacts to the former ballfield, beyond those needed to prepare and use the site for drilling, would be needed to allow its use as a staging area.

Upon completion of this project, the former ballfield would be used as a staging area for future projects.

Lindbergh Hill

Lindbergh Hill (*Figure 21*) would be used for staging and contractor lodging in two areas, north and south. The Lindbergh Hill north site would be used primarily for contractor lodging. It is currently surfaced with gravel and has existing electrical hookups with metering. Water and sewer infrastructure is not present at the site, so water would be delivered and temporary water hookups, wash stations, and restrooms would be installed for the duration of construction. Some cleanup of the area may be needed, such as burning or removing slash or wood debris piles and laying additional gravel. Limited staging and stockpiling may also occur at the north site.

The Lindbergh Hill south site is a former landfill that has been closed in accordance with ADEQ regulations. Currently, a weather station is at the site, but it is otherwise unused. The expected primary use of the south site would be for staging and stockpiling; however, it could also serve as a fallback location for contractor housing or as a spike camp for other users who normally use the Lindbergh Hill north site, such as wildland fire crews. Staging or other project activities would not be allowed within 15 feet of the weather station. Minor grading and vegetation removal may occur at the south site.

The contractor camp and staging area boundaries are approximately 3.7 acres at Lindbergh Hill north and 2.1 acres at Lindbergh Hill south, and are shown on *Figure 21*.

A two-track, dirt road connects the Lindbergh Hill north and south sites. If the Lindbergh Hill south site is used, minor improvements would be required to the existing dirt road. The construction zone along the road would be 40 feet wide (1.2 acres) to allow for improvements such as minor widening, grading, adding a road base, surfacing with gravel, and removing trees to allow an adequate clear zone for larger construction vehicles. Additionally, minor improvements, such as widening, grading, vegetation removal, and placing gravel, may be made to Lindbergh Hill Road to improve access to Lindbergh Hill. The construction zone would be approximately 20 feet wide (½ acre).

Marble Flats

Marble Flats is a former landfill that has been closed in accordance with ADEQ regulations. It is an open space with herbaceous vegetation surrounded by forest. The site, which is approximately 8 acres, is accessed from Widforss Trailhead Road and W-1/Point Sublime Road.

Marble Flats would be used as a temporary staging area, such as for stockpiling mulch, timber, or salvageable excavated materials for reuse. The staging area at Marble Flats is 7 acres.

Proposed Water Treatment Plant

Prior to construction of the proposed water treatment plant, the area within the construction zone would be available for staging. Earthwork and tree removal would occur at this site to accommodate the new water treatment plant and storage tanks. No additional impacts beyond those required to construct the facility and ancillary items would occur.

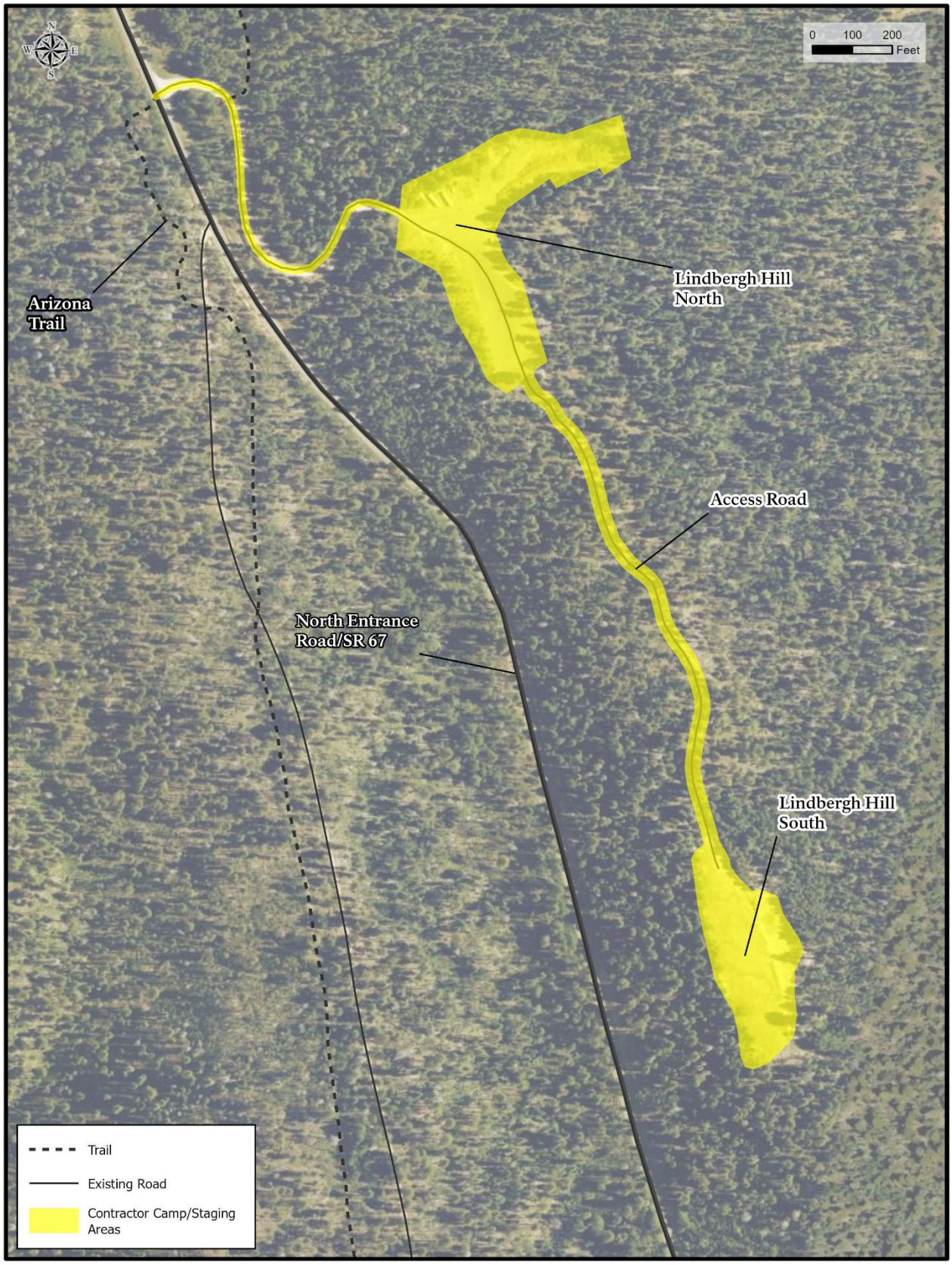


Figure 21: Lindbergh Hill Project Boundaries

Roaring Springs Day Use Area

The Roaring Springs Day Use Area is located in the inner canyon approximately 1,200 feet north of the Roaring Springs Pumphouse and is accessed via the Roaring Springs Trail, which is narrow, averaging about 3 feet wide, and receives minimal maintenance. The Roaring Springs Trail is only accessible via the North Kaibab Trail. The day use area and trail are currently open to the public, but do not have operating visitor facilities; the composting toilets at the day use area are not in service.

The day use area would serve as the primary contractor camp for all inner canyon work. It is expected that 15 to 20 personnel would be housed at the Roaring Springs Day Use Area at any given time. Up to four modular or flatpack housing units would be installed at the site to house contractor personnel. The units would be removed upon project completion, and the area restored.

To maximize the use of this area, the site would be graded, leveled, and vegetation removed. Ancillary components at the day use area, such as the hitching post and debris or detritus, would also be removed. The contractor would rehabilitate the existing composting toilets for their use during construction. Provisions, including water, food, small tools, and supplies, would be sling-loaded into the day use area via helicopter.

The contractor camp boundary is approximately 0.3 acre and is shown on *Figure 22*.

During inner canyon construction at Waterline Areas 2 and 3 and Roaring Springs Pumphouse, the Roaring Springs Day Use Area and Roaring Springs Trail would be designated as administrative use only and closed to the public. Minor improvements, such as widening and vegetation trimming or removal, may be made to the Roaring Springs Trail, and a temporary footbridge would be installed over Roaring Creek and adjacent wetlands to minimize foot traffic and potential resource degradation. Similar minor improvements may be made to the Roaring Springs Pumphouse administrative route to improve contractor access. The construction zone along both trails would extend 5 feet from each side of the trail centerline (10 feet wide total). To reduce the contractor's travel distance between the Roaring Springs Trail and the Roaring Springs Pumphouse, temporary ladders, scaffolding, or similar items may be installed on an existing unofficial path that follows a drainage directly west of the pumphouse. The construction zones for the Roaring Springs Trail, Roaring Springs Pumphouse administrative route, and temporary access to Roaring Springs Pumphouse are shown on *Figure 22*.

South Gate

South Gate is an existing staging area at the South Rim, located east of the intersection of SR-64 and Center Road. This staging area was included under the TCWL Environmental Assessment and would also be used for this project.

South Rim Contractor Support Facilities

The South Rim Contractor Support Facility is an area of existing contractor housing and administrative buildings at the South Rim, located south of the South Rim Helibase and west of the Facilities Maintenance and Engineering complex. The Contractor Support Facility also includes an area at the west end of the South Rim Helibase to accommodate project-related helicopter operations. The South Rim Contractor Support Facility was included under the TCWL Environmental Assessment and would also be used for this project (NPS 2018a).

Miscellaneous Construction Activities

Rappelling or other similar activities may be needed for certain construction work in the inner canyon. All climbing and rappelling hardware would be removed (as feasible considering safety) or concealed upon completion of the project.

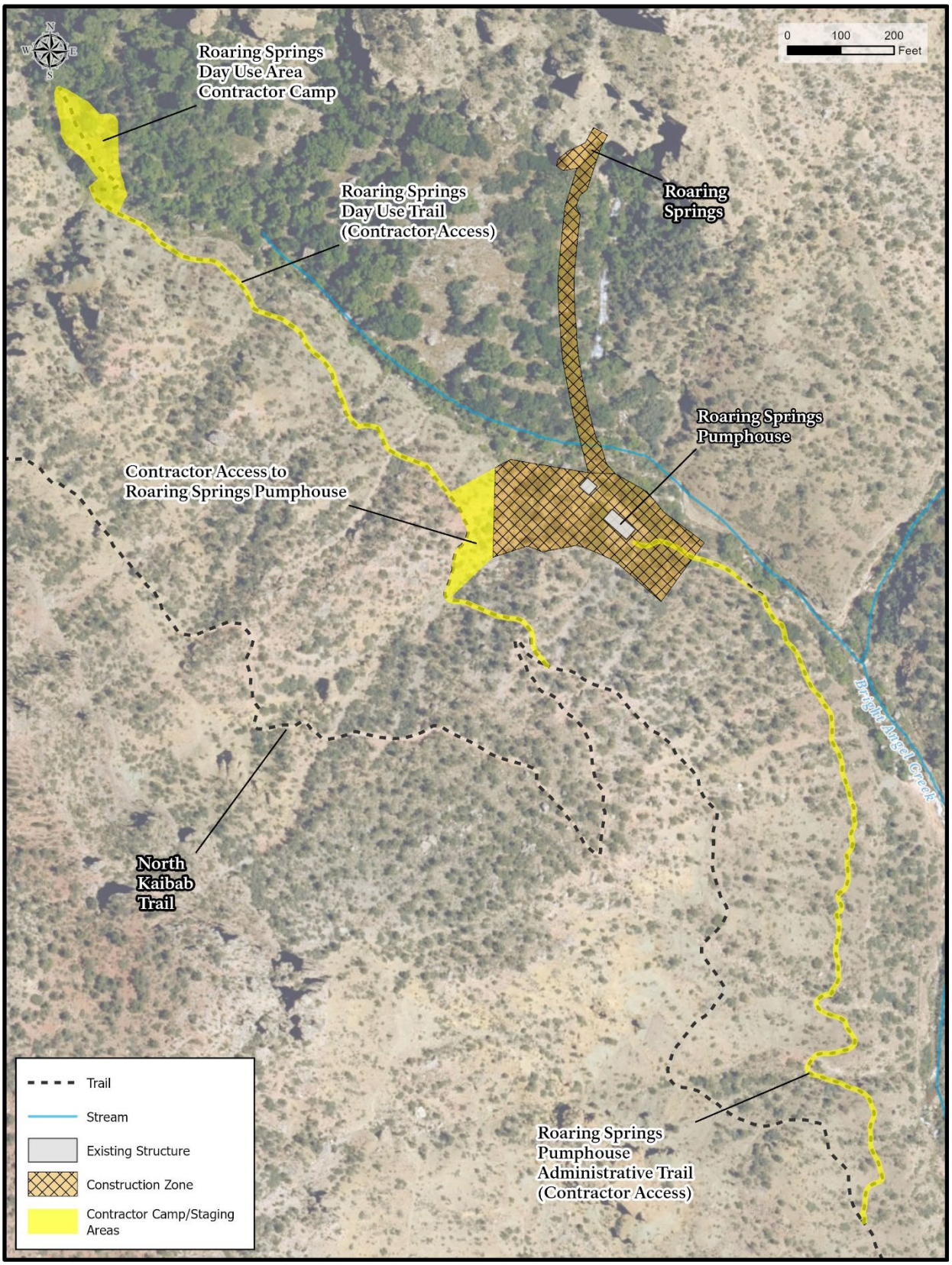


Figure 22: Construction Zones for Roaring Springs Trail, Roaring Springs Pumphouse Administrative Route, and Temporary Access to Roaring Springs Pumphouse

Generators would be used at most project areas and would generally be restricted to use during daylight hours, unless associated with borehole drilling activities or if enclosed in a building.

As necessary, permanent signage would be installed at non-potable water spigots or similar appurtenances to indicate these water sources are not potable. A permanent sign would be installed near the junction of the North Kaibab Trail and Roaring Springs Trail indicating the closure of the Roaring Springs Trail and Day Use Area. Additional permanent signs may be installed in construction zones as needed, such as along the improved Ballfield Road (see the *Access* section). Temporary signs and fencing would also be installed as needed for any closures, such as trail closures, during construction, as well as around active construction zones.

Construction fencing and erosion control measures, such as silt fencing, erosion blankets, and wattles, would be installed along the construction zone boundaries.

Temporary utility lines, such as water and electrical, may be installed within the construction zones and would be removed upon project completion. These temporary lines would be routed inside the construction zone or along previously disturbed routes or routes with minimal potential for resource impact.

Construction Zone Summary

Table 2: Summary of Alternative Elements and Construction Zones

Location	Alternative Elements	Construction Zone Size (Acre)
North Rim	Waterline Area 1 Installation, Ballfield Access Road, and Norton Court Improvements	5.4
North Rim	Waterline Area 2 Drill (Bore Entry) Site	4.3
North Rim	Waterline Area 2 – Drill (Bore Entry) Site Contingency Area	4.8
Inner Canyon	Waterline Area 2 – Bore Exit Site	0.29
Inner Canyon	Waterline Area 2– waterline installation between bore exit and RSPH	Included in Roaring Springs Pumphouse construction zone
Inner Canyon	Waterline Area 3 Installation	0.5
Inner Canyon	Waterline Area 4 Installation and Supai Tunnel Improvements	3.8
Inner Canyon	Roaring Springs Pumphouse Improvements	1.3
North Rim	Water Treatment Plant, including electrical and wastewater connections	5.9
North Rim	Rim Trail Detour Improvements	3.5
North Rim	North Entrance Road shoulder widening/hardening	0.8
Total[1]		29.7

[1] Note that the total acreage is not an exact sum of the acreages due to overlaps in the construction zones.

Table 3: Summary of Staging and Contractor Camp Areas

Location	Alternative Elements	Staging/Contractor Camp Size (Acre)
North Rim	NPS Administrative Area	16.5
North Rim	Lindbergh Hill north and south sites, including access roads, staging area, and contractor camps	7.6
North Rim	RV Pads (contractor lodging) – Helibase and Dusty and Abbey Way Pads	6.3
Inner Canyon	Roaring Springs Day Use Area (contractor camp)	0.3
Inner Canyon	Roaring Springs Pumphouse administrative route	0.4
Inner Canyon	Roaring Springs Trail and Temporary Access to Pumphouse	0.7
South Rim	Contractor Support Facilities (existing staging area)	10.7
South Rim	South Gate (existing staging area)	6.6
Total	**-**	49.1

Construction Schedule

Overall construction of all project elements is expected to take 36 months; however, the work months would likely be nonconsecutive and dependent on whether the contractor works during winter months. While the contractor would be allowed to work during the winter, weather conditions may limit their ability to do so. As such, construction would occur over an estimated three- to five-year period. Providing the contractor with the option to work during winter allows for flexibility and the potential to complete the project sooner. It also reduces potential risks by not requiring work to occur during winter, especially if weather conditions are challenging. However, the contractor would be required to complete the Roaring Springs Pumphouse improvements and Roaring Springs Cave to Roaring Springs Pumphouse waterline improvements (*Waterline Area 3*) during the visitor off-season, when the pumphouse and waterline are winterized and therefore not pumping, to minimize interruptions to park operations.

Chapter 3: Affected Environment and Environmental Consequences

This chapter describes the affected environment (existing settings or baseline conditions) and analyzes the potential environmental consequences of the No Action and Proposed Action alternatives.

As noted in the background section, the 2025 Dragon Bravo Fire substantially altered the North Rim landscape (affected environment) by burning approximately 71,130 acres of GRCA-managed land and associated infrastructure, including roughly 110 buildings. The affected environment reflects the post-fire conditions, and this EA evaluates the alternatives and potential environmental impacts within the context of the changed landscape shaped by wildfire effects and emergency response and stabilization activities.

This chapter also considers the collective or incremental impacts resulting from past, present, and reasonably foreseeable actions that are within the immediate vicinity of the project area. *Appendix D* lists the past, present, or reasonably foreseeable actions considered for analysis in this chapter. Additionally, the influences of past and present actions are reflected in baseline resource conditions (i.e., affected environment) where applicable. Importantly, please note that any future redevelopment efforts that may result from the Dragon Bravo Fire are not considered reasonably foreseeable actions for purposes of NEPA because the concept, timing, and scale of any such efforts are currently unknown and are therefore unable to be analyzed in meaningful detail.

Historic Districts

Affected Environment

The Area of Potential Effect (APE) includes the construction zones (direct APE), as well as the entire Bright Angel Peninsula (indirect APE) and Roaring Springs Canyon (indirect APE). The APE includes “the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist” (36 CFR 800.16[d]).

The project areas are within or immediately adjacent to eight historic districts (HDs) and one National Historic Landmark Districts (NHLDs). These districts, which are described below and depicted in *Figure 23*, have been documented in National Register nominations, cultural landscape reports (CLRs), and/or cultural landscape inventories (CLIs).

With the exception of the Transcanyon Water Line Historic District, all HDs and the NHLD discussed below were affected by the Dragon Bravo Fire, which damaged or destroyed various contributing features within these districts, including numerous historic buildings and portions of the surrounding forest. Fire suppression and post-fire emergency stabilization activities, specifically tree removals to minimize fire spread, also contributed to the loss of forested areas. Ponderosa pine and boreal forests are contributing features of several HDs of the North Rim.

Within the APE, the areas extending from the WWTP to the south side of the NPS Administrative Area, and between the motels and Grand Canyon Lodge experienced the greatest tree and building losses. These changes have altered the viewshed in the historic districts, resulting in a more “open” appearance, setting, and feeling due to the loss of buildings and vegetation.

The park is continuing to evaluate these historic districts in the aftermath of the Dragon Bravo Fire to determine whether revisions will be needed to their registrations, such as revising their boundaries or de-listing features that were destroyed. As of this writing, all historic districts discussed below remain listed or eligible for listing in the National Register of Historic Places and are treated as such for purposes of analysis in this EA. These conditions provide the baseline against which potential effects of the alternatives will be assessed.

North Rim Entrance Road Historic District

The North Rim Entrance Road HD includes the North Rim Entrance Station and 10.6 miles of the North Rim Entrance Road and its associated pull offs, viewsheds, including adjacent meadows and forests, and other adjacent features. The HD boundary begins at the northern boundary of the park and extends to CC Hill, ending just before the northern edge of the North Kaibab Trailhead parking lot turnoff. The North Rim Entrance Road HD National Register form notes that the road corridor retains high levels of integrity and that "the appearance and character of the 'scenic Entrance Road' that most visitors …associate with their experience of park scenery, wildlife, and wilderness remains intact from the North Rim Entrance Road's period of significance" (1928–1942) (NPS 2022a). This HD was determined eligible for listing in the National Register of Historic Places through a consensus Determination of Eligibility (DOE) with the State Historic Preservation Office (SHPO) in March 2022.

Bright Angel Peninsula Historic District

The Bright Angel Peninsula HD includes the Bright Angel Peninsula bounded to the north by CC Hill, to the south by the Grand Canyon Lodge NHLD, and to the west and east by the Transept and Roaring Springs Canyons, respectively. Contributing resources to the HD include 71 buildings, 5 sites, 19 structures, and 1 object; however, many of these resources were destroyed by the Dragon Bravo Fire. The Bright Angel Peninsula HD is significant for "its association with national park planning movements between 1917[17] and 1942, and for its association as a masterwork of the Civilian Conservation Corps and National Park Service landscape architects" (NPS 2011). The Cultural Landscape Inventory states that "[m]ost essential is that the visitor experience on the Peninsula remains very similar to what existed during the period of significance; the feeling of being in a forested, natural setting, away from intense civilization and development, with visual and recreational access to the Grand Canyon. Of note, is that the forest is a contributing feature to this HD. This HD is being treated as eligible for National Register listing. It is not listed in the National Register nor has it been determined eligible for listing through a consensus DOE with the SHPO.

The 2011 National Register nomination states that the district is divided into seven sub-areas: The Bright Angel Peninsula Entrance Road Corridor (three miles of the entrance road from CC Hill to Grand Canyon Lodge); NPS Headquarters, Housing, and Maintenance; Campground; Concessionaire; Transept Trail Corridor; Wastewater Treatment; and Water Tank sub-areas. Within these sub-areas, National Register nominations already exist for the Grand Canyon North Rim Headquarters HD and Grand Canyon Inn and Campground HD (described further below). Both districts were listed on the National Register in 1982 and focus on the buildings of the two areas (NPS 1982a, 1982c).

[17] While the existing DOE states 1917, SHPO does not concur with this date as there are no remaining physical properties on the Peninsula that remain from 1917. The revised DOE will state 1928. E. Brennan, Cultural Resources Program Manager, personal communication, January 18, 2026.

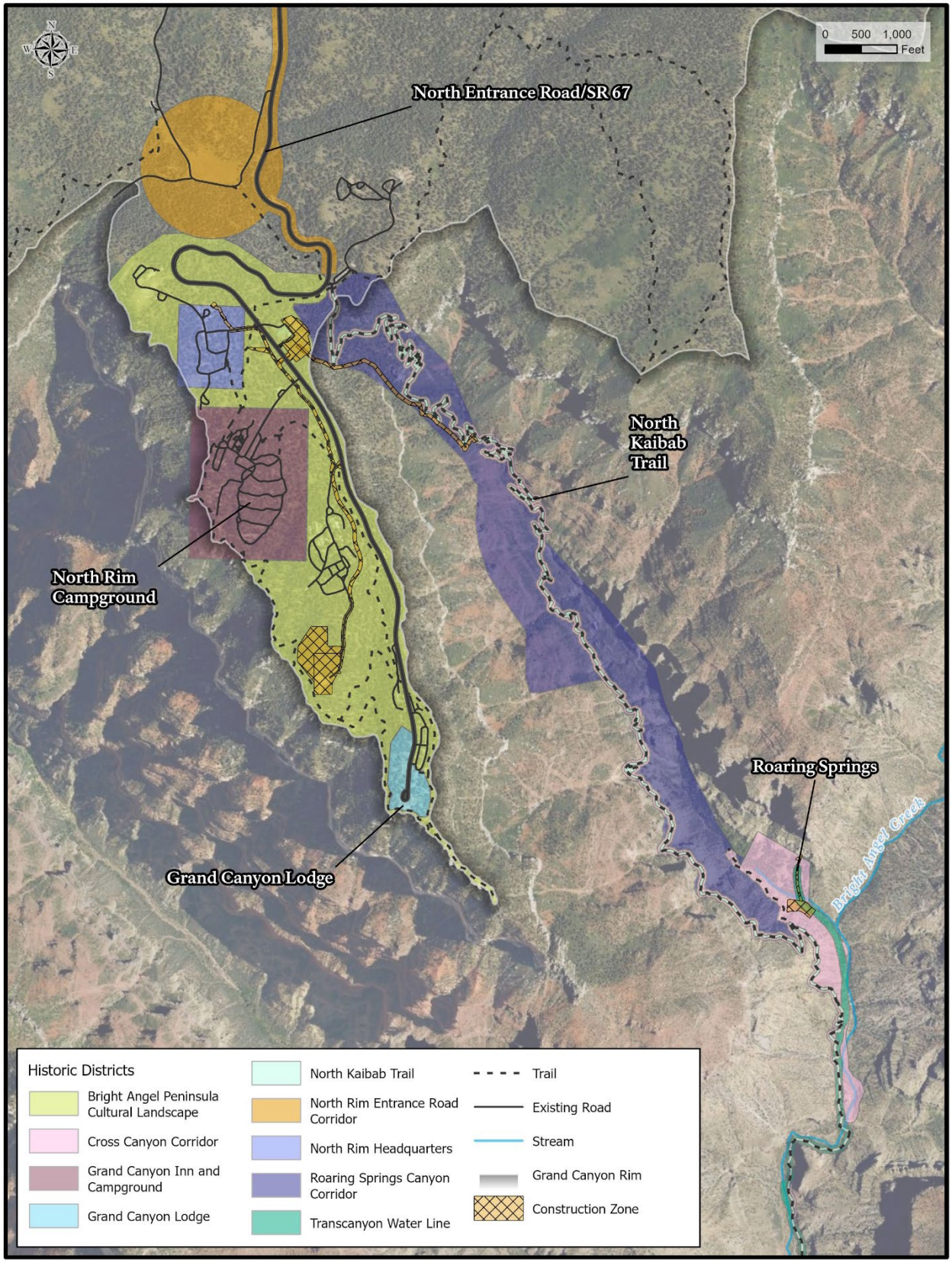


Figure 23: Historic Districts

Grand Canyon National Park North Rim Headquarters Historic District

The Grand Canyon National Park North Rim Headquarters HD was listed on the National Register in 1982. The Grand Canyon National Park North Rim Headquarters Historic District is south of the wastewater treatment plant and consists of two groupings of primarily residential and utilitarian buildings. The easternmost area of the district consists of several residences, a garage, and ranger station (non-extant), while the western group consists of maintenance buildings, a resource management office, a barn, and multiple facility and operations buildings. Since its listing on the National Register in 1982, modern housing units, including single family and apartments, and administration buildings have been constructed in this district. Additionally, this historic district is a contributing feature to, and one of the seven sub-areas of the Bright Angel Peninsula Historic District. Of note, many of the contributors to this district were destroyed by the Dragon Bravo Fire.

Grand Canyon Inn and Campground Historic District

The Grand Canyon Inn and Campground HD was listed on the National Register in 1982. The historic district is northwest of the Grand Canyon Lodge and includes the Grand Canyon Campground, Grand Canyon Inn (currently North Rim General Store), external frame cabins, duplex cabins, and miscellaneous buildings within the area, such as the laundry and firehose house, washroom house, and linen house. Additionally, this historic district is a contributing feature to, and one of the seven sub-areas of the Bright Angel Peninsula Historic District. Of note, many of the contributors to this district were destroyed by the Dragon Bravo Fire

Grand Canyon Lodge National Historic Landmark District

The Grand Canyon Lodge NHLD was listed in the National Register in 1982 and designated a National Historic Landmark in 1987. This NHLD centers on the 1936-37 Grand Canyon Lodge and its 114 cabins. In addition to the lodge and cabins, a small linen storage building is also a contributing resource to the NHLD (NPS 1982b, 1987). The lodge and numerous contributing cabins were destroyed by the Dragon Bravo Fire. Prior to fire, the district was considered one of the most intact rustic hotel developments in the national parks from the era when railroads fostered construction of "destination resorts." It is also significant for its association with architect Gilbert Stanley Underwood, an architect characterized as one of the shapers of the standards known as the "Rustic" style of park design. The period of significance is from 1927 to the present (NPS 1987).

The Grand Canyon Lodge NHLD was included in the 2003 CLR, 2006 CLI, and 2011 CLI and National Register nomination for the Bright Angel Peninsula HD.

Roaring Springs Canyon Historic District

The Roaring Springs Canyon Historic District was determined eligible for National Register listing through a consensus DOE with SHPO in March 2024. The 220-acre district extends the full length of a large side canyon (Roaring Springs Canyon) within Bright Angel Canyon averaging approximately 750 feet wide, 2.2 miles long, and extending 3,000 feet into the canyon from the rim. The district encompasses the linear historic contributing resources of the 1927-1928 North Rim Water Pipeline, the rebuilt structural segments from 1936 and 1966 between Roaring Springs Cave and the North Rim, two 2-million-gallon Water Tanks dating to 1963 and 1979, and the 1927-1936 Aerial Tramway. Also included in the nomination is Roaring Springs Cave's 1977 water gathering features, the 1979 Roaring Springs Pumphouse, and three small Meter-and-Pump Houses on the North Rim dating to 1928, 1936, and 1964.

The north end of the Roaring Springs Canyon HD shares a short boundary with the North Rim Entrance Road HD and overlaps with the Bright Angel Peninsula HD, North Kaibab Trail HD, Cross Canyon Corridor HD, and Transcanyon Water Line HD.

The Roaring Springs Canyon HD was determined eligible for listing in the National Register through a consensus DOE with the SHPO in March 2024.

Cross Canyon Corridor Historic District

The Cross Canyon Corridor HD was determined eligible for National Register listing through a consensus DOE with SHPO in 2015. The Cross Canyon Corridor was found eligible as a historic district on the national level under Criteria A and C, for the functions of recreation and culture, transportation, and landscape. The period of significance extends from 1890-1942. The district, which spans the canyon from the South Rim to the North Rim, encompasses the four primary corridor trails – the Bright Angel Trail, the South Kaibab Trail, the Colorado River Trail, and North Kaibab Trail. The district includes the developed areas of Havasupai Garden, Phantom Ranch, Yaki Point, Tip-off, Manzanita Rest Area, Cottonwood Campground, and Roaring Springs. There are 66 contributing resources and 77 noncontributing resources. Contributing resources include 36 buildings, two sites, 25 structures, and three objects newly determined eligible. It also contains one previously listed structure, the Trans-canyon Telephone Line.

Within the APE, the North Kaibab Trail and Supai Tunnel are contributing features of this district. The Roaring Springs Pumphouse is not contributing as it was built after the district's period of significance.

North Kaibab Trail Historic District

The North Kaibab Trail HD was determined eligible for National Register listing through a consensus DOE with SHPO in August 1997. The district is significant for its association with the NPS's concerted efforts to accommodate the rapidly expanding tourist trade in the 1920s and 1930s. The North Kaibab Trail was constructed by NPS and the CCC and was an important piece in developing the Grand Canyon's emerging central trail corridor. The boundary of the North Kaibab Trails extends 14.5 miles long from the south end of the Kaibab Bridge (also known as the Black Bridge) in the inner canyon and ends at the North Rim adjacent to the North Kaibab Trailhead parking area along North Rim Entrance Road. Stops along the North Kaibab Trail include Supai Tunnel (1.7 miles from the trailhead), Roaring Springs (4.7 miles from the trailhead), Manzanita Rest Area (5.4 miles from the trailhead), and Cottonwood Campground (6.8 miles from the trailhead). The historic district follows the approximate 5-foot trail with a 20-foot buffer on either side of the trail.

The North Kaibab Trail is also included in the Cross Canyon Corridor Historic District.

Transcanyon Water Line Historic District

The Transcanyon Water Line HD was determined eligible for National Register listing through a consensus DOE with SHPO in August 2015. The pipeline was designed, installed, and improved between 1963-1986 (period of significance) as the main water supply for the South Rim. The pipeline is 12.4 miles in length and extends from Roaring Springs Cave to Havasupai Gardens and was found significant under the areas of Architecture, Community Planning and Development, Engineering, Invention, Politics/Government. "The pipeline is exceptionally important as a singular engineering feat in a premier National Park, fundamentally changing water-resource management

and visitor accommodations in the park, and closing the Mission 66 program at Grand Canyon with a crowning infrastructure achievement unmatched by any other National Park" (NPS 2015).

Within the APE, contributing features include the TCWL waterline itself, which begins at Roaring Springs, the Roaring Springs Cave Intake Complex, and the Roaring Springs Pumphouse developed area.

The TCWL and its associated structures, except for the Havasupai Garden South Pumphouse, are noncontributing elements to the Cross Canyon Corridor HD because they were constructed after the Cross Canyon Corridor HD's period of significance (1890-1942).

Environmental Consequences

Impacts of Alternative A – No Action

Direct and Indirect Impacts

Under the No Action Alternative, the park would continue current operations of the water system, and no major improvements or changes would be made to the water system. Recurring/ongoing maintenance and repairs to the North Rim waterline, Roaring Springs Pumphouse, North Rim Pumphouse, and North Rim water tanks would be performed as needed, as described in *Chapter 1* and *Alternative A: No Action*. Repair and maintenance of these facilities would be unlikely to result in adverse effects to the facilities themselves or the historic districts which they are located in because these activities are typically minor in nature, require minimal disturbances, and would be designed to minimize impacts to historic properties.

Repairs to the waterline could result in impacts to the North Kaibab Trail where the waterline and trail are in close proximity; however, trail impacts, such as digging up the trail or modifying its ancillary features (e.g., retaining walls), would be uncommon since the pipeline is surface mounted and not buried within the trail. Any damage to the trail or its features would be repaired in kind if damaged during waterline repairs and would retain its integrity; therefore, these repairs would not adversely affect the historic districts of which the waterline is a contributing feature.

Under the No Action Alternative, the viewsheds, settings, and feelings and other aspects of integrity[18] of the historic districts would remain largely unchanged from their current condition, as no new structures, such as a WTP and water tanks, would be constructed, and no existing structures or trees would need to be removed in order to perform construction activities.

The current water storage capacity provided by the tanks on the North Rim would remain insufficient to provide proper fire suppression to protect the remaining historic buildings on the North Rim. A water tank to provide capacity for fire suppression at RSPH, Manzanita Rest Area, and Cottonwood Campground would not be constructed at RSPH, so those facilities would remain at an elevated risk if a fire were to occur. Additionally, the pipeline from the Roaring Springs Pumphouse to the North Rim would continue to be shut down in the winter due to freezing potential thereby limiting water from December through March.

[18] The seven aspects of integrity are location, design, setting, materials, workmanship, feeling, and association (36 CFR 800). See the NPS National Register Bulletin – *How to Apply the National Register Criteria for Evaluation* (NPS 1997) for more information on the aspects of integrity.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

Past, present and reasonably foreseeable actions have impacted and would continue to impact historic districts, mainly through construction- and development-related activities, vegetation removals, and ground disturbing activities. These activities have the potential to directly or indirectly modify contributing features or the aspects of integrity of a district.

Past, present, and reasonably foreseeable actions have and would continue to incrementally introduce modern materials, new facilities, and vegetation removals into HDs. While such changes could alter or diminish certain aspects of historic integrity over time, projects have been and would continue to be implemented in accordance with the Secretary of Interior's *Standards for the Treatment of Historic Properties* and multiple avoidance and minimization measures, so that the eligibility of the HDs is not lost. Nevertheless, when considered collectively, these past, present, and reasonably foreseeable actions contribute to adverse impacts on historic districts.

The No Action alternative would contribute to the collective adverse impacts on historic districts because, as noted above, recurring/ongoing maintenance and repairs to the existing water system are generally minor, require minimal disturbances to historic districts, and would be designed to minimize impacts to historic properties.

Impacts of Alternative B – Proposed Action and NPS Preferred Alternative

Direct and Indirect Impacts

The Proposed Action would affect multiple historic districts, including the pending Bright Angel Peninsula HD, Roaring Springs Canyon HD, North Rim Headquarters HD, North Entrance Road HD, North Kaibab Trail HD, Cross Canyon Corridor HD, and TCWL HD. The impacts primarily relate to changes in the setting and feeling of the districts[19] resulting from introduction of new buildings, structures and appurtenances; removals of buildings; abandonment of utilities; ground disturbances, such as trenching and excavating; and/or tree removals.

In the Bright Angel Peninsula, Roaring Springs Canyon, North Kaibab Trail, Cross Canyon Corridor, and Transcanyon Water Line HDs, construction of new facilities – such as the WTP, new water tanks on the rim and at Roaring Springs Pumphouse, and above-ground utilities or utility-associated appurtenances – would introduce new visual elements into the landscape, thus changing the historic characters of the three districts. However, these facilities would be located within developed areas where similar infrastructure is already present, and where people should expect to see development. The new facilities, especially new buildings and water tanks, have been designed to be visually compatible with the surrounding development in terms of color, massing, and materials. Similarly, the materials and finishes that would be used in rehabilitation of existing facilities that contribute to historic districts, such as the proposed roof at Roaring Springs Pumphouse, would be also appropriate considering the resource's period of historic significance and the surrounding development. The siting, design, and materials of the new and rehabilitated facilities would be compatible with the existing uses and structures in the surrounding area and would not adversely affect the historic integrity of the districts.

Vegetation removals would result in localized changes to the setting and feeling of HDs; however, much of the vegetation in the areas that would be affected by the Proposed Action has already been

[19] According to the NPS National Register Bulletin – *How to Apply the National Register Criteria for Evaluation* "[s]etting is the physical environment of a historic property" and "[f]eeling is a property's expression of the aesthetic or historic sense of a particular period of time" (NPS 1997).

substantially altered by the Dragon Bravo Fire, thereby limiting the incremental visual effects of the Proposed Action resulting from tree removals. Vegetation removals have been minimized during design to the extent practicable by following existing disturbed corridors where possible, such as the Bridle Path, Admin Loop Road, and the existing Ballfield Road, as well as by collocating new facilities in the same corridors, such as trenching waterlines in the same corridor as the proposed Ballfield Road extension. Additionally, vegetation removals were minimized by choosing the former ballfield as the drill entry site because it is already an open space that would require less tree removals compared to other drill sites that were considered (see Appendix A for alternative elements considered but dismissed). Vegetation removals would also be minimized by protecting select trees within the construction zone as feasible while still allowing for construction of the facilities. Where possible, buffer zones of trees and other vegetation have been designed to remain between higher-traveled areas and new facilities to provide screening, such as between North Entrance Road and the proposed WTP.

Removal of one contributing utility shed, a meter shed, that is located south of the North Rim water tanks may constitute an adverse effect on the Roaring Springs Canyon HD. If, through continuing consultation with the SHPO, it is determined to be an adverse effect, it would be mitigated by commissioning Historic American Engineering Record (HAER) documentation for the shed, and the park would continue consultation with the SHPO to determine if additional mitigation would be required, such as interpretive signage to convey the historic importance of this structure.

The North Rim waterline, a contributing feature of the Roaring Springs Canyon HD, would be abandoned in place and left unmaintained. Due to its steel composition, the waterline is not expected to deteriorate in the near future and the abandonment of the waterline would not constitute an adverse effect (36 CFR 800.5(a)(2)(vi).

In the North Rim Headquarters and North Entrance Road HDs, impacts would result primarily from trenching, road modifications, and associated tree removals. Tree removals are expected to be minimal as these project areas were largely cleared of trees due to the Dragon Bravo Fire. Impacts to these HDs would mainly be temporary and short-term, ceasing upon construction completion, and would not adversely impact the integrity of these historic districts.

Impacts to the inner canyon HDs of Roaring Springs Canyon HD, TCWL HD, North Kaibab Trail HD, and Cross Canyon Corridor HD would also result from waterline rehabilitation and installation, site work at Supai Tunnel and Roaring Springs Pumphouse, exterior rehabilitation of the pumphouse, bore exit activities, and associated ground disturbance and vegetation removal. The impacts would occur largely within previously disturbed corridors, development zones, and historic utility areas/alignments, thereby minimizing additional effects to historic character. The exterior improvements at Supai Tunnel and Roaring Springs Pumphouse have been designed to be compatible with the surrounding development in terms of color, massing, and materials. Based on this, the activities and improvements in the inner canyon would not adversely impact the integrity of these HDs.

Construction activities also have the potential to impact other smaller contributing historic resources, such as historic stone curbing; however, mitigation measures would be incorporated to avoid or minimize these impacts. For example, trenching through certain areas of parking lots or trails could damage historic stonework (e.g., retaining walls, curbstones). To minimize impacts, work that may impact historic resources would only occur under the guidance of a park historic preservation or cultural resource specialist, and mitigation measures would be implemented.

While the Proposed Action would result in changes to the setting, feeling, design, workmanship, or materials of several historic districts, most impacts would be localized, within existing developed areas and compatible with existing adjacent developments/facilities, or temporary in nature. Impacts to contributing features and HDs have been minimized to the extent feasible through design, and mitigation measures would be implemented to further avoid or minimize adverse impacts during construction. Therefore, the majority of impacts resulting from the Proposed Action would not adversely affect HDs and, adverse effects would be limited to removal of the contributing utility shed within the Roaring Springs Canyon Historic District.

Additionally, the Proposed Action would provide a beneficial impact to historic districts and their contributing features by improving fire protection for remaining historic properties through more reliable water delivery and increased water storage capacity for firefighting activities.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

Past, present and reasonably foreseeable actions have impacted and would continue to impact historic districts, mainly through construction- and development-related activities, vegetation removals, and ground disturbing activities. These activities have the potential to directly or indirectly modify contributing features themselves or the aspects of integrity of a district.

Past, present, and reasonably foreseeable actions have resulted and would continue to result in the incremental introduction of modern materials and new facilities into HDs, as well as vegetation removals. While such changes could diminish certain aspects of historic integrity over time, projects have been and would continue to be implemented in accordance with the Secretary of Interior's *Standards for the Treatment of Historic Properties* and applicable impact avoidance/minimization measures, so that HDs are not diminished to a point of losing eligibility. Nevertheless, past, present, and reasonably foreseeable actions collectively result in adverse impacts on historic districts.

The Dragon Bravo Fire is a past action that substantially affected HDs through the destruction of contributing buildings, structures, and forested areas, altering viewsheds and resulting in a more "open" setting. As such, the fire contributed considerably to the collective adverse impacts on historic districts resulting from past, present, and reasonably foreseeable actions.

Other reasonably foreseeable actions, particularly construction- or development-related projects, would contribute to additional tree removals to accommodate new or reconstructed facilities, thereby incrementally impacting forested areas within developed areas.

Therefore, when the effects of the Proposed Action are considered collectively with other past, present, and reasonably foreseeable future impacts, the total collective impacts on historic districts would be adverse, with the Proposed Action contributing to these adverse impacts by altering the setting and feeling, primarily through the introduction of new facilities and tree removals.

Karst and Hydrogeology

Affected Environment

The geology of the Grand Canyon is significant because it preserves a clear, extensive record of Earth's history spanning nearly two billion years (NPS 2024f). Layered sedimentary rocks exposed along the canyon walls document changes in ancient environments, including shallow seas, coastal plains, deserts, and river systems. These strata capture evidence of past ecosystems that allow scientists to reconstruct ancient life and evolutionary transitions. In the carbonate layers, the park's extensive cave systems also preserve world-class mineral formations endemic to Grand Canyon and

significant vertebrate fossils that reveal information about the last Ice Age. Beneath these layers, older metamorphic and igneous rocks record early mountain-building and volcanic processes that shaped the continent's foundation. The incision of the Colorado River, combined with regional uplift of the Colorado Plateau, exposed these rock units in a continuous cross section, allowing scientists to study long-term geologic processes such as deposition, erosion, and tectonic change in a single landscape. As a result, the Grand Canyon serves as an important natural reference for understanding geologic time, landscape evolution, and the interactions between climate, water, and rock (NPS 2024a).

The North Rim is characterized by a karst-dominated landscape that includes sinkholes, caves, and springs occurring both on the plateau surface and along the canyon walls. Sinkholes primarily form on the rim in the upper units of the Kaibab and Toroweap Formations, while caves are typically found within underlying carbonate units exposed deeper in the canyon. Precipitation initially infiltrates the subsurface through the sinkholes on the plateau and follow fractures and solution pathways within the bedrock, where it eventually emerges as springs, primarily out of the Redwall and Muav Limestones. Because karst systems often include direct hydraulic connections between surface recharge and spring discharge, these features can be sensitive to changes in subsurface flow conditions. Karst aquifers also tend to be more vulnerable to contamination because groundwater moves rapidly through fractures and dissolved conduits, reducing the natural filtering that typically occurs in non-karst aquifers. This is important because the North and South Rims and inner canyon corridor rely entirely on drinking water sourced from karst aquifer springs that discharge into Bright Angel Creek.

The analysis area for karst and hydrogeology consists of the Bright Angel Peninsula and its canyon walls down to the base of the Bright Angel Shale geological layer. The analysis area also includes a 50-foot-wide buffer on each side of SR-67.

Environmental Consequences

Impacts of Alternative A – No Action

Direct and Indirect Impacts

Under the No Action Alternative, the park would continue current operations of the water system, and no major improvements or changes would be made to the water system. As the current waterline is surface mounted and no boreholes would be drilled under this alternative, no impacts to karst or hydrogeology would occur.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

Because there would be no direct or indirect impacts on karst or hydrogeology, the No Action alternative would not contribute to any collective impacts resulting from past, present, and reasonably foreseeable actions.

Impact of Alternative B – Proposed Action and NPS Preferred Alternative

Direct and Indirect Impacts

The Proposed Action would affect karst and hydrogeology by drilling two parallel boreholes, each approximately 9 to 26 inches in diameter by 9,320 feet long and resulting in displacement of up to approximately 34,400 cubic feet (1,300 cubic yards) of subsurface material. The boreholes would be

drilled through the Kaibab Formation, Toroweap Formation, Coconino Sandstone, Hermit Formation, Supai Group, Redwall Limestone, Temple Butte Formation, Muav Limestone, and Bright Angel Shale. See the *Waterline Area 2: North Rim Ballfield Drill (Bore Entry) Site to Roaring Springs Pumphouse* section for more information about the drilling process.

Geophysical investigations, including electrical resistivity tomography (ERT) and seismic reflection and diffraction imaging, were completed in 2023-2024 to inform the proposed borehole drilling. These studies served to better understand subsurface conditions along the bore paths and address geologic uncertainties and associated risks related to drilling. The investigations found no substantial risks of large karstic voids (defined as greater than 40 feet in any dimension), faults, other geologic features, or groundwater conditions along the borehole paths (GEI Consultants, 2025).

The results of the investigations showed some potential faulting, which is limited in extent and does not intersect the proposed bore paths, as well as some small-scale, stress-related features, which may represent areas of slightly reduced rock quality with the potential for small-scale karstic solutioning. No large voids greater than 40 feet in any dimension, nor confined aquifers or groundwater with high confining pressures were identified along the proposed bore paths. This indicates that any void less than 40 feet in any direction, if encountered, would most likely be isolated, rather than connected to other larger conduits. Additionally, surface evidence on the Bright Angel Peninsula shows no major faults or sinkholes, potentially suggesting a lack of interconnected subsurface voids or conduits along the bore paths. Considering the inherent uncertainties associated with geophysical interpretations in a complex karst environment, this investigation so far indicates that the geology along the bore paths appears coherent and represents a relatively low risk for drilling operations. (GEI Consultants, 2025.)

Based on the results of the investigation, the potential for drilling fluids contaminating groundwater is anticipated to be low. Additionally, few voids are expected within the proposed bore paths, and any that are encountered are expected to be small. However, voids that are encountered during drilling may need to be filled with cement in order to progress drilling. Cementing cavities can alter subsurface flow paths by blocking water-filled voids, potentially redirecting groundwater flow and, in some cases, affecting spring discharge.

Based on the results of the geophysical investigations, adverse effects to sizeable karst features or subsurface water flows associated with borehole drilling are not expected, and geological and hydrogeological risks associated with drilling are considered low at this time.

Karst features also occur on the North Rim along State Route 67, which would be used to transport materials, equipment and personnel to and from the project site. While unlikely to occur, vehicle-related spills occurring near surface karst features along the road could introduce contaminants into the subsurface, which could result in spills entering karst features and, subsequently, the groundwater system connected to Roaring Springs and Bright Angel Creek in a matter of days to weeks. Standard best management practices, such as equipping vehicles with spill kits, would be implemented to minimize potential impacts should vehicle-related spills occur. In summary, the chances of vehicle-related spills associated with the project are low and adverse effects to karst features along State Route 67 are unlikely.

Based on the above discussion, adverse impacts to karst and hydrogeologic resources are expected to be small and localized.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

There are no present or reasonably foreseeable actions that would impact karst and hydrogeology.

Past actions potentially affecting karst or hydrogeology in the analysis area consist of geotechnical borings to better understand subsurface conditions for potential construction projects. However, these borings typically did not extend beyond approximately 50 feet below ground surface and therefore had minimal potential to affect karst or hydrogeology. Past geotechnical borings have not resulted in known impacts to karst or hydrogeology; therefore, there are no known ongoing impacts associated with this past activity. Because past, present, and reasonably foreseeable actions have not resulted in impacts to karst and hydrogeology, the Proposed Action would not contribute to collective impacts to these resources and impacts would be limited to the direct and indirect impacts described above.

Soundscapes and Noise

Affected Environment

NPS management policies direct, to the extent practicable, the protection, maintenance, or restoration of natural soundscapes within parks. Intact natural soundscapes enhance visitor experience and allow for natural functioning of wildlife communication and other biological processes. In a national park setting, soundscapes generally comprise natural ambient sounds and human-made, or anthropogenic, sounds. Locations near or within developed areas, such as the Bright Angel Peninsula (North Rim), inner canyon corridor, and Grand Canyon Village (South Rim), experience more consistent noise intrusions and increased sound levels, while remote areas, such as backcountry and proposed wilderness, typically reflect more natural soundscapes.

The analysis area for soundscapes consists of the construction zones, staging and contractor lodging areas, and existing helicopter flight paths[20]. Helicopter flight paths are shown on *Figure 18*. The analysis area consists largely of development zones but also includes backcountry and proposed wilderness[21] areas where helicopter flight paths occur. The soundscape within the analysis area is generally impacted and does not reflect a natural soundscape because most of the analysis area is within developed areas where increased sound levels are common and to be expected due to administrative and visitor use activities, or is located in helicopter flight paths where helicopter noise currently intrudes the environment intermittently.

The primary anthropogenic contributors to the existing soundscape in the analysis area include people speaking/voices, vehicular traffic, maintenance and operations functions (e.g., use of power tools, exterior HVAC units), helicopters, and airplane overflights. Seasonal fluctuations in visitation also influence noise levels, with summer months typically experiencing higher anthropogenic noise. Natural ambient sounds, such as wind, wildlife, and flowing water, also contribute to the overall soundscape in the analysis areas. Common sounds and their sound levels[22] are provided in *Table 4* below.

[20] Helicopter flight paths include the helibases, landing zones, and sling load locations described in the *Helicopter and Unmanned Aircraft System (UAS) Operations* section. The same or very similar flight paths are expected to be used for construction support activities.

[21] Approximately 1,143,918 acres at GRCA are proposed for wilderness designation. No designated wilderness exists at GRCA, as the 2010 wilderness recommendation has not been approved by Congress. However, for purposes of applying the wilderness resource management policies contained in *NPS Management Policies 2006, Chapter 6: Wilderness Preservation and Management*, proposed wilderness is treated as designated wilderness (§ 6.3.1).

[22] This EA primarily uses A-weighted decibels (dBA) and L_{eq} and L_{max} metrics for reporting sound levels. L_{eq} (equivalent level) is the mean noise level over a given period of time, representing a constant sound level that contains the same overall energy as the actual, time-varying sound level. L_{max} is the instantaneous sound pressure level. Sound pressure level (SPL) is the sound pressure amplitude expressed in decibels (dB).

Helicopter use is a notable contributor to noise levels in the analysis area. Helicopter operations generate short-term but high-intensity sound levels that can be heard over long distances when there are no or minimal obstructions. In canyon environments, helicopter noise may be more localized to certain canyons and can reverberate and linger. Helicopter sound levels are influenced by a number of variables, such as the helicopter's make and model, cargo weight, travel speed, distance and topography between sound source and receiver, air density, humidity, temperature, and wind speed and direction. Therefore, the contribution of helicopter noise in the analysis area is dependent on a variety of factors and can fluctuate at any given time. For reference, *Table 5* provides helicopter sound levels from previous studies and *Figure 24* shows a plot based on reported data (FAA 1982) of the expected L_{max} of different helicopters hovering at different distances.

Table 4: Safe and Unsafe Decibel Levels (National Council on Aging 2024)

Decibel (dB SPL)	**Sound**
140 dB	Aircraft Carrier Deck, Fireworks, Custom Car Stereo System, Gunshot/ Shotgun
130 dB	Jet Taking Off, Jackhammer, Loudest Music/ Sporting Events Ever Recorded
120 dB	Steel Mill, Car Horn, Emergency Vehicle Siren
110 dB	Concert, Sporting Events, Maximum Output of Apple Airpods
100 dB	Dog's Bark, Snowmobile, Hand Dryer
90 dB	Motorcycle at 25 Feet, Power Tools, Lawn Mower, Hair Dryer
80 dB	Garbage Disposal, Food Blender, Alarm Clock
[Sound Below This Line is Considered Safe; Sound Above this Line is Considered Harmful]	
70 dB	Vacuum-Cleaner, Washing Machine, Average 'Non-Quiet' Dishwasher, Average Maximum Television
60 dB	Normal Conversation, Air Conditioning Unit, Background Music
50 dB	Certified 'Quiet' Dishwasher, Moderate Rainfall, Refrigerator
40 dB	Quiet Library, Average Room Noise
30 dB	Whisper From Nearby (More Than 5 Feet Away)
20 dB	Rustling Leaves, Ticking Watch, Whispering from 5 Feet Away
10 dB	Breathing
0 dB	Threshold of Human Hearing

Park administrative flights, including personnel transport, maintenance and operations support, wildfire response, and search and rescue missions, contribute to elevated sound levels in the analysis area. An average of approximately 880 administrative flights[23] occur each year, most of which originate from the South Rim Helibase (J. Boyd, Park Aviation Manager, personal communication, December 22, 2025d). Approximately 95 of those annual flights support servicing infrastructure at Roaring Springs Pumphouse and repairing breaks in the North Rim waterline (see Chapters 1 and 2 for more background information). Park administrative flight durations from takeoff to touch-down average approximately 20 minutes and generally use the park's helicopter, which is equivalent to the Bell 47G (*Figure 24*). Depending on the distance between the helicopter (source) and the location of sound receiver (e.g., a person) in the analysis area, and considering that noise attenuation would be unlikely to extend beyond approximately two to three miles, noise impacts produced over those 20

[23] One helicopter flight is defined as one helicopter departing from the South Rim Helibase, performing its mission, and returning to the South Rim Helibase.

minutes by park administrative flights could vary from approximately 30 dBA to 100 dBA and occur an average of 1,760 times[24] each year.

Furthermore, the TCWL replacement project has contributed considerably to helicopter traffic and associated noise impacts in the analysis area since that project began in October 2023. Construction of the TCWL project required 8,841 helicopter flights from October 2023 through January 9, 2026, all originating from the South Rim Helibase. An additional 2,160 TCWL helicopter support flights are estimated to be needed from January 9, 2026 through project completion in Winter 2026, at which time these construction support flights would cease[25].

Areas beneath helicopter flight paths currently experience intermittent, short-term soundscape disturbances daily due to helicopter noise. Where flight paths pass over proposed wilderness, the wilderness quality of "solitude or primitive and unconfined recreation[26]" is impacted by helicopter noise.

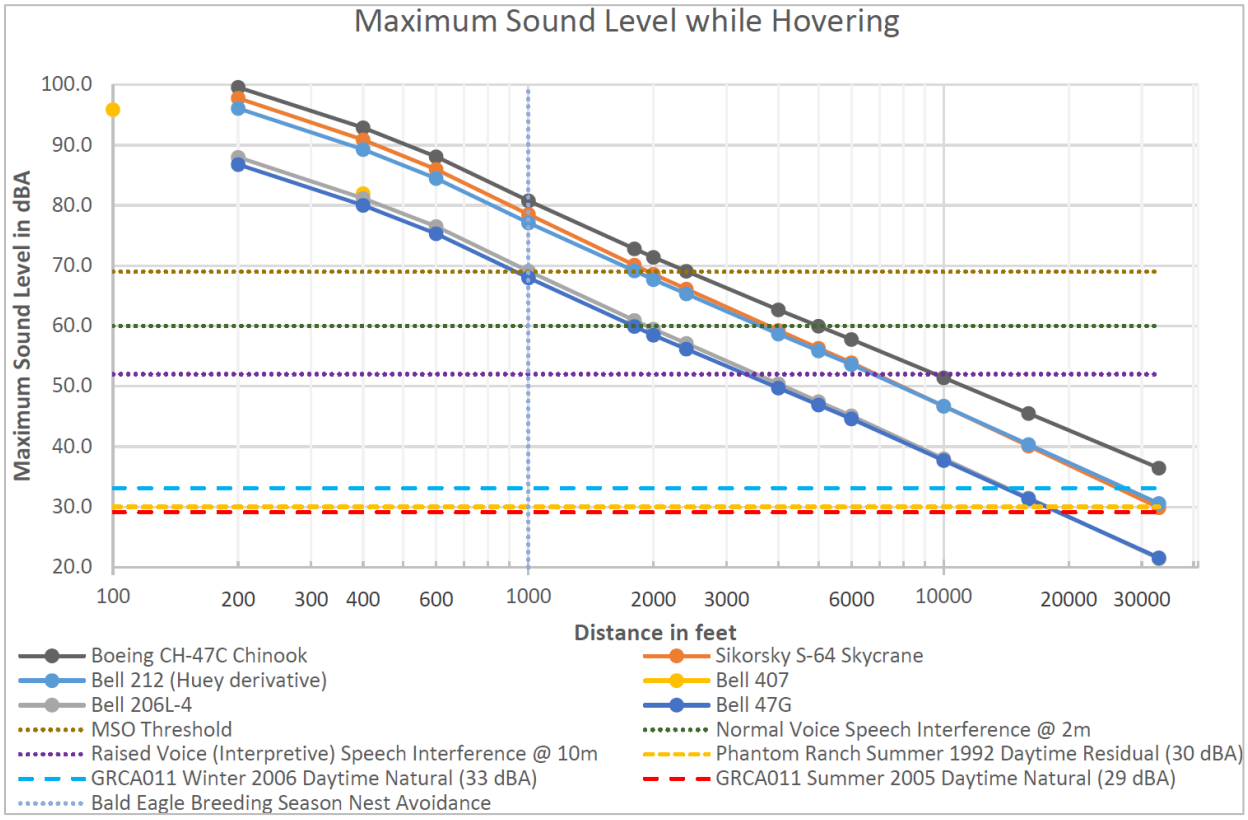


Figure 24: Lmax of hovering helicopters (logarithmic scale)

[24] As there are approximately 880 round-trip administrative flights each year, each round trip departing from and returning to the South Rim Helibase would result in two noise impact occurrences – one for the departing flyover and one for the returning flyover.
[25] Upon completion of the TCWL project, helicopter flights would still be needed to operate and maintain the system. This is discussed further under *Past, Present, and Reasonably Foreseeable Actions and Collective Impacts*.
[26] An indicator of this quality is "remoteness from sights and sounds of people inside the wilderness" (NPS 2014). Hearing (or seeing) helicopters while in wilderness may impact ones feeling of solitude.

Table 5: Helicopter Sound Levels (HDR 2025)

Helicopter Type	Noise Run	Estimated Noise Level
Light Duty – Airbus AStar AS355 Ecureuil 2	Level flyover at 150 meters (500 feet) above ground with microphone in centerline	~84 dBA[1]
Medium Duty – Bell 204/205 ("Huey")	Level flyover at 150 meters (500 feet) above ground with microphone in centerline	~98 dBA[2]
Heavy Duty – Boeing Vertol Chinook (CH-47C)	Level flyover at 150 meters (500 feet) above ground with microphone in centerline at 60 knots true air speed	~90 dBA[3]

[1] European Union Aviation Safety Agency, Type-Certificate Data Sheet for Noise, AS350-EC130, Airbus Helicopters, 2022
[2] NASA Medium Sized Helicopter Noise Abatement Flight Test Data Report, Report TM-20210011459, July 2021
[3] Helicopter Noise Measurements Data Report, Report No. FAA-RD-77-57, Department of Transportation, April 1977

To help understand current ambient noise levels within portions of the analysis area, baseline noise measurements were gathered between October 11, 2023 and November 14, 2023[27] at three sites – the Grand Canyon Lodge, former ballfield, and Supai Tunnel. *Table 6* shows the results. (see *Appendix G: Noise Report* for more information). One item of note is that at these locations, helicopters accounted for less than one percent of anthropogenic sounds during the measurement period.

Table 6: Baseline Noise Measurements at Supai Tunnel, the Ballfield, and Grand Canyon Lodge

Measurement Location	Duration	Period[1]	Average Hourly L_{eq}[3]	Average Hourly L_{max}[3]	Overall L_{max}[3]
Supai Tunnel	Oct 12 – Nov 10	Overall	41	58	82
		Daytime	40	60	82
		Nighttime	41	54	78
Ballfield	Oct 12 –Nov 10 (full measurement duration)	Overall	32	46	69
		Daytime	33	48	69
		Nighttime	29	42	67
	Oct 12 – Nov 6 (project-specific work excluded)[2]	Overall	30	45	69
		Daytime	32	47	69
		Nighttime	27	40	65
Grand Canyon Lodge	Oct 12 – Nov 10 (full measurement duration)	Overall	37	54	89
		Daytime	40	59	89
		Nighttime	32	46	76
	Oct 12 – 15 (Grand Canyon Lodge open)	Overall	44	77	89
		Daytime	46	77	89
		Nighttime	40	62	67

[1] Overall includes all hours; daytime includes the hours from 7:00 am through 9:00 pm; nighttime includes the hours from 10:00 pm through 6:00 am.
[2] Other survey work associated with this proposed project was occurring at the ballfield while noise measurements were being obtained and contributed to atypical and excess noise at this location. Therefore, this period was analyzed separately so extraneous noise from those activities could be excluded.
[3] See footnote 22 above for descriptions of L_{eq} and L_{max}.

[27] This time period is considered shoulder season on the North Rim when less visitors and staff present. However, this same period is popular for cross-canyon hiking, often resulting in an increase in visitors in the inner canyon corridor zone during this time.

Environmental Consequences

Impacts of Alternative A – No Action

Direct and Indirect Impacts

Under the No Action Alternative, soundscape impacts would be expected to remain similar to those described in the Affected Environment. Routine maintenance and operations activities and visitor use would continue to be the primary sources of anthropogenic noise.

Helicopters would continue to be used to transport personnel, equipment, and materials for North Rim waterline repairs and Roaring Springs Pumphouse operation and maintenance (see Chapter 1, *Purpose and Need* for more information). Operating, maintaining, and repairing the existing North Rim water system would be expected to, using best professional judgement, require between 70-120 flights annually using a Bell 47G-equivalent helicopter, which would result in intermittent adverse impacts to the soundscape in the analysis area. These flights are part of ongoing operations and represent existing conditions in the analysis area. Because the number of breaks or failures and subsequent repairs to inner-canyon portions of the water system cannot be reliably predicted, the exact number of flights may fluctuate from the numbers presented here, in which case the soundscape impacts resulting from helicopter flights would vary. These variations reflect the continuation of routine operations rather than new impacts.

Overall, increased anthropogenic noise levels in the analysis area would continue in developed areas and along helicopter flight paths, while natural soundscape would continue to dominate most areas of the park that are outside development zones and helicopter flight paths.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

Past, present, and reasonably foreseeable actions have had and would continue to have impacts on soundscape in the analysis area due to construction-related activities, such as using power tools, equipment, machinery, and helicopter support.

In general, helicopter use similar to that described in the *Affected Environment* would persist and continue to contribute to collective soundscape impacts. The following paragraphs and Table 7 provide rough (order-of-magnitude) estimates of past, present, and reasonably foreseeable helicopter flights based on best available information and professional judgement; however, as alluded to above, the number of future flights cannot be quantified with high level of certainty or confidence because they would continue to fluctuate based on both known or recurring needs, as well as various unforeseeable and unpredictable situations, such as pipeline breaks or search and rescue missions.

Helicopter flights for park administrative actions would continue to contribute to short-term noise impacts multiple times each day. While the amount of future parkwide administrative helicopter flights cannot be estimated with a high degree of certainty, it is roughly estimated that an average of 900 (+/- 300) park administrative flights would occur each year, with the No Action alternative contributing roughly between 70-120 flights to operate, maintain, and repair the existing North Rim water system, thereby contributing to the collective soundscape impacts resulting from helicopter noise. Overall, administrative helicopter flights have and would continue to contribute to collective adverse soundscape impacts in the analysis area into the future.

The TCWL replacement project has contributed substantially to helicopter noise in the analysis area. As noted previously, from October 2023 through January 9, 2025, 8,841 flights occurred to support

TCWL construction. The noise associated with these flights contributed considerably to the collective adverse impacts to the soundscape but would cease upon project completion. An additional 2,160 flights are estimated to be needed between January 9, 2026 through late 2026 to complete the TCWL replacement project. These flights would be ongoing or reasonably foreseeable actions under the No Action alternative, contributing to increased noise levels along flight paths in the analysis area; however, they would cease upon project completion.

While the TCWL replacement project has and will continue to contribute to increased helicopter flights and soundscape impacts during construction, the number of flights needed in the long term to repair breaks in the TCWL is expected to be substantially reduced once the TCWL replacement project is complete, thereby also substantially reducing soundscape impacts. The EA for the TCWL estimated that an average of approximately 1,500 flights would be needed annually to repair breaks if the pipeline were not replaced. Once the TCWL replacement project is complete, long-term operation and maintenance flights are expected to drop to 300 or less per year, substantially reducing future helicopter noise in the analysis area.

Other reasonably foreseeable work at the North Rim and Roaring Springs Canyon would require helicopter support. These reasonably foreseeable actions and their estimated flights are shown in *Table 7*, below, and their helicopter-associated noise impacts are considered part of the No Action baseline. Except for park administrative flights, which would be recurring and ongoing into the future, the project-specific support flights are expected to be short-term and intermittent, resulting in temporary soundscape impacts over the next five to ten years and ceasing upon project completion.

Table 7: Flight Estimates for Past, Present, and Reasonably Foreseeable Projects

Past, Present, or Reasonably Foreseeable Action	Estimated Number of Flights[a]
Overhead Power Replacement – North Rim to Roaring Springs Pumphouse (reasonably foreseeable; flights expected to occur over one construction season)	543[b]
Powerline Replacement – Roaring Springs Pumphouse to Manzanita (reasonably foreseeable; flights expected to occur over one construction season)	364[b]
Construct Solar Power Shade Structure at Cottonwood Campground (reasonably foreseeable; flights expected to occur over one construction season)	122[b]
TCWL Replacement (past; October 2023 through September 2025)	8,841
TCWL Replacement (reasonably foreseeable; September 2025 through construction end in late 2026)	2,160
TCWL Operation and Maintenance (reasonably foreseeable; post-TCWL replacement project completion)	200
Other Park Administrative Flights (past, present and reasonably foreseeable; annual average;)	900
Total Flight Estimate	12,279

[a] One helicopter flight is defined as one helicopter flying from the South Rim Helibase to the project site and back to the South Rim Helibase. If a helicopter needs to stop briefly at the North Rim or another inner canyon site, for example, to pick up personnel, this is considered as part of the one flight and is not counted as an additional flight. As such, one helicopter flight may involve multiple takeoffs and landings.

[b] Helicopter trip estimates are expected to have an accuracy range between -30% to +50% of the estimated value; therefore, for purposes of this EA, the +50% values are reported in this table and are used for analyses herein as they represent the expected upper limit of number of flights needed, and thus the upper-bound impact scenario.

Overall, past, present, and reasonably foreseeable actions collectively result in adverse impacts to soundscape, with the No Action alternative providing a variable contribution to the impacts due to the ongoing need for increased helicopter support to operate, maintain, and repair the aging North Rim water system.

Impact of Alternative B – Proposed Action and NPS Preferred Alternative

Direct and Indirect Impacts

The Proposed Action would temporarily impact the soundscape in the analysis area through noise generated from typical construction activities (e.g., excavation, erecting buildings, transporting personnel/materials, etc.), borehole drilling, and helicopter flights to support construction.

As shown in *Table 8* below, the sound levels from typical construction equipment measured at a distance of 50 feet ranges from 72–92 dBA, with certain equipment specifically associated with borehole drilling expected to be louder. Construction work hours, and therefore the associated soundscape impacts, would be limited to daylight hours from Monday through Friday; however, there may be limited instances when work outside of these times is allowed. Known exceptions include when work is occurring indoors and for borehole drilling activities (borehole drilling is discussed further below). The temporary, construction-related noise impacts would persist throughout the three- to five-year construction period.

Table 8: Construction Activities and Sound Levels (HDR 2024c)

Equipment	Sound Level at 50-FT (L_{max}, dBA, unless otherwise noted)	Equipment	Sound Level at 50-FT (L_{max}, dBA, unless otherwise noted)	Equipment	Sound Level at 50-FT (L_{max}, dBA, unless otherwise noted)
Chainsaw	83	Excavator	87	Pneumatic Tools	71
Circular Saw	75	Flatbed Truck	74	Portable Generator	68
Compactor (roller)	82	Front End Loader	81	Shaker/Suction Tanks[2]	104 (Overall L_w[1], dBA)
Compressors and Boosters[2]	104 (Overall L_w[1], dBA)	Generator[2]	114 (Overall L_w[1], dBA)	Skid Steer	72
Concrete Pump Truck	87	Grader	79	Small Track Backhoe	84
Crane	75	Helicopter	See Table 5 and Figure 24	Vac-truck	87
Drill Floor[2]	109 (Overall L_w[1], dBA)	Light Plant[2]	92 (Overall L_w, dBA)	Vibratory Concrete Mixer	79
Drill Top Drive[2]	99 (Overall L_w[1], dBA)	Hydraulic Personnel Lift	72		
Dump Truck	92	Mud Pumps[2]	104 (Overall L_w[1], dBA)		

[1] L_w stands for sound power level and describes the total amount of sound energy emitted by a noise source and is not location dependent. L_w is frequently used as input data for noise models.
[2] Equipment is specific to drilling operations.

Upon completion of construction, exterior noise generated from the operation and maintenance of new facilities, such as the WTP, would contribute to the ambient soundscape in the long-term; however, these noise contributions are not expected to be readily noticeable or distinguishable by the casual passerby but would instead "blend" with the other noises experienced in the developed area.

Borehole Drilling

Borehole drilling would occur continuously (24/7) over an expected three to five months resulting in drilling-related noise impacts to the soundscape over this same period. Results from noise modeling completed to better understand the potential noise impacts from drilling activities are shown on *Table 9* and *Figure 25* (see *Appendix G: Noise Report* for more information). Noise from borehole drilling activities is estimated to be 35 dBA or higher throughout most of the North Rim developed area, with higher noise levels occurring generally in the area between the campground and lodge. Although 35 dBA is not particularly loud compared to everyday sound levels (see *Table 4*), it would be perceived as twice as loud in those areas that have an average existing background sound level of 25 dBA. Levels of 50 dBA would be fairly obtrusive given the generally quiet background at the North Rim and would be similar to a nearby road with continuous light traffic. As such, those visiting the North Rim during borehole drilling would experience increased noise.

Noise from drilling would also be expected to impact rim areas across Transept and Roaring Springs Canyons (approximately 25-40 dBA), as well as some inner canyon areas. Modeled sound levels within the inner canyon were generally below 25-30 dBA due to the effects of the terrain.

To reduce noise and soundscape impacts from borehole drilling, equipment mitigation, such as enclosures and silencers, would be used. As shown in *Table 9*, equipment mitigation can reduce sound levels by 4 to 13 dBA depending on the location.

To further mitigate noise impacts from drilling, consideration was given to installing temporary sound barriers around the drill site. Temporary 20-foot-tall and 40-foot-tall sound barriers were modeled and determined to effectively reduce noise impacts from drilling activities (see *Appendix G: Noise Report* for more information). However, the use of barriers was dismissed due to the high cost (estimated between $800,00 and $2.3 million) of transporting barriers to the remote North Rim for a relatively short duration (approximately 5 months) of use, the temporary soundscape impacts associated with transporting and installing barriers, and the additional ground disturbance and tree removals that would be required for installation.

Table 9: Noise Model Results

Location[1]	Distance from Borehole	Baseline Measured Sound (dBA)	Modeled Sound without Mitigation (dBA)	Modeled Sound with Equipment Mitigation (dBA)
Outside Boring Site	380	32	68	58
Motels/Cabins	1100	-	50	46
Parking Lot	1630	-	51	43
Concessionaire Housing	1700	-	43	32
Grand Lodge	2160	37	43	36
North Rim Campground	2570	-	39	28
Bright Angel Point	3760	-	37	30
NPS Housing	4900	-	32	20
North Kaibab Trailhead	5520	-	31	19
Uncle Jim Point	6040	-	40	27
Widforss Trailhead	8280	-	27	14

[1] Locations correspond to those on the *Map of Modeled Noise during Drilling figure on the following page*

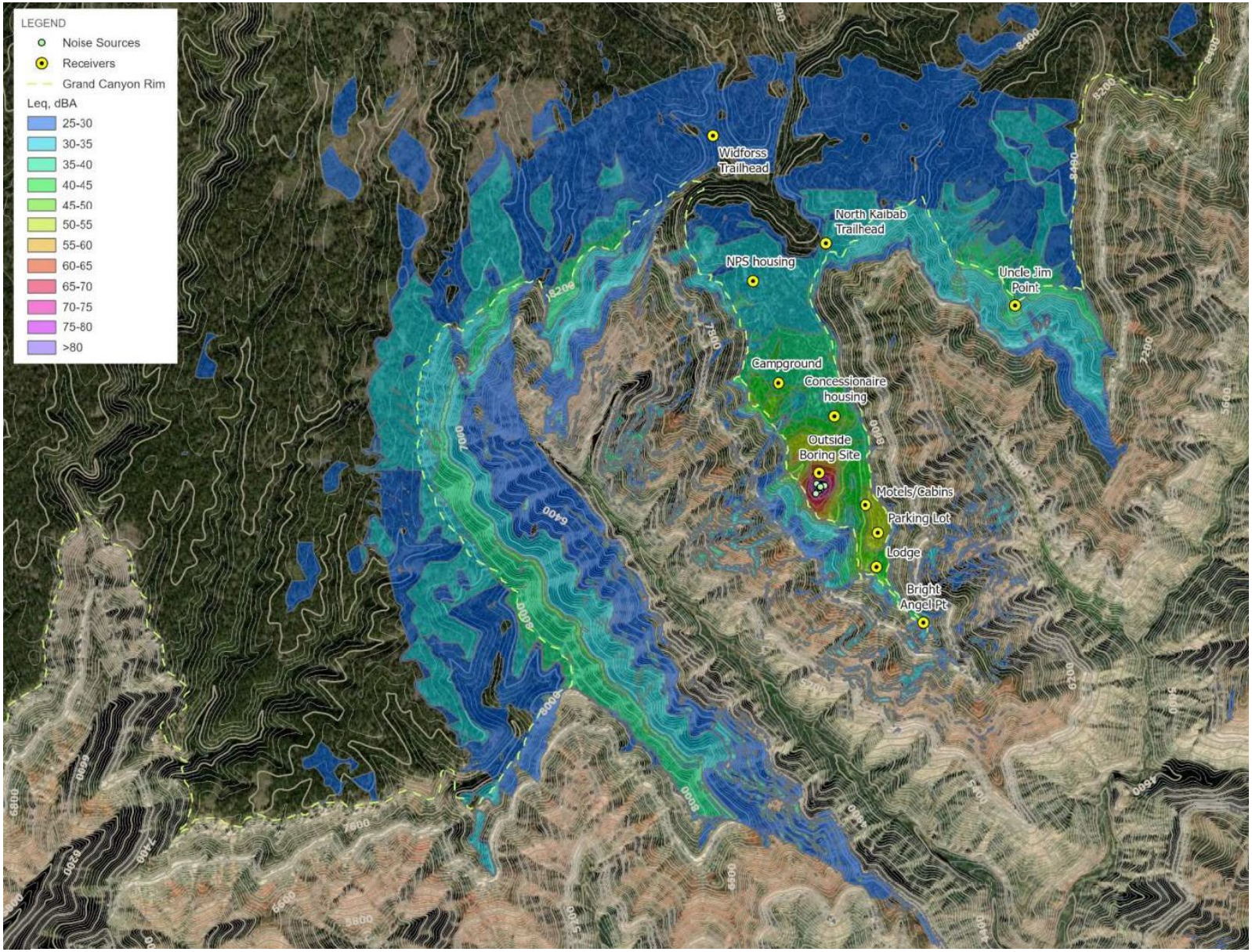


Figure 25: Map of Modeled Noise during Drilling

Helicopter Flights

Helicopter Flights for Construction Support

Helicopter support required to construct the Proposed Action would contribute to increased level and frequency of noise and soundscape impacts within the analysis area along flight paths (including the helibases, landing zones, and sling load locations identified in Chapter 2: *Helicopter and Unmanned Aircraft System (UAS) Operations*). Most flights are expected to use light- or medium-lift helicopters, which are expected to produce noise levels between approximately 30 and 100 dBA depending on the distance between the helicopter and the receiver, as well as other factors, such as wind direction and speed (see *Table 5* and *Figure 24*). Noise attenuation from helicopters would not be expected to extend beyond two to three miles due to the complex terrain and line of sight. Approximately 1,735 flights are estimated to be needed over the two-year construction period in the inner canyon, with up to 20 flights occurring per day on busy days or if construction of multiple project components overlaps in timing. Helicopter flights would only be allowed from 8 am (power on) to 5 pm (power off) so soundscape impacts resulting from helicopters would be limited to a nine-hour period each day. Helicopters supporting the project would be required to use existing flight paths to the extent feasible to minimize introducing soundscape impacts outside of existing flight corridors.

During construction of the Proposed Action, additional helicopter flights to support the project would temporarily increase noise levels and impact soundscapes in proposed wilderness, diminishing the wilderness quality of "solitude or primitive and unconfined wilderness." These temporary project support flights and associated noise during construction would negatively impact wilderness users' opportunities to experience quiet and solitude in proposed wilderness areas that are in the vicinity of flight paths. However, these impacts would be intermittent, localized along flight corridors, and would cease upon completion of construction. See *Wilderness: Opportunities for Solitude or Primitive and Unconfined Recreation* in *Appendix C*.

The effect of helicopter noise on visitor experience is difficult to characterize as adverse, or neutral, because some visitors find helicopters intriguing or noteworthy, while others perceive the presence of helicopters as diminishing their experience. Additionally, perception of helicopters can also be location dependent; for example, helicopter activity may be considered more detracting to visitor experience in backcountry or proposed wilderness areas than in developed settings, such as Grand Canyon Village or the inner canyon corridor, where anthropogenic features are common (see *Visitor Use and Experience*).

Noise from helicopters would also impact wildlife, including special status species (see *Special Status Species).*

In summary, each helicopter flight required to support construction would result in short duration, intermittent, adverse soundscape impacts in the analysis area during a nine-hour period each day over the two-year construction period in the inner canyon. To minimize soundscape impacts, flights would only be allowed between the hours of 8 am to 5 pm and would use established flight paths, helibases, and landing zones, with minimal exceptions.

Long-term, Recurring Helicopter Flights for Operation of the Improved Water System

Under the Proposed Action, helicopter flights required to operate, maintain, and repair the North Rim water system are expected to be reduced by at least half from the current annual total of approximately 70 to 120 flights. This reduction is largely due to changes in water treatment processes at the pumphouse and updated equipment and infrastructure, which should require less maintenance for the foreseeable future, and because most of the waterlines would be protected within boreholes, thereby reducing the risk of breaks. However, some waterline sections in the inner canyon would

remain surface mounted and be more susceptible to breaks due to natural forces, such as landslides. If breaks occur to these surface mounted sections, it would be likely that helicopter support would be required.

Implementation of the Proposed Action would have long-term beneficial impacts to soundscapes due to the need for fewer helicopter flights to operate, maintain, and repair the North Rim water system.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

Past, present, and reasonably foreseeable actions that have and would continue to impact soundscapes are discussed under the No Action Alternative and are the same for the Proposed Action, with the following exceptions.

Noise generated by the helicopter flights that are required to construct the Proposed Action would temporarily contribute to the collective adverse impacts to soundscapes over the two-year construction period in the inner canyon.

Upon completion of the Proposed Action, substantially less recurring operational flights would be needed to operate and maintain the new North Rim water systems when compared to the existing, deteriorated system. As such, the Proposed Action would contribute to the collective long-term, beneficial impacts to soundscapes resulting from fewer helicopter flights.

In summary, when considered collectively with past, present, and reasonably foreseeable actions, construction of the Proposed Action would temporarily contribute to collective adverse soundscape impacts over the two-year construction period in the inner canyon. Upon completion of the Proposed Action, the project would contribute to the collective long-term, beneficial soundscape impacts resulting from less flights being required to operate and maintain the improved North Rim water system.

Special Status Species

Affected Environment

California Condor (Gymnogyps californianus)

In 1996, the USFWS established a nonessential experimental population of California condor in northern Arizona (USFWS 1996a). California condor nesting habitat includes various rock formations such as caves, crevices, and overhung ledges. The active breeding season for condors is designated as February 1 to September 30. Roost sites include cliffs, tall trees, and snags (USFWS 1996). California condors typically forage in open terrain, although in the park foraging on deer and elk carcasses occurs in forested areas.

Within the park, California condor nesting habitat is generally limited to cliffs and caves in the redwall limestone of the inner canyon. Condors are active year-round at the park; however, they are at rim level less frequently in winter and are more often seen along the river corridor during this time. Historically, condors have selected nest sites closer to the South Rim more frequently than the North Rim. The condor nest nearest to the project areas was southwest of Buddha Temple, more than four miles from the project areas, and was last used in 2010. In 2025, one condor nest was successful near Deer Creek, and one was near Fishtail Canyon (both over 10 miles from project areas).

Mexican Spotted Owl (Strix occidentalis lucida)

Mexican spotted owls are a federally listed threatened species and are generally found in habitat that includes mixed conifer and pine-oak forests, riparian woodlands, and sandstone canyonlands (USFWS 1995). Nest and roost sites of Mexican spotted owls are primarily in closed-canopy forests or rocky canyons that provide the cool microclimates the owls prefer. Breeding occurs from March to August annually. Protected activity centers (PACs) surround known Mexican spotted owl sites and are intended to protect the owls and their breeding territory (USFWS 2012). There are 55 PACs located in the park, and GRCA is currently working with USFWS to delineate boundaries of six new PACs identified in 2025. All PACs within the park are located below the rim of the canyon. Two PACs are in relative proximity to the analysis area; all others are greater than three miles away.

While a large portion of the North Rim plateau contains Mexican spotted owl forest critical habitat (mixed conifer), no project areas are within this mixed conifer habitat. Project areas above the rim are within a ponderosa pine dominant habitat and although the owls may use this habitat for occasional foraging, defending territory and as a travel corridor to or from the Grand Canyon, surveys have only identified Mexican spotted owls infrequently on the plateau. Thus far, all Mexican spotted owl nest sites are located below the canyon rim in the redwall limestone of the canyon walls.

Environmental Consequences

Impacts of Alternative A – No Action

Direct and Indirect Impacts

California Condor

Due to the distance between North Rim water system facilities and the nearest historic California condor nest (located more than four miles from project sites and not currently active), potential direct and indirect effects on California condors under Alternative A would be limited to helicopter activity required to support North Rim waterline repairs and operation and maintenance of Roaring Springs Pumphouse. No ground-disturbing activities or construction would occur within condor nesting, roosting, or concentration areas.

Potential impacts from helicopter noise on condor nesting and breeding would be minimal because helicopters would remain at least one mile from any active condor nest locations, except where human safety would be compromised. Helicopter activity could result in brief disturbance to feeding or foraging behavior, which could cause individual condors to expend additional energy; however, given established flight restrictions and the distance maintained from known condor use areas, these effects would be infrequent and short-term.

The potential exists for collision between a condor and a project-related helicopter; however, this risk is considered very low. The park conducts approximately 900 (+/- 300) round-trip administrative helicopter flights annually from the South Rim Helibase, and no condor collisions or near-miss incidents have been reported. In addition, project-specific helicopter flights associated with Transcanyon Waterline replacement activities have occurred since October 2023 without documented collisions or near-misses. Helicopters would maintain a minimum separation distance of approximately 1,200 feet from condors in flight, and pilots would maneuver away from condors when observed, to the extent practicable while maintaining human safety.

Based on the distance between project activities and condor use areas, the limited duration and frequency of helicopter flights, ongoing monitoring of condor locations, and implementation of flight

avoidance measures, the likelihood of adverse effects to condors from helicopter activity associated with operation, maintenance, and repair of the existing North Rim water system would be very low under Alternative A.

Mexican Spotted Owl

Potential direct and indirect effects on Mexican spotted owls could include temporary increases in noise and visual disturbance associated with waterline repair activities and helicopter operations to support waterline repairs and operation and maintenance of Roaring Springs Pumphouse. Helicopter use would be intermittent and limited to the duration needed to transport personnel, equipment, and materials to the pumphouse or repair locations along the waterline.

No construction or repair activities would occur within any Mexican spotted owl PACs. The two PACs nearest to the waterline corridor likely have nest/roost sites 0.75 miles or greater to the nearest project site. Based on distances calculated to project areas we expect effects of the action to be insignificant and discountable.

Mexican spotted owls are primarily active during nighttime and twilight periods. All repair work and helicopter flights would occur during daylight hours; therefore, project activities would not interfere with primary foraging periods. In addition, helicopter flights are required to remain at least 1,200 feet above and laterally from the boundaries of all Mexican spotted owl PACs during the breeding season (March 1 through August 31), except when necessary for safety or emergency response.

Although brief behavioral responses to noise or visual disturbance may occur during helicopter operations, these effects would be localized and short term. Given the distance of work areas from PACs, the absence of construction within PAC boundaries, the limited duration and infrequency of repair events, and adherence to flight restrictions, project-related disturbance would not result in adverse effects such as nest abandonment, reduced reproductive success, malnourishment, or population-level impacts. Impacts to Mexican spotted owls would therefore be minor and temporary.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

The impacts of past, present, and reasonably foreseeable actions (see *Appendix D*) on special status species would primarily result from helicopter activity associated with park administrative functions and construction and maintenance activities, including ongoing operation and repair of the North Rim waterline and Roaring Springs Pumphouse, as well as other infrastructure projects in the inner canyon, such as the TCWL replacement project. Helicopter use would result in intermittent noise and visual disturbance within portions of the inner canyon corridor. See *Table 7* for flight estimates for past, present, and reasonably foreseeable actions.

These impacts would be small because best management practices (BMPs) and mitigation measures have been and would continue to be implemented to minimize disturbance, including flight path restrictions, seasonal avoidance where applicable, and minimum altitude requirements over sensitive habitats. However, because helicopter overflights would continue to occur as part of ongoing park operations and infrastructure maintenance, collective negative impacts to special status species from helicopter activity would remain at a low level.

Under Alternative A, approximately 70-120 helicopter flights per year would be required to support operation, maintenance, and repair of the existing, aging North Rim water system. The No Action alternative would therefore contribute to collective negative impacts to special status species associated with helicopter support for past, present, and reasonably foreseeable actions.

Other past, present, and reasonably foreseeable actions, including prescribed fire, forest thinning, visitor use, and ground-disturbing activities associated with unrelated construction projects, would also contribute incrementally to collective impacts on special status species through temporary noise, human presence, and localized vegetation disturbance. However, as described under direct and indirect impacts, no ground-disturbing or vegetation-removal activities under Alternative A would occur within known nest sites, roost sites, PACs, or other documented concentration areas for special status species. Therefore, Alternative A would not measurably contribute to collective habitat-related impacts, and its contribution would be limited to intermittent disturbance associated with helicopter operations.

Impacts of Alternative B – Proposed Action and NPS Preferred Alternative

Direct and Indirect Impacts

California Condor

Potential direct and indirect effects on California condors include visual disturbances, disturbance from noise, attraction to human activity, and risk of collision with aircraft.

Noise and activity from construction and helicopter support could temporarily affect California condors by flushing individuals from perching, roosting, or scavenging sites or briefly altering foraging and reproductive behavior for periods ranging from minutes to hours over the three- to five-year project duration (see Chapter 2, Helicopter and Unmanned Aircraft System (UAS) Operations). Construction would occur year-round during daylight hours, including during the condor breeding season, with the exception of borehole drilling activities, which would operate continuously (24 hours per day/7 days per week) for approximately three to five months and require nighttime lighting at the drill site, as well as at bore exit site when each borehole daylights. These activities could intermittently affect normal breeding and roosting behavior of individual condors.

Although condors utilize cliffs and canyons throughout the park and are frequently observed flying near and over the inner canyon corridor, historically, condors have not nested within four miles of the construction zones. Potential effects on breeding and nesting associated with project helicopter support and general construction activities would be minimized through conservation and mitigation measures (see *Appendix B*). With these measures in place, noise-related effects on condors would be temporary and localized.

It is possible that a condor could collide with a project-related helicopter, however, no collisions or near misses of condors have ever been reported by NPS helicopter pilots. The Proposed Action would require approximately 1,735 flights over the two-year inner canyon construction period. It is assumed that the increased number of helicopter flights during construction under this alternative would increase the overall risk of a collision. Since condors are highly visible due to their size, it should be possible to avoid collision; however, any collision with a condor would be a catastrophic accident for both the bird and the aircraft. Potential disturbance and risk of collision associated with helicopter use would be reduced through conservation and mitigation measures (see *Appendix B*). Although the chance of an aircraft strike exists, the likelihood is very low.

Additionally, while flight numbers would temporarily increase during construction, long-term, recurring flights required to operate, maintain, and repair the improved North Rim water system under the Proposed Action are expected to be reduced by at least half from the current annual total of approximately 70 to 120 flights, which would be a beneficial impact to condors.

Although the risk of condors being attracted to construction activities exists, as does the chance of collision with helicopters, implementation of mitigation measures will help to prevent human, helicopter, and condor interactions.

The park contains 1.2 million acres of condor habitat and is surrounded by similar habitat types in all directions; therefore, with such an abundance of habitat readily available, condor habitat would not be negatively impacted by the Proposed Action. In addition to plentiful condor habitat within the park, condors regularly cover great distances each day, venturing over suitable foraging and nesting habitat as far north as southern Utah. With an abundance of habitat, and because the Proposed Action would occur year-round and over the course of several years, condors may choose to avoid the areas of disturbance during the life of the project.

Because of the small number of California condors in existence, even a single failed nesting attempt or mortality of a condor due to implementation of the Proposed Action would have a negative impact on this species. However, for the reasons described above, including the implementation of mitigation measures, the likelihood of negative effects on condors from the Proposed Action would be very low.

Mexican Spotted Owl

Potential direct and indirect effects on Mexican spotted owls would occur from removal of and changes to habitat for prey species and noise from helicopters and construction equipment.

Removal of vegetation and ground disturbance in the construction zones would somewhat degrade the quality of foraging habitat. The Proposed Action would occur outside of all PAC boundaries and would not result in a loss of nest or roost habitat for Mexican spotted owls. Although the Proposed Action would result in some alteration of ponderosa pine on the North Rim, we do not anticipate the changes to have an impact on the owls due to the locations being in or surrounded by an existing developed area and abundant habitat that will remain intact and unchanged nearby. Additionally, based on survey results and installations of acoustic recording devices, Mexican spotted owls have only infrequently been detected utilizing the habitat above the rim (NPS 2023c, 2024h, 2025e). Although Mexican spotted owl critical habitat occurs on the North Rim (mixed conifer), construction activities would not impact this habitat.

Noise and activity from construction during the breeding season may affect individual owls. Construction work would occur year-round for three to five years (two of which would be in the inner canyon corridor), including during the Mexican spotted owl nesting season. With the exception of borehole drilling activities, all construction would be restricted to daylight hours. Borehole drilling activities would occur continuously (24/7) over the three- to five-month drilling period, resulting in increased noise and requiring nighttime lighting of the drill site. The normal breeding and roosting behavior of Mexican spotted owls may be affected by the various construction activities throughout the project. The use of mechanized equipment would occur more than 0.5 miles from Mexican spotted owl nest/roost sites.

Foraging by Mexican spotted owls is unlikely to be affected by construction activities because of the distance between PACs and construction zones, because Mexican spotted owls are nocturnal, and helicopter flights and most construction activities would occur during daylight hours, with the exception of borehole drilling. The potential negative impacts described could impact up to two of the 55 PACs parkwide. It is not expected that the local population would be measurably affected, especially with implementation of mitigation measures (see *Appendix B*) which greatly reduce the chances of negative impacts.

Alternative B would require approximately 1,735 helicopter flights over the two-year inner canyon construction period. Potential effects on Mexican spotted owls associated with project helicopter support would be minimized through conservation and mitigation measures (see *Appendix B*). Based on the distance between PACs and construction zones, and implementation of BMPs, noise impacts on roosting or nesting Mexican spotted owls would be minimized to the extent that negative effects from helicopter overflights are not expected to occur.

Additionally, while flight numbers would temporarily increase during construction, long-term, recurring flights required to operate, maintain, and repair the improved North Rim water system under the Proposed Action are expected to be reduced by at least half from the current annual total of approximately 70 to 120 flights, which would be a beneficial impact to Mexican spotted owls.

Past, Present and Reasonably Foreseeable Actions and Collective Impacts

As previously described for the No Action alternative, past, present, and reasonably foreseeable actions would result in minor negative impacts from ground disturbance, helicopter flights, and temporary displacement from increased noise and human activity. These impacts would be small because BMPs and mitigation measures would be used to reduce impacts from helicopters and the areas disturbed would be relatively small. Overall, collective impacts from past, present, and reasonably foreseeable actions are small and negative. Alternative B would contribute to collective negative effects on California condors and Mexican spotted owls due to noise disturbance from construction and helicopter flights; however, this contribution would be temporary and limited to the three-to-five-year construction period. In the long-term, past, present, and reasonably foreseeable actions would continue to have collective negative impacts to California condors and Mexican spotted owls due to helicopter use in the park; however, Alternative B would reduce potential helicopter-related impacts to condors and owls due to less flights being needed to operate and maintain the improved North Rim water system, thereby resulting in a small contribution to the collective negative impacts in the long-term.

Visitor Use and Experience

Affected Environment

Visitor use and experience (VUE) encompass the ways in which people access, use, and perceive park facilities, trails, and services. The North Rim of Grand Canyon National Park is characterized by its remote setting, lower visitation relative to the South Rim, and opportunities for quieter, more dispersed recreation. These conditions contribute to a visitor experience that emphasizes solitude, natural soundscapes, and immersion in high-elevation forest and inner-canyon environments. The analysis area for VUE includes all recreation and visitor facilities on the Bright Angel Peninsula and in Roaring Springs Canyon, as well as helicopter flight paths (*Figure 18*), North Entrance Road, and South Entrance Road (South Rim).

The Dragon Bravo Fire (see Chapter 1, *Background*) has affected VUE on the North Rim. The fire and its after-effects have resulted in the closure of many visitor services as of the time of this writing. The only facilities to open in the fall of 2025 were State Route 67 down to its intersection with Cape Royal Road, as well as Cape Royal and Point Imperial Roads and the facilities along them, making the entire Bright Angel Peninsula inaccessible to visitors. Additionally, the North Kaibab Trail was closed between its trailhead and Cottonwood Campground, making the inner canyon inaccessible from the North Rim. As of this writing, it is undetermined when and to what extent the North Rim and Roaring Springs Canyon visitor facilities will be reopened. For purposes of this EA, the affected

environment and analysis of environmental consequences assumes that future VUE on the North Rim and in Roaring Springs Canyon will be similar to historic use (NPS 2026).

North Rim

From 2014 to 2024, the North Rim received approximately 280,000 visitors annually during its operating season, accounting for less than 10 percent of the park's overall annual visitation of approximately 4.5 million visitors (NPS 2024e). Although visitation levels are lower than on the South Rim, the North Rim remains an important destination for hiking, backpacking, wildlife viewing, bicycling, camping, and stock use. The primary and only paved access to the North Rim is via State Route 67 (North Entrance Road). The North Rim is generally open to overnight use and full visitor services from May 15 through October 15 and open for day use only from October 16 through November 30, unless snow or hazardous conditions require earlier closure of State Route 67. Vehicular access is typically closed from December 1 through May 15 due to winter conditions, although the area may still be accessed by non-motorized means, such as cross-country skiing, and overnight use may occur under backcountry permits. Visitor services and facilities include trails, campgrounds, restrooms, ranger programs, food service, retail services, lodging, and fuel.

Several multi-use trails connect and provide access to nodes of visitor service or points of interest without reliance on motorized vehicles. The Bridle Path extends approximately 1.2 miles from the Bright Angel Point Trail at the southern tip of the peninsula to the North Kaibab Trailhead and generally parallels State Route 67. The Bridle Path is used by hikers, bicyclists, and stock, and provides an important connection between visitor lodging and services and the primary inner-canyon trailhead and averages about 130 users a day throughout the summer season. The 1.9-mile-long Transept Trail (*Figure 3*) runs along the west side of the Bright Angel Peninsula and connects the lodge area with the campground and north end of Bridle Path; serving as a key pedestrian corridor between visitor facilities, it averages about 190 users a day throughout the summer season. Several unnamed paths are also present, which provide connections between the Bridle Path, Transept Trail, and various visitor facilities. These trails are commonly used by visitors traveling between lodging, campgrounds, trailheads, and other service areas and contribute to the overall circulation of non-motorized visitor traffic across the peninsula.

The North Rim Campground is located north of the lodge area and provides overnight accommodations for visitors. The North Rim General Store, located near the campground, provides food, supplies, and basic services for visitors and backcountry users. A gas station is located near the campground area along Campground Road, providing the only fuel service available to visitors on the North Rim. These facilities support both 'developed' and backcountry recreation and are focal points of visitor activity, particularly during the peak summer season.

The Arizona National Scenic Trail is a long-distance, non-motorized trail that extends approximately 800 miles across Arizona from the Mexico border to the Utah border and passes through the park. At the North Rim, the Arizona Trail generally parallels State Route 67 before connecting and sharing its alignment with the North Kaibab Trail. Private stock use is permitted on the Arizona Trail within the park.

The North Kaibab Trailhead is located at the northeast end of the Bright Angel Peninsula, along the east side of State Route 67. The trailhead features a parking lot with capacity for approximately 40 standard vehicles, composting toilets, a water filling station, and a mule corral. The North Kaibab Trailhead also functions as the trailhead for a segment of the Arizona National Scenic Trail, as well as the Ken Patrick Trail, which also connects to the Uncle Jim Trail. Additionally, CC Hill is accessed through the North Kaibab Trailhead parking lot.

Roaring Spring Canyon

The North Kaibab Trail begins at the northeast end of the Bright Angel Peninsula and serves as the primary access route from the North Rim into the inner canyon. The North Kaibab Trail extends from the rim to the Colorado River and is the primary maintained route connecting the North and South Rims. The inner canyon corridor zone is the park's most heavily used backcountry area and accommodates year-round visitation. As shown in *Figure 26*, between May and November of 2024 over 106,00 visitors were counted at the North Kaibab Trailhead and over 38,000 visitors were counted at Manzanita Rest Area. Peak use typically occurs during the spring and fall "rim-to-rim" hiking seasons, particularly in May and October with up to an estimated 1,600 through hikers on a single day (October 12th). Corridor users include day hikers, overnight backpackers, commercial and private stock users, and river runners accessing trail connections to and from river camps. Additionally, mule rides down to Supai Tunnel and back to the trailhead are offered by a concessioner.

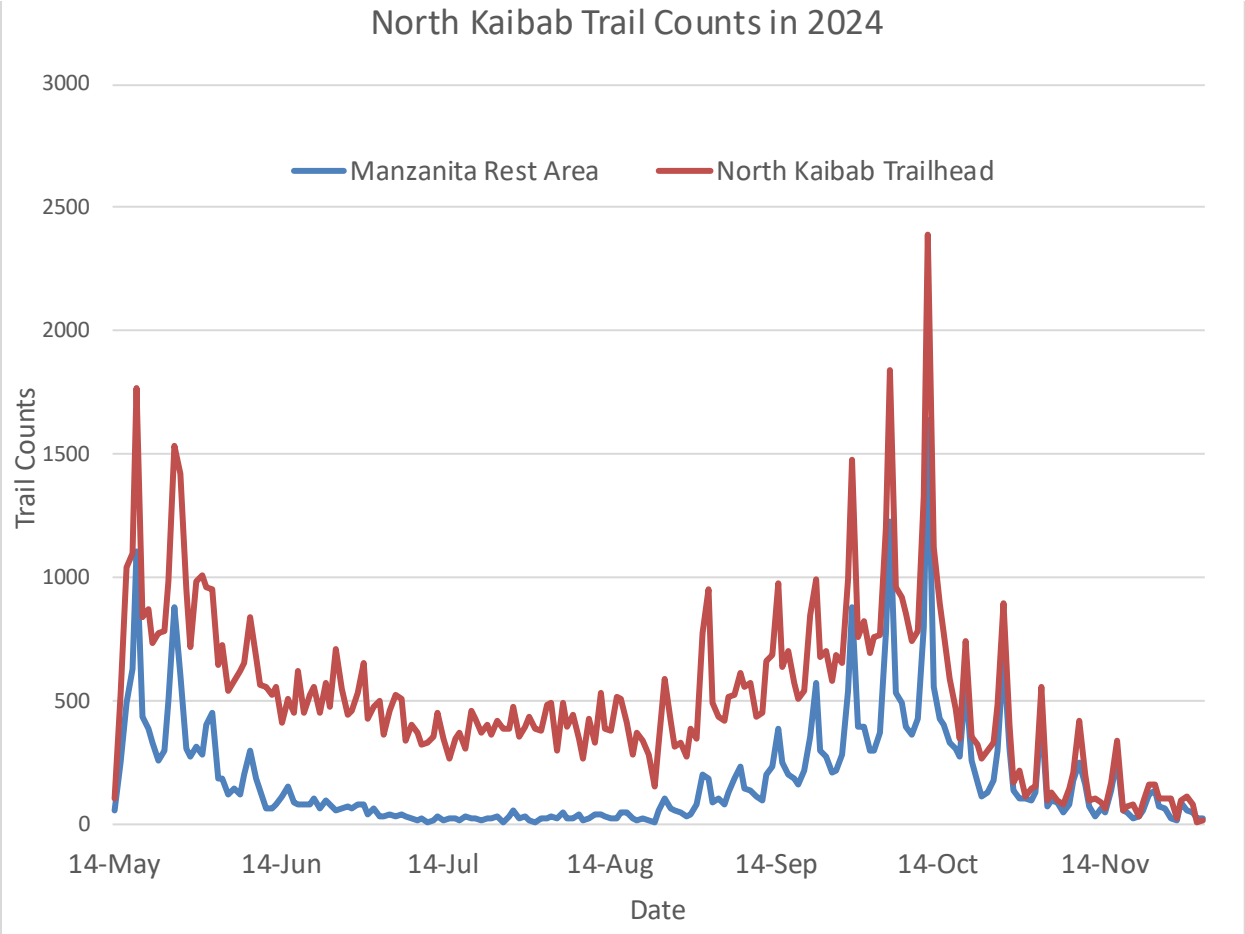


Figure 26: Daily Trail Counts on the North Kaibab Trail in 2024

Within the analysis area, Supai Tunnel, located along the North Kaibab Trail approximately 1.7 miles from the trailhead, provides potable water seasonally, restrooms, and shade, and functions as a major stopping point for hikers and mule trips. Trail use data at Supai Tunnel and Roaring Springs Day Use Area are more limited, but trail counts at Supai Tunnel were 25,000 people from September 23 to December 2 of 2024 (*Figure 27*) and the park estimates 84% of users accessing North Kaibab Trail (including both out and back and cross-canyon hikers) travel to Supai Tunnel. Below Supai Tunnel,

the trail continues its descent through Roaring Springs Canyon, where visitor facilities are absent until Manzanita Rest Area, where trail counts were 20,000 people from September 23 to December 2 of 2024 (*Figure 27*).

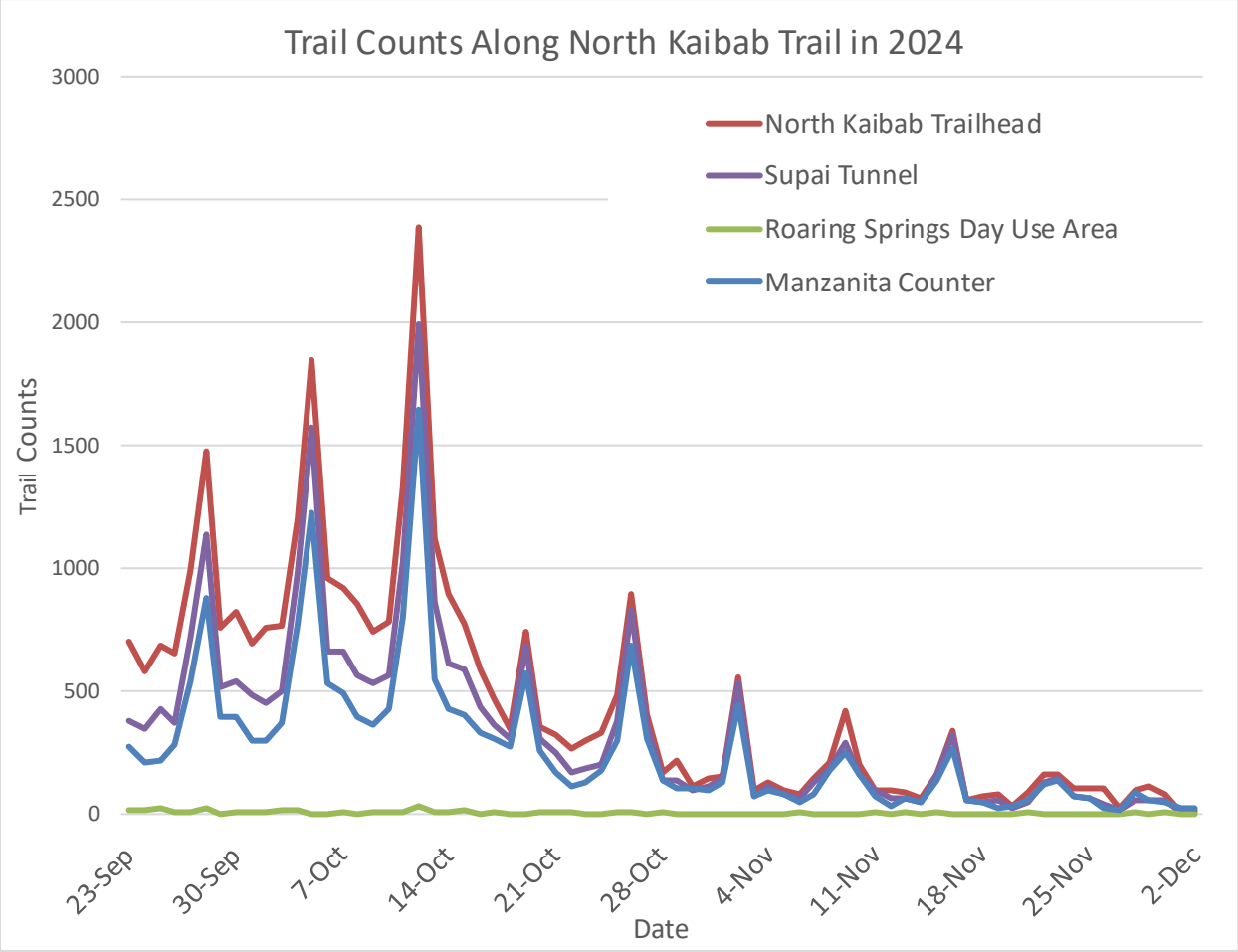


Figure 27: Daily Trail Counts on the North Kaibab Trail Visitor Services Areas in 2024

Visitors on the North Kaibab Trail may encounter a mix of rugged terrain, limited infrastructure, and extreme environmental conditions, as well as periods of intense human activity and associated anthropogenic noise (see *Soundscapes and Noise*). The corridor also functions as a development zone, with accessible water and power for staff and emergency services as well as frequent helicopter flights. Despite high visitor use, the area retains a sense of remoteness that contributes to the visitor experience. Access to potable water, rest areas, and campgrounds along the corridor is important for visitor safety and trip planning, particularly during peak hiking seasons and high temperatures. Trails outside the inner canyon corridor zone offer increased isolation, more challenging terrain, and a quieter natural environment.

The Roaring Springs Day Use Area is located approximately 1,200 feet north of the Roaring Springs Pumphouse and is accessed via Roaring Springs Trail, which is narrow, averaging about 3 feet wide, and receives minimal maintenance. The Roaring Springs Trail is only accessible via the North Kaibab Trail. The day use area and trail are currently open to the public, but do not have operating visitor facilities; the composting toilets at the day use area have been out of service for years. Data for Roaring Springs use is limited, but trail counts from September 2024 through December of 2024 indicated an average use of seven visitors a day (*Figure 27*).

State Route 64 (South Entrance Road)

State Route 64 (South Entrance Road) is the primary road used by visitors, as well as staff, to access Grand Canyon Village, which sees more than 4,000,000 annual visitors and supports a small year-round residential population associated with park operations and visitor services. Once into the village, South Entrance Road is the primary motorist corridor, providing access to a multitude of visitor services and facilities. Visitor use in the village is largely concentrated within 1 mile of the rim, where there is the Rim Trail, Bright Angel Trailhead, overlooks, visitor lodging and other amenities. South Entrance Road also provides the primary access to South Gate and the South Rim Contractor Support Facilities (see Chapter 2*, Staging and Contractor Lodging*).

Helicopter Flight Paths

The analysis area for VUE pertaining to helicopter flight paths are the same as the flight paths[1] described in the *Helicopter and Unmanned Aircraft System (UAS) Operations* section and shown on *Figure 18*.

Environmental Consequences

Impacts of Alternative A – No Action

Direct and Indirect Impacts

Under the No Action Alternative, visitor access to and use of park facilities, trails, and recreational features would continue under existing conditions. No construction would occur to perform major upgrades to the water system, and no new ground disturbance, tree removal, trail rerouting, or facility development would be implemented. As a result, there would be no construction-related effects on VUE, including access, circulation, or visual or audible conditions on the North Rim or within the inner canyon.

However, the No Action Alternative would not address the ongoing deterioration of the North Rim water infrastructure. Roaring Springs Canyon experiences high levels of visitor use along the North Kaibab Trail throughout the year, with peak use during the spring and fall rim-to-rim hiking seasons. These peak periods coincide with times when waterline failures and maintenance needs are most frequent due to freeze–thaw cycles. Under the No Action Alternative, water system failures would be expected to continue to occur intermittently and unpredictably, requiring emergency response and ongoing maintenance, and trails closures and restrictions, in remote locations where ground access is limited or unavailable.

Operation, maintenance, and repair of the existing water system would continue to rely on helicopter support to transport personnel, equipment, and materials. Approximately 95 helicopter flights are currently required each year for these activities, with typical flight times of approximately 20 minutes between the South Rim Helibase and North Rim or inner-canyon work sites. Helicopter flight paths pass over or near heavily used locations within the inner canyon corridor (see *Figure 18*), where visitors commonly hike, rest, and camp. The flight paths also pass over developed areas with high visitor use at both the North and South Rims. As a result, visitors would continue to experience intermittent aircraft noise and visibility during repair and maintenance activities. Individual helicopter flights and their associated effects would be short in duration, but they would occur

[1] Helicopter flight paths include the helibases, landing zones, and sling load locations described in the *Helicopter and Unmanned Aircraft System (UAS) Operations* section.

repeatedly over time and would be expected to occur more frequently as the existing water system continues to age. See *Soundscapes and Noise* for additional information and analysis pertaining to helicopter flights.

As noted in the *Helicopter Flights for Construction Support* section under *Soundscapes and Noise*, the effect of helicopter noise on visitor experience is difficult to characterize as adverse, or neutral, because some visitors find helicopters intriguing or noteworthy, while others perceive the presence of helicopters as diminishing their experience. Additionally, perception of helicopters can also be location dependent; for example, helicopter activity may be considered more detracting to visitor experience in backcountry or proposed wilderness areas than in developed settings, such as Grand Canyon Village or the inner canyon corridor, where anthropogenic features are common. As such, although characterization of the impact is difficult and dependent on several factors, it is likely that visitors in backcountry areas outside development zones would expect a level of solitude and more natural soundscape; therefore, the presence of helicopters in these backcountry areas is likely an adverse impact to visitor experience.

Water infrastructure failures under the No Action Alternative could also affect visitor services and facilities. Waterline breaks often result in temporary water restrictions or service interruptions at North Rim and inner-canyon developed areas, potentially affecting visitor safety, comfort, and trip planning. These effects could include reduced availability of potable water at rest areas and campgrounds, reduced services, or temporary closures of facilities, including partial or full closure of the North Rim similar what occurred in 2023 (see Chapter 1*, North Rim Waterline*). In some cases, repair activities adjacent to trail corridors could require temporary trail closures or access restrictions, limiting visitor access to key destinations and altering planned hiking or stock routes.

Overall, while the No Action Alternative would avoid short-term construction-related disturbances, it would result in continued—and potentially increasing—effects on VUE over time due to recurring infrastructure failures, emergency repair activities, repeated helicopter operations, and intermittent limitations on water availability and facility services. These effects would occur unpredictably and could affect both rim-based and inner-canyon visitors.

Past, Present and Reasonably Foreseeable Actions and Collective Impacts

Past, present, and reasonably foreseeable actions have contributed and would continue to contribute to collective adverse impacts on VUE in the analysis area. These actions primarily consist of facility construction projects that involve temporary trail or other facility closures, restricted access or delays, and helicopter operations. Such activities are common within development zones and primary travel corridors, where construction-related disturbances are an expected component of maintaining visitor infrastructure.

Past, present, and reasonably foreseeable actions have and would continue to require helicopter support (see *Soundscapes and Noise* section for these actions and flight estimates), resulting in visual and audible effects that would be experienced by visitors. As noted previously, the No Action alternative would be expected to average roughly 70-120 flights to operate, maintain, and repair the existing North Rim water system, thereby contributing to collective VUE impacts associated with helicopter flights.

Past and present actions have resulted in closures of visitor facilities, thereby altering VUE. In 2025, the Dragon Bravo Fire and its after-effects resulted in the closure of the Bright Angel Peninsula and all inner canyon corridor facilities north of Cottonwood Campground, substantially limiting visitor access and altering visitor travel patterns. As of this writing, it is undetermined when and to what

extent the North Rim and Roaring Springs Canyon facilities, including the North Kaibab Trail, will be open to visitors in 2026.

Visitors traveling through the inner canyon corridor zone currently experience increased helicopter activity and construction-related effects associated with the Transcanyon Waterline (TCWL) replacement project. While the TCWL replacement project is not within the construction zone or analysis area, the TCWL project has introduced construction activity, periodic helicopter overflights, and temporary trail and campground management measures, including extended closures, in the south segment of the inner canyon corridor, resulting in impacts to VUE (NPS 2018a). The TCWL replacement project has also resulted in increased traffic and temporary lane restrictions on South Entrance Road due to construction-related deliveries, which have likely led to minor delays for visitors using this road to access the South Rim.

Several reasonably foreseeable actions would further affect VUE in the analysis area through temporary closures and restrictions. Overhead powerline replacement between the North Rim and Roaring Springs Pumphouse would require closure of the North Kaibab Trail between Redwall Bridge and Manzanita, and closure of the Roaring Springs Day Use Area and Trail for approximately eight weeks (see *Figure 28*), as well as the closure of a portion of the North Rim Visitor Center parking lot for staging. This project would also close the Bridle Path for trenching fiber optic cable from the overhead powerline to the EMS facility, requiring similar detours as outlined in Chapter 2, *Trail Closures*. Replacement of underground power between Roaring Springs Pumphouse and Manzanita would require a four-week closure of the North Kaibab Trail between the Roaring Springs Day Use Trail junction and Manzanita and closure of the Roaring Springs Day Use Area and Trail (see *Figure 28*). Rehabilitation of the wastewater collection system on the North Rim would require partial closures of the North Rim Campground for four months. Each of these reasonably foreseeable projects would collectively result in adverse impacts to VUE by temporarily reducing access to or use of park facilities but would provide collective long-term benefits through reduced shutdowns or restrictions for regular maintenance and emergency repairs. The No Action alternative would contribute to the collective adverse impacts to VUE due to ongoing water restrictions and temporary closures/ restrictions to visitor facilities resulting from operation, maintenance, repairs, or failures of the existing North Rim water system, and would not contribute to the collective long term beneficial impacts.

In summary, the No Action alternative would continue to contribute to collective adverse impacts on VUE. This is due to water system failures that necessitate intermittent closures or restrictions to water availability or visitor services or facilities, such as closing trails, restaurants, or lodging. Collective VUE impacts resulting from visual and audible effects from helicopter activity are unable to be reliably determined due to the varied visitor perceptions of helicopter activity; however, helicopter effects on VUE are likely considered adverse in backcountry areas outside of development zones. As such, the No Action Alternative would contribute to the collective adverse impacts to VUE in backcountry areas resulting from helicopters.

Impacts of Alternative B – Proposed Action and NPS Preferred Alternative

Direct and Indirect Impacts

Trail Closures and Access Restrictions

Alternative B would require temporary trail closures, reroutes, and visitor use restrictions to construct the project and provide visitor and worker safety. These actions would affect hiking, mule trips on

the North Kaibab Trail, and pedestrian routes used to access visitor services, developed facilities, and backcountry destinations.

Several project components would require extended or staged closures of specific trail segments. The Bridle Path on the Bright Angel Peninsula would be closed for approximately eight months between Norton Court and Admin Loop Road to accommodate utility installation. During this closure, trail users would be rerouted to the Transept Trail, on average doubling use, increasing traffic and travel times, and potentially leading to congestion on this trail. Stock users and bicyclists would experience reduced route options and would be required to self-detour.

Closures of the North Kaibab Trail would be required for several project activities. Borehole drilling would require closures of the North Kaibab Trail between Redwall Bridge and Manzanita Rest Area for approximately three weeks per borehole as drilling approaches the exit points (see *Figure 28*). Installation of a new water pipe between the North Rim and Supai Tunnel would require closure of the North Kaibab Trail between the trailhead and Supai Tunnel for approximately five weeks, as well as the closure of Supai Tunnel for five months (see *Chapter 2, Waterline Area 4* and *Figure 12*). To the extent practicable, the North Kaibab Trail and Supai Tunnel closures would occur concurrently to minimize impacts to visitors.

These closures would temporarily limit visitor access to and use of water, rest areas, and facilities in the inner canyon corridor north of Manzanita Rest Area and could complicate trip planning for hikers and stock users. Closures of the North Kaibab Trail would make cross-canyon hikes via the inner canyon corridor temporarily impossible and would restrict access to the inner canyon corridor from the North Rim during closure windows. These closures could occur throughout the year and during peak visitation periods. With these closures, it is possible that visitors would be displaced and would seek trails on the rim or otherwise outside of the inner canyon corridor, thereby increasing traffic on other trails.

In addition, closures of the North Kaibab Trail and Supai Tunnel would require the suspension of concessioner-operated mule rides between the North Kaibab Trailhead and Supai Tunnel, resulting in adverse impacts to visitors wanting to participate in this mule ride; however, mule rides on the Uncle Jim and Ken Patrick Trails would remain open.

The Roaring Springs Day Use Area and Trail would be closed to visitors for the entire two-year duration of inner canyon work (see *Roaring Springs Day Use Area* and *Figure 28*), eliminating visitor access to Roaring Springs viewpoints and reducing short side-trip opportunities for corridor users.

Overall, these trail closures and access restrictions would result in temporary adverse effects on VUE by reducing accessibility, concentrating use on fewer available routes, increasing trip planning complexity during construction, and affecting the quality of visitors' experience. Visitors may choose to use other trails or instead visit other areas of the park to avoid construction activities and associated closures and restrictions. All trails and facilities affected by construction would be fully reopened following completion of the project and visitor use would be expected to return to normal conditions. Adverse impacts on visitors would be somewhat mitigated by notifying the public in advance of closures.

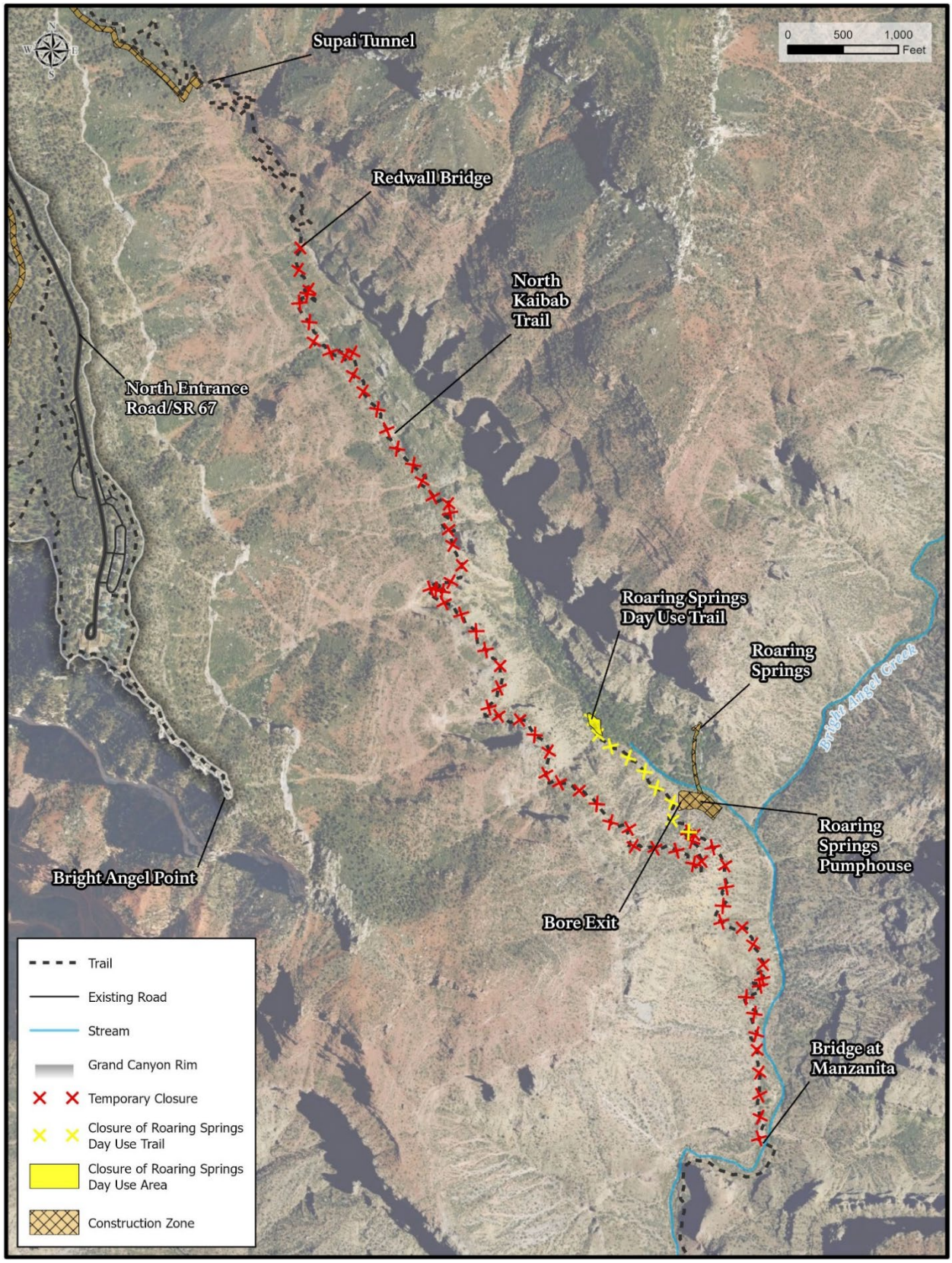


Figure 28: North Kaibab Closure from Redwall Bridge to Bridge at Manzanita

Road Traffic and Visitor Travel

Delivery of oversized equipment and materials could require intermittent traffic controls on North Entrance Road, including brief road closures or one-way traffic controlled by pilot cars and/or flaggers. Other construction traffic would lead to increased vehicles on North Rim roads, particularly North Entrance Road. Additionally, materials and equipment needed for inner canyon construction would be delivered to the South Rim staging areas via South Entrance Road, also resulting in increased construction traffic. These road restrictions and increased construction traffic could result in delays to motorists, but the impacts would be temporary. Extended or seasonal closures of North Entrance Road or other park roads are not anticipated under Alternative B; therefore, visitor access to the park would remain open.

In addition, utility installations across North Entrance Road would also require temporary restrictions, resulting in short-term delays for visitors traveling on the North Rim.

Helicopter Operations

Construction would require approximately 1,735 helicopter flights to transport personnel, equipment, and materials to remote work sites. Each flight would involve two flyovers (outbound and return), with each flyover lasting approximately 20 minutes. Helicopter operations would occur along established flight corridors connecting the South Rim and North Rim helibases and would generally be limited to between 8 a.m. and 5 p.m., except in limited circumstances. These flights would continue to contribute to recurring aircraft noise and visual presence, resulting in ongoing effects to visitor experience.

Within inner canyon, flight paths pass over or near high-use recreation areas and backcountry destinations. Visitors hiking the North Kaibab Trail would experience periodic short-duration noise and visual disturbance from helicopter transits, staging, and material delivery operations. The flight paths also pass over developed areas with high visitor use at both the North and South Rims. Visitors within approximately three miles of flight paths could experience intermittent overflights during construction.

Visitor perceptions of helicopter activity vary; therefore, helicopter-related impacts on visitor use are difficult to characterize as neutral or adverse. Some visitors may find helicopters noteworthy, while others may perceive them as detracting from their perceived experience of solitude, and natural soundscapes. These effects may be more noticeable in backcountry settings in the canyon than in the developed inner canyon corridor where anthropogenic features and activities are already present and common. Impacts would be intermittent and localized to flight paths and would not involve continuous helicopter activity at any single location (see *Soundscapes and Noise*). As such, it is likely that those visitors in backcountry areas outside development zones would expect a level of solitude and more natural soundscape; therefore, the presence of helicopters in these backcountry areas would likely have a negative effect on visitor experience.

Construction-related Noise and Visual Effects

Borehole drilling would require continuous 24-hour operations for an estimated two- to five-month period on the North Rim and two three-week periods at the bore exit sites near Roaring Springs Pumphouse. Continuous operations would necessitate nighttime lighting, operation of drilling equipment, and on-site staffing throughout the drilling period.

Nighttime lighting would be installed at borehole drill (entry) and exit sites to support safe operations. Lighting would be downcast and shielded to the extent practicable to reduce light spill beyond the immediate work area; however, the presence of artificial lighting would remain visible from nearby visitor use areas during nighttime hours. Lighting at the borehole entry and exit sites

would be visible from portions of the inner canyon corridor, adjacent trail segments, and some rim overlooks, particularly during periods of low ambient light. Lighting would also occur at contractor camps, but would be required to comply with backcountry rules and regulations, including "lights out" times.

In addition to lighting, the drill derrick—approximately 150 to 175 feet tall—would extend above the tree line and be visible from the surrounding terrain as far away as Grand Canyon Village during all hours. The derrick, associated equipment, and activity areas would introduce a prominent vertical industrial feature for the duration of drilling. Other construction activities would also produce temporary visual impacts due to the presence of construction machinery and general construction activities. These temporary visual intrusions would reduce perceptions of naturalness and undeveloped character during construction.

Noise generated by drilling equipment would persist continuously throughout the 24-hour drilling period (see *Soundscapes and Noise*). Additionally, other construction activities would also result in increased sound levels, but non-drilling activities would be restricted to daylight hours. Visitors on the North Rim during the daytime may not notice the noise above the ambient anthropogenic sound; however, people staying overnight may experience increased awareness of industrial activity and noise associated with drilling operations.

These nighttime lighting, noise, and visual effects would have temporary adverse impacts on the quality of visitors' experience but would cease following completion of construction. After drilling activities conclude, nighttime conditions would return to pre-construction conditions.

Facility Access and Visitor Services

Construction under Alternative B would not require closure of campgrounds, lodging, visitor centers, restaurants, retail facilities, ranger stations on the North Rim. Visitor services in the inner canyon corridor south of Roaring Springs Pumphouse, such as at Phantom Ranch, Cottonwood Campground, Bright Angel Campground, and Havasupai Gardens, would not be directly affected by the Proposed Action and would remain operational. However, access to these facilities would be temporarily disrupted by the Proposed Action due to trail closures, waiting periods, or other restrictions, which may complicate travel logistics for hikers and stock users, thereby temporarily adversely impacting visitor use.

Long-Term Visitor Use and Experience

Following completion of construction, all trails, roads, and other visitor facilities affected by construction would be fully reopened. Implementation of Alternative B would improve the long-term reliability of potable water delivery to visitor facilities on the North Rim and in the inner canyon down to Cottonwood Campground. This improvement would reduce the likelihood of emergency repairs, water restrictions, delayed seasonal openings, and recurring helicopter-supported maintenance and operation activities.

The new water treatment plant, water tanks, and other above-ground utilities and associated appurtenances would be new built features on the landscapes, altering the views experienced by visitors. However, these features would be in developed areas where similar infrastructure is already present, and finishes and materials would be designed to be compatible and blend with the surrounding structures and landscape. Tree removals would also impact visitor use by altering the setting and feeling in the areas affected by construction. See *Historic Districts* for more discussion on visual impacts from new built features and tree removals.

Summary
Compared to the No Action Alternative, Alternative B would result in short-term adverse effects to VUE; however, it would provide long-term beneficial effects by improving system reliability, reducing recurring disruptions, and supporting more consistent visitor services and experiences over time.

Past, Present, and Reasonably Foreseeable Actions and Collective Impacts

Past, present, and reasonably foreseeable actions that have and would continue to impact VUE are discussed under the No Action Alternative and are the same for the Proposed Action, with the following exceptions.

Closures of trails, including the Bridle Path, Roaring Springs Trail, and North Kaibab Trail, as well as construction noise, visual effects, and road restrictions would have a moderate, but temporary contribution to the collective adverse impacts to VUE during construction. Visual and audible intrusions from the borehole drilling would have a temporary contribution to the collective adverse impacts to VUE over the three- to five-month construction period on the North Rim and two three-week periods in Roaring Springs Canyon.

Visual and audible effects generated by the helicopter flights that are required to construct the Proposed Action would have a temporary contribution to the collective adverse impacts to VUE over the two-year construction period in the inner canyon.

Upon completion of the Proposed Action, substantially less recurring operational flights and closures would be needed to operate and maintain the new North Rim water systems when compared to the existing, deteriorated system. As such, the Proposed Action would contribute to the collective long-term, beneficial impacts to VUE resulting from fewer helicopter flights and closures.

In summary, when considered collectively with past, present, and reasonably foreseeable actions, construction of the Proposed Action would have temporary contributions to collective adverse VUE impacts during construction. Upon completion of the Proposed Action, the project would contribute to the collective long-term, beneficial VUE impacts resulting from less flights being required to operate and maintain the improved North Rim water system and improved water reliability.

Appendix A: Alternatives and Alternative Elements Considered and Dismissed

This appendix summarizes alternatives and design elements (alternative elements) that were considered during planning but were dismissed from further analysis in this EA. These include both full alternative concepts and specific design-level components related to the Proposed Action that were evaluated but dismissed.

While the full alternatives analyzed in detail are presented in Chapter 2, this appendix provides additional context on other approaches and elements that were considered during project development but ultimately eliminated from detailed study.

The purpose of including this information is to demonstrate that a range of options was evaluated, consistent with NEPA requirements, and to provide transparency about the decision-making process.

Boring/Drilling Alternative Elements

Bottom-Up Directional Drilling

Bottom-up directional drilling alternative elements would place the borehole drill site within the inner canyon and the bore exit on the North Rim; as such, these alternatives involve placing a drill rig within the inner canyon.

Directional drilling rigs that would be used for a project such as this weigh at least 70,000 pounds, with some exceeding 100,000 pounds. This weight greatly exceeds the lifting capacity of the most readily available heavy-lift helicopter, a Chinook, which has a capacity of 18,000 pounds. Therefore, any directional drilling rigs that could be flown into the canyon would be substantially undersized and likely unable to complete the drilling and pipeline installation.

Additionally, a relatively flat and open space of at least 250 feet long by 250 feet wide is typically required for directional drilling rig sizes appropriate for a project such as this. Spaces of this size and topography are extremely limited within the inner canyon. As such, grading would likely need to occur to create a flat space, or, where a sufficiently sized flat space already exists, extensive vegetation removal would be required to accommodate a drill rig. Alternatives that place a directional drilling rig within the inner canyon would have much greater impacts on park resources compared to drill rigs above the rim. For example, noise impacts from machinery would be substantially more disruptive to visitors, wildlife, and proposed wilderness because baseline noise levels are lower in the inner canyon than in developed areas on the rim.

Because equipment staging in the inner canyon is limited by topography and helicopter lift capacities, and because drilling in the inner canyon would cause additional environmental impacts, bottom-up drilling methods and other alternative elements involving drilling from the inner canyon were dismissed from further consideration as nonviable installation methods for this project.

Horizontal Directional Drilling

Horizontal Directional Drilling (HDD) is a method commonly used to install pipelines two to 48 inches in diameter along relatively shallow and long alignments (often less than 50 feet deep and more than 300 feet long). For bores using HDD and exceeding 6,000 feet long, it is typical to use the intersect method, which involves drilling from both directions until the drills meet at the midpoint of

the bore alignment. This would require mobilization of drill rigs on the North Rim and within Roaring Springs Canyon.

As noted under the Bottom-Up Directional Drilling Alternative, any option requiring a drill rig in the inner canyon has been deemed nonviable. This alternative element was also dismissed because HDD is generally suited for shallow alignments and would not effectively achieve the drilling proposed for this project. Based on these reasons, this alternative element was dismissed from further analysis.

Bore Entry (Drill Site) Locations

Bore Entry Near North Rim Water Tanks

This bore entry site would be located along the west side of Bridle Path and North Entrance Road, across from the existing water tanks. While this bore entry location would result in the shortest length of open-cut trenching on the rim to install pipelines (approximately 700 linear feet), it was dismissed because it would require the longest distance of directional drilling (approximately 12,950 linear feet)[1], thus carrying the highest risk of unsuccessful boring. These risks are described below.

In addition to the length of drilling, most of the borehole alignment is closer to the face of the canyon wall, where less competent subsurface material is present. The geophysical report prepared for this project states that "the difference in competence may be related to weathering, as the areas of weaker competence appear closer to the cliff face and exposed surfaces" (GEI Consultants, 2025). Based on this, the proximity of this borehole alignment to the canyon wall increases the risk of losing circulation (drilling fluid) through voids and raises general concerns about borehole stability due to weaker competence of subsurface materials closer to the canyon wall.

This alternative element would also require the longest distance through the Bright Angel Shale. Shale poses increased challenges during drilling because it is more prone to swelling, fracturing under high pressures, and results in a less stable borehole.

As drilling length increases, torsional, compressive, and tensile forces to advance drilling and install casing and pipes also increase. Due to the length of this alignment, this alternative element would experience the greatest equipment and material stresses compared with other alternative elements, resulting in a higher potential for damaging drilling equipment, casing, and pipes.

This alternative element would require the greatest length of horizontal drilling, which increases the risk of complications, such as reduced ability to steer the drill bit, clear cuttings from the borehole, and maintain borehole stability. These risks are further exacerbated when drilling through dissolution cavities, which are more likely to be present near canyon walls due to the presence of less competent rock.

Because this bore entry site is along the Bridle Path and North Entrance Road, the short-term visual and noise disturbances from active construction and long-term visual disturbances due to tree removals would be more noticeable and readily experienced by visitors compared to the Proposed Action. In addition, this location would require closing at least a 300-foot-long section of Bridle Path for the duration of drilling (estimated at 15 weeks), necessitating lengthy detours for the same period.

Based on these factors, this alternative element was dismissed from further consideration.

[1] For reference, the Proposed Action would trench approximately 5,600 feet on the rim to install waterlines and directionally drill approximately 9,320 linear feet.

The proposed WTP site was also considered as a potential bore entry site because it would already be disturbed by WTP construction activities. However, it was dismissed for those reasons described above and because the available area (approximately 2.7 acres) is not large enough to accommodate drilling operations and would require the area to be fully cleared of trees.

Bore Entry at the North Rim Visitor Center/Grand Canyon Lodge Parking Lot

This bore entry location would require the longest distance of open-cut trenching on the rim to install pipelines to the proposed WTP (roughly 7,000 linear feet), and the shortest distance of directional drilling (about 7,635 linear feet) (see footnote 1 above for a comparison to the Proposed Action).

This bore entry location was dismissed due to anticipated adverse effects on the Grand Canyon Lodge National Historic Landmark District (NHLD). Construction would require grading and removing all trees, medians, curbs, and landscaping in the parking lot, which contributes to the district's historic character. This alternative element would also substantially reduce available visitor parking in the primary parking lot on the entire Bright Angel Peninsula during construction. This location also poses a higher risk of borehole failure due to its proximity to the canyon wall, similar to the *Bore Entry Near North Rim Water Tanks* alternative element described above. Additionally, this drilling site is within approximately 150 feet of the canyon wall and carries a higher risk of rockfalls being induced by drilling action and vibrations from the drill rig.

Bore Exit Locations

Bore Exit at Redwall Bridge

Under this alternative element, the boreholes would exit at the Redwall Bridge in the inner canyon, and the remaining length of pipelines between the Redwall Bridge and Roaring Springs Pumphouse (approximately 1.2 miles) would be surface mounted. While this alternative element reduces the distance of surface-mounted waterlines compared with the existing waterline, the 1.2-mile segment of surface mounted pipelines would remain vulnerable to rockfalls and freezing. This segment would also traverse extreme terrain, increasing the difficulty of installation and future maintenance. Additionally, the alternative element would require more surface ground disturbance and vegetation removal in the inner canyon for waterline installation. Based on these factors, this alternative element does not meet the project's purpose and need, and it has been dismissed from further evaluation.

Bore Exit at Roaring Springs Day Use Area

Under this alternative element, the boreholes would exit at the Roaring Springs Day Use Area. From the day use area, the water pipelines would be installed by surface mounting and trenching either following the Roaring Springs Trail or the existing pipeline alignment that parallels the east side of Roaring Creek.

While routing the waterlines in the Roaring Springs Trail minimizes the amount of surface-mounted waterlines, this option was dismissed because major trail improvements, including widening and structural reinforcement, would be required to allow trenching. The trail is narrow (approximately 2 feet wide,) and surrounded by steep slopes on both sides. This would result in substantially increased ground disturbance compared to the Proposed Action.

The option to route the waterlines along the existing pipeline alignment by Roaring Creek was dismissed because this entire segment would be surface mounted, requiring multiple crossings of seeps and springs associated with Roaring Springs and causing increased ground disturbance and vegetation removal along the creek. It was also dismissed because it does not fully address the risk of

local geologic and hydrologic forces and freezing concerns due to it being surface mounted, and therefore does not meet the project's purpose and need.

Co-locate Raw and Potable Water Pipelines and Fiber Optic in a Single Borehole

This alternative element would collocate the raw and potable water pipelines and fiber optic conduit as a "bundle" in a single borehole. The bore entry and exit sites would be the same as under the Proposed Action. The borehole would range from 36 inches in diameter at the entry to 12 inches in diameter at the exit and would be cased. This alternative element was dismissed due to solicitation and constructability concerns, including:

- The borehole size (36 inch in diameter) is atypical/non-standard and would require larger drilling equipment and tools than are readily available in the oil and gas market.
    - Custom-made drilling tools would be required.
        - A longer delivery schedule, potentially more than a year, would be needed to obtain the necessary drilling tools and equipment.
    - The pool of qualified and available contractors for drilling would be limited, increasing the risk of few or no bids, which could prevent project implementation.
- Risk of failed utility installation into borehole due to binding and twisting of utility lines during installation, which would render the utility lines unusable. If installation fails, utilities would need to be removed and reinstalled; if that fails, the borehole would have to be redrilled, or other options would need to be considered or reconsidered (such as surface mounting), thus greatly impacting the project schedule.
- If utility installation is successful, they would be cemented in place, preventing retrieval and making future maintenance, repair, or replacement impractical.

Seasonal Restriction for Drilling

While not an alternative element itself, consideration was given to restricting the drilling period to roughly October through March to minimize impacts to visitors and wildlife. This approach was ultimately dismissed because imposing seasonal restrictions would reduce flexibility for a drilling contractor, making the project less attractive to potential bidders and very likely limiting the pool of interested contractors. This could result in few or no bids on the contract, necessitating multiple contract solicitations and substantially delaying the project while also increasing costs.

Allowing a contractor year-round drilling flexibility is especially important considering the North Rim's remoteness and often-shortened construction season. Not restricting drilling to a specific time of year is expected to enable more timely completion of the boreholes and avoid multiple mobilization and demobilization efforts.

Water Source Alternatives

Wells

Introduction

Under this alternative, the water source for the North Rim, Supai Tunnel, Roaring Springs Pumphouse, Manzanita Rest Area, and Cottonwood Campground would come from two new wells drilled on the North Rim. The wells would generally be located in an area northwest of the Widforss Trailhead or near CC Hill. These wells would target the R-aquifer, located approximately 2,000 to 3,300 feet below ground surface (bgs), as it is anticipated to offer the most reliable groundwater

source. The R-aquifer is also the source of supply for Roaring Springs Cave. A raw water pipeline, along with necessary utilities such as electricity, would be trenched between the wells and a proposed WTP adjacent to the existing North Rim water storage tanks and the Emergency Services building.

This alternative was informed in part by previous investigations into North Rim wells, documented in two reports by Yeh and Associates, Inc. (2012 and 2015). The reports identified the R-aquifer in the general area northwest of the Widforss Trailhead as the most attractive groundwater target in the study area; however, they recommended further exploration if wells were to be pursued, including downhole testing (drilling test wells) and seismic reflection surveys at specific target locations identified in the reports.

Description of Alternative

This alternative would drill two test wells, each approximately 8 inches in diameter, to depths of at least 3,000 feet bgs. If viable, these test wells would be re-drilled to 30–36 inches in diameter, cased, and fitted with riser pipelines and submersible pumps. Well houses would be constructed to enclose necessary equipment, including surface pumps and electrical components, and a water storage tank would be installed at each well site. The facilities would be fenced for security. If the test wells are not viable, they would be capped and abandoned, the sites restored, and alternative water sources reconsidered. Drilling the wells would require clearing and leveling two separate sites, improving existing roads, and possibly constructing new access routes, resulting in additional tree removal and ground disturbance. Roads to the wells would likely need to be paved for winter access and maintenance. Additionally, a borehole would still occur under this alternative to provide water to inner canyon areas.

A raw water pipeline and other necessary utilities, such as electrical, would be installed between the wells and a new WTP, proposed to be located near the existing North Rim water storage tanks and the Emergency Services building. The pipeline would likely be installed using open-cut trenching but could incorporate trenchless methods, such as horizontal directional drilling (HDD), to reduce impacts. A minimum of 4,000 linear feet of pipeline would be required for wells near the Widforss Trailhead, and would be installed along existing roads, trails, or utility corridors to the extent possible. Overhead or underground electrical cabling would also be installed between the wells and the proposed WTP, and would attempt to follow the raw water pipeline route as feasible. The construction zone is assumed to be 40 feet wide, the same width used for Waterline Area 1 under the Proposed Action, resulting in a minimum of approximately 3.7 acres of impact. These installations would increase tree removal and ground disturbance.

To supply water to the inner canyon locations of Roaring Springs Pumphouse, Manzanita Rest Area, and Cottonwood Campground, a new potable waterline would be installed via borehole from the North Rim. The bore entry and exit sites would be the same as those described in the Proposed Action. A new potable waterline would also be installed between the bore entry site and the proposed WTP, following the same alignment and using the same construction zone described in the Proposed Action. Supai Tunnel would receive potable water either through reuse of the existing North Rim waterline or construction of a new parallel waterline. Portions of the existing line not reused would be abandoned in place. Separate drill rigs would be required to drill the wells and the borehole, increasing costs. Because this alternative involves three separate drill sites, as well as pipeline installation between the wells and WTP and between the WTP and bore entry site, the extent of tree removal and ground disturbance would be substantially greater than under the Proposed Action.

This alternative also includes constructing a new WTP near the existing water tanks, as described in the Proposed Action. Pumping operations at Roaring Springs Pumphouse would cease, but the

building would be rehabilitated for other uses. Roaring Springs Cave would be decommissioned as a water source, allowing natural water flows to resume. This would increase flows in Roaring Springs, Roaring Creek, and Bright Angel Creek.

A sub-alternative was considered that would eliminate the borehole and retain Roaring Springs Cave as the water source for the inner canyon locations of Roaring Springs Pumphouse, Manzanita Rest Area, and Cottonwood Campground. Under this sub-alternative, the new wells would serve only the North Rim and Supai Tunnel, while Roaring Springs Cave would continue supplying Roaring Springs Pumphouse, Manzanita, and Cottonwood. Water treatment for the inner canyon would consist of a small filtration and disinfection system at Roaring Springs Pumphouse. However, this sub-alternative was dismissed, along with other options involving full water treatment at Roaring Springs Pumphouse (see the *Full Water Treatment at Roaring Springs Pumphouse* section below).

Reasons for Dismissal

This alternative was dismissed from further consideration due to a combination of technical, operational, and environmental concerns:

- Hydrogeological Limitations
    - Groundwater in the targeted formations is stored in isolated fractures and dissolution cavities, resulting in limited pore pressure and low hydrostatic head (H. Chambless, Hydrologist, personal communication, January 16, 2025a). High-powered, specialized pumps would be required to draw water from the R-aquifer, as described further below.
- High Uncertainty and Risk
    - Groundwater availability and well performance in faulted terrain are unpredictable, as faults may act as barriers or conduits.
    - Yeh and Associates (2015) emphasized the difficulty in estimating water yields in the study area without nearby drill hole data.
    - Test wells might not encounter an aquifer or other water source that would yield the required quantity of water, requiring either additional test wells or consideration of alternative water sources.
    - Well productivity could decline over time depending on aquifer characteristics or due to mechanical degradation of the wells themselves, such as from calcification or iron plugging.
- Operational Complexity and Cost
    - Annual operations and maintenance activities would include wellhead protection, testing, monitoring of production data, and equipment inspection and maintenance.
    - Major operations and maintenance activities would occur every three to five years or when production declines more than 25 percent and would include acidification and mechanical scrubbing.
    - Specialty submersible pumps would need to be installed in the wells at depths of 2,000–3,300 feet and serviced every five years. Each pump would be approximately 28 feet tall, weigh over 200,000 pounds (including the weight of the associated drop pipe assembly), and cost over $1 million to procure (excluding installation). Only one vendor, located overseas, was identified as capable of providing a suitable pump for the proposed wells.
    - Servicing would require a drill rig with a 100-foot-tall derrick to pull the riser pipelines and pumps from the wells. Each maintenance event could take two to three weeks.

Pumps would need to be serviced on a staggered schedule to maintain at least one operational well.
    - The North Rim experiences high turbidity during snowmelt and runoff, which increases the potential of pump damage and could raise maintenance frequency.
    - If offsite servicing of the pumps is required, the well and pump could remain offline for an extended period, placing all water supply reliance on the remaining well.
- Access Requirements
    - The wells must be accessible year-round; however, heavy snow accumulation often makes the proposed well areas difficult to reach. Snow maintenance would be necessary on currently unmaintained roads, requiring additional staffing during winter months.
    - The park frequently experiences staffing shortages on the remote North Rim, creating a risk that appropriate winter staffing levels may not be met to keep the roads maintained for access.
- Environmental Effects
    - This alternative would be expected to have environmental impacts that substantially exceed those under the Proposed Action. These impacts include constructing new utility infrastructure and facilities in undeveloped areas, tree removal, and disturbance to surface and subsurface resources (such as archaeological sites and karst features). These impacts result from the need for three separate drill sites and utility installations between the wells and the proposed WTP and between the WTP and the bore entry site.
- Uncertain Effects on Roaring Springs Cave
    - Extracting water from the R-aquifer could affect flow at Roaring Springs Cave, though impacts are not fully understood.

Given the above factors, this alternative and its sub-alternative were dismissed from further consideration.

Bright Angel Creek Intake

Under this alternative, the water source for the North Rim, Supai Tunnel, Manzanita Rest Area, and Cottonwood Campground would be the new water intake constructed in Bright Angel Creek at the Phantom Ranch delta as part of the TCWL replacement project. Roaring Springs Cave would be decommissioned as a water source and water flows from the cave would return to natural conditions.

Water would be treated at the new Phantom Ranch WTP, which is also being constructed under the TCWL replacement project, and pumped to the inner canyon demand points north of Phantom Ranch. Roaring Springs Pumphouse would pump the treated water to the North Rim via new waterlines placed in boreholes drilled between the North Rim and Roaring Springs Pumphouse. The bore entry and exit sites would be the same as the Proposed Action.

This alternative was dismissed for several reasons. This alternative would require resizing the Phantom Ranch WTP, which is currently under construction as part of the TCWL project, to meet the additional water treatment demands associated with supplying potable water to the North Rim. Additionally, the existing WWTP at Phantom Ranch would need to be resized. Resizing these facilities would increase environmental effects and substantially delay the TCWL project, resulting in greatly increased costs. In addition, this alternative would require replacing the TCWL segment

within "The Box[2]" area of the inner canyon. However, under the TCWL project and associated Environmental Assessment, the decision was made to abandon the TCWL section within The Box and change the TCWL intake to Bright Angel Creek. This decision was made for various reasons, including:

- **Frequent Breaks and Failures:** The section of pipeline within The Box experiences the most breaks and failures compared to any other reach. This section has low resiliency due to natural site hazards such as flooding, channel migration, slope instability, and rockfall. These challenges would persist, albeit potentially with less frequency, even if this section of pipeline were replaced.
- **Difficult Repairs:** Waterline repairs within The Box are challenging and hazardous due to the steep, rugged terrain and difficult access. Repairs almost always require helicopter support and occasionally technical climbing or rappelling. Furthermore, the box presents hazardous flying conditions caused by its terrain and microclimate, further complicating repairs. These factors lead to slow repair times, extended service outages, and increased costs.
- **Construction Risks:** Replacing the pipeline in The Box would lead to increased construction risks due to the length of pipeline needing replacement, difficult terrain for access and construction, and increased exposure risk for workers due to rough terrain and high temperatures.
- **Environmental Impacts:** Replacing approximately seven to eight miles of pipeline through The Box would increase environmental impacts compared to the Proposed Action. Replacement would require crossing numerous drainages that flow into Bright Angel Creek, increasing wetland and channel impacts. It would also affect known archaeological sites, cause additional ground disturbance and vegetation clearing, and impact visitors due to extended closures of the North Kaibab Trail through The Box during construction.

Based on the above factors, this alternative has been dismissed from further consideration.

Replace Waterline with a New Surface Mounted Waterline within the Existing Corridor

This alternative would replace the North Rim waterline within the existing pipeline corridor. Same as the existing waterline, the replacement waterline would be installed at grade using supports and anchors. The new waterline would be essentially the same as the existing one, except it would use a 4-inch-diameter Flexsteel pipe or another improved pipe material. The new waterline would provide a similar capacity as the existing.

Under this alternative, the surface-mounted waterline would still be vulnerable to rock falls and freezing temperatures. Emergency repairs would continue to be needed for breaks caused by rock falls. Maintenance and repair activities would continue to require helicopter support and encounter hazards due to the terrain. Water restrictions at the North Rim, and potentially within the inner canyon from Supai Tunnel to Cottonwood Campground (depending on the inner canyon potable water solution, see below), would continue to be required during waterline breaks and repairs. Water would not be pumped to the North Rim during winter months because of the potential for the pipeline to freeze.

[2] The Box is a deep, narrow section of the North Kaibab Trail generally located between the north end of Phantom Ranch and extending to about two miles south of Ribbon Falls. It is called The Box for the canyon walls that tower over the trail, enclosing the hiker in a narrow passage of granite and schist. This can be the hottest section on the North Kaibab Trail, with temperatures often exceeding 120 degrees Fahrenheit in the shade. (https://www.nps.gov/media/video/view.htm?id=B01C9B26-6E27-41A0-866B-839174539320)

To continue providing potable water to Manzanita Rest Area and Cottonwood Campground, either an additional water pipeline would be surface mounted in the existing corridor to back-feed potable water from the North Rim water tanks to these inner canyon sites, or a treatment system would be installed at Roaring Springs Pumphouse to meet inner canyon potable water needs. The additional surface-mounted waterline would be subject to the same vulnerabilities as the existing waterline described above, and options to provide full water treatment at Roaring Springs Pumphouse have been dismissed from further consideration (see *Full Water Treatment at Roaring Springs Pumphouse* section below).

This alternative element was dismissed because the current pipeline is exposed, which has led to multiple breaks each year from geologic processes and freezing. Additionally, this alternative element does not resolve the purpose and need for the project.

Full Water Treatment at Roaring Springs Pumphouse

Under this alternative element, water for the inner canyon would be treated at Roaring Springs Pumphouse. The Roaring Springs Pumphouse interior would be reconfigured to accommodate an upgraded water treatment system and processes, including new equipment. Water treatment would likely consist of a bag and cartridge filtration system. In general, options under this alternative would only pump raw water to the North Rim to be treated at the proposed North Rim WTP, and this treated water would not be back-fed to the inner canyon. As a result, no potable water pipeline would be installed between the North Rim and Roaring Springs Pumphouse. The pipeline between Roaring Springs Cave and Roaring Springs Pumphouse would continue to provide raw water to the pumphouse for treatment.

All alternatives involving full water treatment at Roaring Springs Pumphouse were dismissed for the following reasons:

- **Higher Long-Term Costs:** Increasing operations and maintenance at the remote site of Roaring Springs Pumphouse does not meet the project's purpose and need and would be substantially more expensive in the long-term when compared to a treatment facility on the North Rim.
- **No Reduction in Helicopter Flights:** This alternative would not reduce long-term/recurring helicopter flights needed for deliveries (such as filters and water treatment chemicals), operations, and maintenance.
    - It is estimated that at least three round-trip flights would be needed twice per month (72 round-trip flights per year) for operation and maintenance of the water treatment system at Roaring Springs Pumphouse. These flights include one trip to transport staff to the pumphouse, one trip for materials and equipment transport, and one trip to return staff to the rim.
    - **Shared Helicopter Resources**: Park helicopters are shared among all park divisions and are not dedicated solely to the water system operations. Scheduled flights for the water treatment system at the pumphouse could be delayed by search and rescue incidents, weather, or other scheduling conflicts.
    - **Visitor and Wilderness Impacts:** Compared to the Proposed Action, increased, long-term helicopter flights to Roaring Springs Pumphouse would be expected to increase adverse impacts to visitor experience, wilderness character, and soundscapes.
- **Additional Permitting and Monitoring:** ADEQ permitting and associated water quality monitoring would be required for this water treatment system, in addition to the permitting

and monitoring required for the proposed North Rim WTP. Water quality sampling is time sensitive and requires helicopter transport, potentially adding flights beyond those already estimated.

- **Future Uncertainty:** If Roaring Springs Cave is reclassified as surface water or groundwater under direct influence of surface water, a surface-water treatment system would not fit within Roaring Springs Pumphouse. At that point, other alternatives, such as expanding the pumphouse or constructing a new WTP on the North Rim would need to be considered. Construction costs in the inner canyon are substantially higher than on the North Rim.

Potable Water Supply to Supai Tunnel Facilities

Reuse Existing North Rim Waterline to Convey Water to Supai Tunnel

Under this alternative element, the existing North Rim Waterline would be used to convey potable water from the North Rim water storage tanks to the Supai Tunnel facilities. Minor improvements could be made to improve stabilization and structural supports.

This alternative element was dismissed because the existing pipeline, which is sized to pump water from Roaring Springs Pumphouse to the North Rim, would be considerably oversized for the water demand at Supai Tunnel. As such, the water would not cycle frequently enough, leading to water quality issues. These issues could only be resolved by a substantial flushing of the waterline and installing a supplemental disinfection system at Supai Tunnel. The amount of water that would need to be flushed to maintain water quality makes this option unsustainable. In addition, the flushing and additional disinfection system at Supai Tunnel would increase maintenance and operations at a remote inner canyon site, which does not align with the project's purpose and need and would be substantially more costly over the long term.

Slip-line the Existing North Rim Waterline between the North Rim and Supai Tunnel

This alternative would supply potable water to Supai Tunnel by slip-lining the existing North Rim waterline between the North Rim water storage tanks and Supai Tunnel. Slip-lining involves inserting a smaller-diameter pipe into an existing pipe. This alternative was dismissed because the existing pipeline's diameter is too small to accommodate the required pipe material, Flexsteel (or similar), for the slip-lining. Flexsteel would be required due to the bends in the existing pipeline and the need for the inner pipe to be self-supporting. Based on this, slip-lining is not considered a viable alternative.

Roaring Springs Cave to Roaring Springs Pumphouse Parallel Pipeline

This alternative element would install a new raw water pipeline parallel to the existing waterline between Roaring Springs Cave and Roaring Springs Pumphouse. This alternative was dismissed because observations of the pipeline's exterior show that it is in good condition and not in need of full replacement. Additionally, this alternative element would increase the construction zone from 30 feet wide to 60 feet wide, resulting in additional vegetation removal and ground disturbance compared to the Proposed Action. Although this alternative element has been dismissed at this time, this pipeline segment will be inspected in the future to confirm whether the pipe's interior is also in good condition. If inspection shows the pipeline is in need of replacement, this alternative will be reconsidered and reviewed through NEPA in the future, as needed.

Appendix B: Mitigation Measures and Best Management Practices

The following mitigation measures and best management practices would be implemented during the project to minimize the degree and/or extent of adverse impacts.

Air Quality

- The Contractor will control fugitive dust using best practices and other control measures, such as through water application and covering soil stockpiles.

Construction, General

- The Contractor will rehabilitate all areas disturbed by construction activities, including raking/scarifying compacted soils, repairing ruts/tracks left by vehicles, recontouring soil to pre-disturbance conditions, hydroseeding, mulching or other soil stabilization measures, and removing debris, detritus, spoils, waste, etc.
- The Contractor will clean project sites at the end of each workday, including disposing of/securing trash, debris, scrap materials, etc. Park staff may conduct periodic spot-checks to ensure adequate project clean-up measures are being appropriately undertaken. If deficiencies are noted, the Contractor must address them as soon as feasible.
- The Contractor will follow all backcountry rules and regulations and Leave No Trace principles (https://lnt.org/why/7-principles/) for work and construction camps.
- The Contractor is required to have a site-specific safety plan and spill/leakage plan in place prior to construction activities. The Contractor will follow the park's protocol for spills and leaks related to vehicles, equipment, and machinery.

Historic, Tribal, and Cultural Resources

- All mitigation measures developed as part of the project-specific Section 106 Programmatic Agreement (PA) will be followed in coordination with the park's NHPA Specialist and, as needed, other cultural resource team members.
- The contractor will make all attempts to avoid impacts to historic rock walls, curbing, edging, flagstone, etc. (such as along trails, sidewalks, parking lots, or roads). If these features must be disturbed, the contractor will not perform this work until the Project Lead has coordinated with the park's Cultural Resources Program Manager. The Project Lead will coordinate with the park's Cultural Resources Program Manager well in advance of any disturbance to these historic features to determine if mitigation will be needed, and will also coordinate prior to and during restoration/rehabilitation. Mitigation could include using construction mats to protect the resource, or numbering/mapping rocks so they can be reinstalled at the same locations upon completion of work.
- The Contractor will take appropriate measures to preserve and protect all historic buildings and structures in the project area, except those approved for removal in the project construction document drawings, in accordance with The Secretary of the Interior's Standards for the Treatment of Historic Properties - Technical Preservation Services (U.S. National Park Service).
- The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes and Director's Order 28: Cultural Resources Management, will be followed for this project.

- In the event that human remains, funerary objects, sacred objects, or objects of cultural patrimony are encountered during construction, provisions outlined in the Native American Graves Protection and Repatriation Act, Agreement and the park's 2022 Monitoring and Discovery Plan, and the park's Memorandum of Agreement Regarding Collections, Inadvertent Discovery, and Intentional Excavation of Native American Human Remains, Funerary Objects, Sacred Objects, and Objects of Cultural Patrimony will be followed. If these remains or objects are encountered, a park cultural resource specialist will be contacted immediately and the Contractor will cease all project activities in the vicinity of the encounter until the remains/objects are evaluated, consultation with the State Historic Preservation Office and/or Tribes are completed, a mitigation plan is in place, and mitigation is completed. The Contractor will not resume project activities in the vicinity of the encounter until authorized by the park's Cultural Resources Program Manager. Depending on the nature and extent of the encounter, work may proceed in other areas free of these remains/objects, as allowed by the park's Cultural Resources Program Manager.
- If a tribe(s) request a tribal resource monitor, the Project Lead, in consultation with the park's NHPA specialist and Tribal Program Office, will coordinate with the tribe(s) to identify what types or locations of work require a tribal monitor. The Project Lead will ensure the tribal monitor is invited to be on site when that work is occurring. The Contractor may be required to adjust their work schedule, as reasonable, to accommodate tribal monitors.
- Archaeologists assigned to the project will meet the Secretary of the Interior Qualification for the profession. Except when environmental conditions, such as bedrock, indicate that monitoring is not necessary, all other ground disturbance, such as excavation or grading, will be monitored.
- The finishes and colors of structures (e.g., buildings, equipment enclosures, tanks, etc.) would be coordinated with and accepted by the park's cultural resources team (Historical Architect, Cultural Resources Program Manager and NHPA Specialist), other applicable park staff, and, if needed, SHPO, to ensure compatibility with their surroundings.
- The Contractor will protect the historic North Rim pump shed (FMSS ID 241476) during construction activities.

Karst and Hydrogeology

Risks to karsts and hydrogeology will be monitored throughout the drilling process. A park monitor may be required to be onsite during drilling activities.

Paleontology

- The park's Physical Science Program will train contractor staff or other project resource monitors to identify paleontological resources.
- The Contractor will conduct construction activities in a way that will not damage or move inventoried paleontological resources. For any known (inventoried) paleontological occurrences, or when a certain site may yield paleontological resources, the contractor will avoid disturbing the site if feasible, or if necessary, the resources will be moved or collected by a park paleontologist before work in that area begins.

  If previously unknown paleontological resources are encountered during project activities, the Contractor will take all necessary steps to protect them, including potentially pausing construction in the vicinity of the resource, and will immediately notify the park's Physical Sciences Program Manager so that an appropriate mitigation strategy can be developed and implemented.

- A park paleontologist will conduct surface assessments prior to construction in areas identified by the park as potentially containing paleontological resources.
- Paleontological monitoring would occur for ground disturbing activities in the Roaring Springs and Manzanita areas, specifically within the Tapeats, Bright Angel, and Muav geological formations.

Resources, General

- The Contractor will confine all project activities to the construction, staging area, and construction camp boundaries as shown on the project construction document drawings. These project boundaries will be clearly demarcated in the field using appropriate methods (e.g., flagging, fencing, etc.). Any requests by the Contractor to modify the project location (e.g., changes to construction, staging area, or contractor camp boundaries, etc.), scope, or timing (e.g., changing work from non-visitor season to visitor season) of project elements will be subject to additional environmental reviews. The Contractor will not proceed with the proposed modifications until necessary environmental reviews, surveys, permits, etc. are completed and clearance is granted by NPS.
- Any sensitive resource areas (e.g., archaeological sites, paleontological sites, etc.) within or near the project limits will be marked in the field for avoidance by qualified park resource specialists with flagging, fencing, or taping. (Please note that all archaeological sites require a 16 feet (5 meter) buffer, and the flagging, fencing, or taping will reflect that buffer.)
- If additional resource surveys (e.g., archaeological, paleontological, vegetation, etc.) are needed in project areas, the Contractor will not perform work in or otherwise use those areas until the surveys are completed and the park's applicable resource Program Manager gives clearance to proceed.
- When resource monitors (e.g., archeological, paleontological, etc.) are required for certain work, the Contractor will not proceed with that work without the required monitors being present, unless otherwise allowed by the applicable park resource Program Manager. It is the sole discretion of the park's resource Program Managers to determine if certain work may proceed without the applicable resource monitor onsite.
- As directed by the park, any sensitive resource areas, such as archaeological, paleontological, or rare/T&E species sites, within or near the project limits will be marked on design drawings as "Sensitive Resource Area - do not enter or disturb."
- The contractor will avoid areas marked as sensitive resource areas on the plans or in the field.
- The Contractor will be required, as directed by NPS, to use construction/equipment mats or similar in saturated areas or in sensitive resource areas.
- The Project Lead is responsible for notifying the NEPA Lead and applicable subject matter experts of any proposed project changes, including changes to the project location (e.g., limits of construction), scope, or timing, to determine if further environmental reviews are required. The Project Lead will ensure the Contractor does not proceed with proposed.
- The Project Lead will coordinate with the NEPA Lead and park subject matter experts to ensure that applicable mitigation measures, BMPs, and other stipulations that are the responsibility of the Contractor are incorporated into the project contract, specifications, drawings, etc. as appropriate.
- The Contractor will implement erosion and sediment control measures to aid in soil stability and prevent runoff and sediment discharges, particularly into wetlands and waterways or other sensitive resource areas. This includes implementing these measures within the limits of construction, as well as at staging areas and contractor camps, as directed by NPS.

- The Contractor must follow all conditions, stipulations, etc. of any Clean Water Act (CWA) Section 404, CWA Section 401, Rivers and Harbors Act Section 10, Endangered Species Act, or other similar environmental permits (e.g., Migratory Bird Treaty Act of 1918) that are required for the project.
- At the conclusion of the project, the Contractor will restore and return areas of ground disturbance, including trails, temporary trails/trail re-routes, sidewalks, roads, trail/sidewalk/road features (e.g., rock walls, curbing, etc.), parking lots, unpaved/undeveloped surfaces (e.g., soils), staging areas, and contractor camps, as close as possible to their pre-disturbance condition or better.

Socioeconomics

- The Contractor, through the Project Lead, will notify the park's Commercial Services Division at least 18 months ahead of any activities that would result in the suspension of concessioners' contractually required services, which consist of lodging, food and beverage, retail, service station, interpretive bus tours, visitor shuttle, and public showers, laundry, vending, and mule rides. The contractor will provide a plan that outlines and assigns timelines for project activities that would result in the suspension of concessioner's contractually required services.

Soundscapes and Noise

- Where practicable, the Contractor will use construction machinery, equipment, tools, etc. that do not exceed 60 dBA at 50 feet per the NPS Audio Disturbances Rule (36 CFR 2.12). The Contractor would use quiet technology equipment, as well as noise enclosures, silencers, and/or other noise-mitigating/attenuation devices for construction equipment/machinery, particularly for generators, pumps, compressors, and shaker/suction tanks. This is particularly important for inner canyon project areas and rim areas in proximity to visitor use facilities/areas.
- To reduce helicopter noise impacts to wildlife, visitors, soundscapes, and natural or wilderness characteristics, helicopters will make every effort to maintain a minimum 2,000-foot altitude where possible, per Federal Aviation Administration (FAA) Advisory Circular 91-36D Visual Flight Rules (VFR) Flight Near Noise-Sensitive Areas. Exceptions include during takeoff, landing, picking up/dropping off sling loads, when instructed otherwise by air traffic control, or where an altitude of less than 2,000 feet above ground level (AGL) is considered necessary to operate safely. The 2,000-foot altitude should be set using the highest terrain within 2,000 feet AGL laterally of the route of flight or the uppermost rim of the canyon.
- Project helicopter use will generally not be allowed between 5:00 PM (power off) and 8:00 AM (power on), except in limited circumstances and as approved by NPS. If flights are required between 5:00 PM and 8:00 AM, the project lead and contractor must coordinate with the Park Aviation Manager and the South Rim Helibase in advance.
- Flights will be minimized by combining material transport with other transport missions to the extent possible.
- To the extent possible, all flight loads will be arranged to minimize the total number of flights required.
- To the extent possible, personnel and gear/equipment/tools will be combined on flights to minimize the number of flights.

- The Contractor is required to use a quiet technology (as defined in NPS Aviation Reference Manual 60), light lift helicopter(s) for project operations, unless it can be demonstrated that quiet technology aircraft will not meet the needs of project aviation operations that require light lift helicopters. NPS Aviation Reference Manual 60 defines quiet technology as aircraft utilizing technological improvements that result in a "quieter" aircraft as opposed to the definition used by the Federal Aviation Administration (FAA) which calculates quiet technology based on the overall noise level of the aircraft divided by the number of passenger seats. Medium lift helicopters to be used for project operations will be, to the maximum extent practicable, the quietest aircraft available and/or be quiet technology aircraft.
- Helicopter pilots will be encouraged to use maneuvers that produce less noise, wherever possible, according to the Fly Neighborly training available at https://go.usa.gov/xQPCW and https://www.rotor.org/operations/flyneighborly.aspx.
- All equipment, machinery, materials, etc. for project components occurring on the North Rim will be trucked directly to the North Rim to minimize helicopter flights and associated noise impacts. Only equipment, machinery, materials, etc. for inner canyon construction will be hauled to the South Rim to be transported by helicopter to the inner canyon project site.

Vegetation and Soils

- The Contractor will mark in the field (e.g., through flagging, fencing, etc.) trees to be removed and protected in place as shown on the project construction documents. The Contractor will attempt to further minimize tree removals to the extent possible.
- The Contractor will adhere to the park's pruning guidelines for any pruning necessary for the project, with the goal of retaining health and integrity of trees and shrubs treated. The Contractor will avoid damage to trees or roots in or adjacent to project areas as much as possible; however, if avoidance is not possible, root pruning guidelines will be followed.
- The Contractor will follow the park's protocol for vehicle, equipment, and machinery washing. In general, prior to entering the park, all vehicles and construction vehicles, equipment, and machinery will be washed to thoroughly remove all dirt, plant, and other foreign material.
- If fill is needed, the Contractor must use clean fill, preferably from an approved site within the park. Any fill materials from outside the park will be obtained from a park-approved source in adherence to Standard Operating Procedure 8213-007 Invasive Plant Free Forage and Construction Materials.
- The park's Vegetation Program will conduct surveys for invasive plant species prior to construction. If invasive plant species are found in or adjacent to the project limits, the park will treat the invasive species prior to ground disturbing activities. The Project Lead will coordinate with the park's Vegetation Program to determine treatment methods. If invasives are unable to be treated onsite, the Contractor will excavate topsoil and vegetation to a depth of four inches and haul to an approved disposal site.
- Invasive plant monitoring and control will occur for 3-5 years following construction completion. Additional mitigations and treatment may be required if invasive species are encountered during monitoring.
- The Contractor will follow the park's protocol for salvaging, storing, and handling topsoil.
- The park's Vegetation Program will conduct surveys for rare, sensitive, special status, and threatened or endangered plant species prior to construction. If rare, sensitive, special status, or threatened or endangered plants are identified within the project limits, the park's Vegetation Program will mark (e.g., through fencing. flagging, taping) these as sensitive resource areas for avoidance during construction.

- The Park will revegetate areas disturbed by construction and will use native seeds and plants.

Visitor Use and Experience

- The following project components would occur during the visitor shoulder season (10/16-11/30) or off season (12/1-5/14): Roaring Springs Pumphouse water system improvements and Roaring Springs Cave to Pumphouse waterline rehabilitation. Any proposed changes to the timing of these project elements may require additional environmental reviews, consultations, and public notices. The Contractor will not proceed with the proposed changes until necessary environmental reviews, consultations, etc. are completed and clearance is given by NPS.
- A trail and sidewalk restoration/rehabilitation plan will be prepared by the contractor and provided to the park for review and acceptance
- The contractor will provide a trail, rest area, campground, and campsite closure plan at least 6 months prior to construction. The plan will be provided to the park for review and acceptance. The plan will be updated regularly. Throughout construction, the Contractor will notify the park at least two months in advance of any needed closures so the public can be notified.
- The contractor will attempt, to the extent possible, to schedule any needed trail, rest area, campground, or campsite closures during lower visitation times (e.g., winter, outside peak rim-to-rim times) to minimize visitor impacts.
- The contractor will attempt, to the extent possible and while considering safety factors, to schedule any needed road restrictions/closures on State Route 67/North Entrance Road during times that would have the least impact to visitors and park operations. Temporary impacts to the traveling public would be mitigated by providing detours, as reasonable, and providing signage and advanced notification at least two weeks prior to closures, detours, and other traffic restrictions.
- The contractor will provide a traffic control and detour plan at least 6 months prior to construction. The traffic control and detour plan will be provided to the park for review and acceptance. Throughout construction, the Contractor will notify the park at least two months in advance of any needed closures so the public can be notified.
- The following trails will be used as a detour for hikers and pedestrians and signed when the Bridle Path is closed during construction: Transept Trail, the unnamed trail that veers northwest from the Bridle Trail just north of the motels and connects with Transept Trail, and the unnamed trail that veers northwest from the Bridle Trail just north of Norton Court and connects to the North Rim Campground parking lot.
- The contractor would install signs, as determined necessary by the park, to alert or inform visitors about construction activities, including closures, restrictions, and detours.
- Construction zones will be properly secured to prevent visitors or other unauthorized personnel from entering.
- All permanent exterior lighting installed by the project will comply with International Dark Skies guidelines and the park's Standard Operating Procedure for Park Outdoor Lighting Guidelines.
- The park would issue alerts, press releases, and/or notifications to inform visitors about construction prior to and throughout the duration of construction. The Project Lead and park Communications staff will strive to notify visitors at least two months, but no less than one month, in advance of any planned closures, such as closures to roads, trails, rest areas, water services, campgrounds, campsites, lodging, or other visitor facilities or amenities.

Water Resources

- The Contractor will not deposit spoils, stockpiles, or other excavated materials in any wash, drainage, channel, or wetland.
- The Contractor will avoid impacts to and not enter or otherwise perform work in wetlands or waterways (e.g., streams, creeks, channels). If work is required in wetlands or waterways, the Contractor, through the Project Lead, will notify the NEPA lead. Additional environmental reviews, consultations, and/or permitting will be necessary, and the Contractor will not proceed with this work until these are completed and clearance is given by NPS. Ample time (at least 1 year) must be provided to complete these reviews, consultations, and permitting.
- Any wetlands or waters within or near the project limits that are not permitted or otherwise authorized to be impacted will be marked on design drawings as avoidance areas.
- The Contractor will install temporary footpath bridges (or similar) spanning Roaring Creek near the Roaring Springs Day Use Area contractor camp and near the Roaring Springs Pumphouse to minimize contractor foot traffic in the creek and adjacent wetlands. The footpath bridge (or similar) will not be within or create impacts to wetlands or waterways.
- Contractor staff using the Roaring Springs Day Use Area contractor camp will minimize foot traffic in Roaring Creek and adjacent wetlands. Silt fencing and other erosion control measures (e.g., wattles) will be installed along wetland and creek boundaries at the Roaring Springs Day Use Area contractor camp to minimize sediment from entering these areas. If the contractor's use of this area degrades the creek or wetlands, the contractor will be required to rehabilitate the degraded aquatic resources, which could require additional environmental reviews and permitting.
- To the extent feasible, any flow changes to Roaring Springs Falls, Roaring Springs Creek, and Bright Angel Creek resulting from the project will be coordinated with natural flow regimes.

Wildlife, Including Special Status Species

- The Contractor will implement all measures, terms, and conditions outlined in the Section 7 Biological Assessment and associated consultations for this project.
- To protect migratory birds, roosting bat species, and other animals using trees and shrubs for forage, nesting, and shelter during the breeding season, the contractor will avoid vegetation clearing to the greatest extent possible during the primary bird nesting season between April 1 and August 31. If this is not feasible, the contractor will follow USFWS Nationwide Avoidance & Minimization Measures for Birds, available at https://www.fws.gov/media/nationwide-avoidance-minimization-measures-birds, and surveys by a biologist qualified in nest searching will be required. If the park is unable to provide a qualified biologist to perform nest surveys, the Contractor will be responsible for retaining a qualified biologist, who will document their surveys in a report and provide it to the park for review and acceptance prior to vegetation removal. The surveys will be conducted no more than five days prior to the scheduled activity. If active nests or breeding behavior are detected during these surveys, no vegetation removal or other construction activities will be conducted within 150-feet of the nest until nestlings have fledged, the nest fails, or breeding behaviors are no longer observed. If vegetation removal is to occur while nests are active or breeding behavior is observed, the Contractor must coordinate with USFWS to determine if a Migratory Bird Treaty Act permit or other avoidance/minimization measures are required.
- If drilling activities, including mobilization at the project site, begin between April 1-August 15, and are not immediately preceded by other work in the immediate vicinity, the Contractor

will be required to work with USFWS to determine if a Migratory Bird Treaty Act permit is required. The contractor will follow the USFWS Nationwide Avoidance & Minimization Measures for Birds, available at https://www.fws.gov/media/nationwide-avoidance-minimization-measures-birds.

- Building design elements that reduce the risk of bird strikes, such as window treatments or fritted glass, will be incorporated on new or rehabilitated buildings. For examples, see https://www.fws.gov/story/threats-birds-collisions-buildings-glass and https://www.fws.gov/media/reducing-bird-collisions-buildings-and-building-glass-best-practices.
- All permanent exterior lighting installed by the project will comply with International Dark Skies guidelines and the park's Standard Operating Procedure for Park Outdoor Lighting Guidelines.
- The park's Wildlife Program will train contractor staff to avoid disturbance to any wildlife species that may be found nesting, hibernating, estivating, or otherwise living in, or immediately nearby, work sites.
- Grand Canyon's Parkwide Spill Response Plan will be utilized by contractors to prevent potential poisoning of condors and other wildlife, as well as soil and water contamination.
- The Contractor will not disturb, approach, or feed any wildlife species (e.g., reptiles, migratory birds, raptors, mammals, or bats) found nesting, hibernating, estivating, or otherwise living in, or immediately nearby, worksites. If wildlife must be disturbed or handled, the Contractor, through the Project Lead, will notify and consult with the park's Wildlife Program to assist with relocating wildlife. The Contractor may be required to pause work in the area until wildlife can be relocated.
- Project staff will avoid interactions with condors and immediately contact the park's Wildlife Program or park dispatch if a condor(s) visits a project site. If a condor(s) visits a project site, the Contractor will cease project activities until the condor(s) leave on their own or until permitted park personnel use approved techniques that result in the condor(s) leaving the area.
- If condor nesting activity is known within 0.5 mile of a construction project area, then light and heavy construction equipment (as defined in the Biological Assessment) in the project area will be restricted during the active nesting season from February 1 to September 30. These dates may be modified based on the most current information, in consultation with the park biologist, the park Section 7 Coordinator, and the U.S. Fish and Wildlife Service.
- The Contractor will attempt to conduct flights prior to 10:00 AM when possible, to minimize potential impacts to condors
- Helicopter pilots will attempt to remain at least one mile from active condor nests, but at times this may not be feasible. In instances when condors are actively nesting within 0.5 mile of helicopter flight paths, landing zones, and/or sling zones, the park will assign a wildlife monitor to observe the area and condor behavior when frequent and high numbers of helicopter flights are expected. If condors establish a nest within 0.5 mile of helicopter flight paths, landing zones, and/or sling zones, the Contractor will record helicopter flight numbers by helicopter type and report this information to the park's Wildlife Program and Section 7 Coordinator. The park will report this information to USFWS.
- Certain work locations and helicopter flight paths may be restricted during the condor and Mexican spotted owl nesting seasons. The active condor nesting season is February 1 to September 30. The Mexican spotted owl nesting season is from March 1 to August 31. These dates may be modified based on the current information regarding condor and Mexican

spotted owl nesting activities (e.g., roosting and fledging) and coordination with the park's wildlife program manager, Section 7 coordinator, and USFWS.

- Helicopters will stay at least 1,200 feet away from airborne condors, unless human safety concerns override this restriction. If airborne condors approach aircraft, aircraft will give up airspace to the extent possible, as long as this action does not jeopardize human safety.
- To minimize noise disturbance within Mexican spotted owl Protected Activity Centers (PACs), helicopters shall remain at least 1,200 feet from the boundary of any designated PAC during the Mexican spotted owl breeding season (March 1 through August 31).
- Light and heavy construction equipment, as defined within the Biological Assessment, will not be used within 0.5 miles from Mexican spotted owl known nest/roost sites during the owl breeding season (March 1 – August 31).
- The Contractor will provide provisions (generally in the form of ramps with a slope <45°) every 20-50' in trenches or excavated holes to allow for the escape of animals that enter these recesses, and/or the trenches/holes must be covered in such a way as to prevent animals (vertebrates) from entering.
- Pilots are required to minimize aircraft use along the rim and cliffs to the greatest extent possible.
- With the exception of borehole drilling activities, night work outdoors is not authorized. However, there may be instances when crews mobilize to/from the work site at dawn or dusk or may need to finish a task at the end of the day. Such instances will be permitted if they are short term, require minimal equipment, and will not occur within 0.25 mile of a Mexican spotted owl Protected Activity Center (PAC) boundary. If the Contractor requests night work outdoors that does not meet the criteria above, the Contractor, through the Project Lead, would submit requests for night work to the park for review and acceptance. Additional environmental reviews may be necessary for night work proposals.
- Following the completion of the project, the park's Fisheries Program will monitor Bright Angel Creek for changes in creek morphology that directly impact habitat availability for fish and other aquatic species, amphibians, and bats. If undesirable changes to creek morphology are identified, the park will develop a plan to address these conditions.
- If culverts are used, they will be designed and installed/retrofitted to maintain animal movement and bank-full width, even in dry washes.
- Prior to UAS flights, Grand Canyon National Park's helibase staff and Project Lead will contact the Wildlife Program Manager concerning the presence/absence of threatened or endangered species utilizing nearby cliffs/canyons.
- Prior to UAS flights, the Project Lead will contact the Wildlife Program Manager, at least two weeks in advance, to schedule a wildlife monitor on site. The monitor will watch for bird activity of all kinds and alert operators of approaching birds. If birds approach the UAS flight area, aircraft will immediately give up airspace and return to the ground.
- To the best of their abilities, aviation staff piloting UAS will provide a buffer of 50-100 feet from areas where birds are present (in trees or on the ground) and airborne aircraft. This may not always be possible at the rim sites during take-off and landing.
- To minimize wildlife disturbance during the breeding season (April 1 – August 31), UAS will maintain a minimum distance from individual animals of 200 feet (vertical and horizontal). To minimize wildlife disturbance during the non-breeding season (September 1 – March 31), UAS will maintain a minimum distance from individual animals of 100 feet (vertical and horizontal).

Appendix C: Impact Topics Dismissed from Further Analysis

This appendix identifies resource topics that were considered during civic engagement and internal interdisciplinary review but were dismissed from further analysis in this EA. These topics were evaluated using NEPA significance criteria, professional judgement, and applicable agency guidance. Unless otherwise noted, no impacts would occur under the No Action alternative.

Air Quality

Local air quality may be temporarily degraded by dust generated from construction activities and emissions from construction equipment. This degradation would result in an overall negligible impact to air quality and would last only as long as construction activities occurred. Dust impacts would be temporary and mitigated by using Best Management Practices (BMPs) (see *Appendix B: Mitigation Measures and Best Management Practices*). Impacts to overall park air quality or regional air quality are not expected; therefore, this topic has been dismissed from further analysis.

Archeology

There are seven known archaeological sites located within or in the vicinity of the proposed project area (B:16:0070, B:16:0071, B:16:0600, B:16:0310, B:16:0973, B:16:0974, and B:16:0975). Sites B:16:0070, B:16:0071, and B:16:0974 are ancestral sites and the rest are Euro-American.

All of the known archaeological sites are located above the rim; there are no documented archaeological sites within or in the vicinity of the inner canyon project areas. With the exception of site B:16:0071, all archaeological sites are outside of the construction zone boundaries and would not be impacted by construction. Where site boundaries were near the project limits of disturbance, those limits were adjusted to provide a 15-foot buffer from the archaeological site.

The Transept Trail, which would be used as a detour route for hikers when the Bridle Path is closed, passes immediately adjacent to B:16:0071. Therefore, this site may be impacted if trail improvements are needed at that location to accommodate the trail detour. However, impacts to this site are not anticipated at this time as it is expected that this short section of trail can be used as a detour in its current condition and without additional work.

Two sites, B:16:0971 and B:16:0972 are near, but west of the potential staging area at CC Hill and would therefore be unimpacted by the project.

If impacts to site B:16:0071 or any other site are determined to be necessary in the future, the contractor would be required to consult with the park's archaeologist prior to performing any work. At that time, avoidance and minimization measures and a historic property treatment plan would be required to be implemented.

Additionally, appropriate steps would be taken to protect any previously unknown archaeological resources that are discovered through the implementation of either alternative discussed in this EA (see *Appendix B*).

As shown above, impacts to archaeological resources are unlikely and mitigation measures and controls would be in place should impacts become necessary in the future or should unknown resources be uncovered; therefore, this topic was dismissed from further analysis.

Ethnographic Resources

The Grand Canyon, spanning from rim to rim, is recognized as a Traditional Cultural Place (TCP) by the park's eleven affiliated tribes. A TCP is defined as a building, structure, object, site, or district that is listed in—or eligible for listing in—the National Register of Historic Places for its cultural significance. This significance arises from its connection to the community's cultural beliefs, customs, or practices, which are rooted in the community's history and help maintain its cultural identity (NPS, 2024i). Due to the cultural importance of the area, the park maintains ongoing consultation with these tribes (see *Appendix E: Consultation and Coordination*).

If previously unidentified site-specific resources within the larger TCP are identified in the project area, the NPS would coordinate with the tribes to implement measures to avoid or mitigate disturbances (see *Appendix B* for mitigations). The Navajo Nation Tribal Historic Preservation Officer (THPO) accompanied park staff on a site visit to project areas on the North Rim on July 17, 2025. The THPO did not indicate any concerns for ethnographic resources. Appropriate consultation with the State Historic Preservation Office (SHPO) would occur as needed. Activities would comply with the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 when applicable. Locations of ethnographic sites would remain confidential.

Because the project is designed to avoid impacts to these resources and consultation is ongoing, ethnographic resources were dismissed from further analysis. If new information regarding these resources or tribal concerns arises, the park would reassess this determination.

Floodplains

The DOI's and USGS's Strategic Hazard Identification and Risk Assessment (SHIRA) mapper depicts Roaring Springs Canyon as being within a potential floodplain. Therefore, for purposes of NPS Director's Order (DO) 77-2, we assumed the presence of floodplains.

In general, the majority of the work in Roaring Springs Canyon would consist of rehabilitating or replacing existing infrastructure, which would have negligible to no impact on floodplains by raising the base flood elevation. The main new exterior feature proposed in Roaring Springs Canyon that could potentially impact the floodplain (i.e., result in an increase in base flood elevation) consists of the new above ground 5,000-gallon water storage tank. The installation of the tank would have a minor impact as it would only add approximately 1,357 cubic feet within the floodplain. Based on assessment of the proposed activities and potential floodplain impacts in Roaring Springs Canyon, the park and WASO WRD determined that the proposed activities are excepted from the need to prepare a Floodplain Statement of Finding under DO 77-2 and Reference Manual (RM) 77-2. Because impacts to the potential floodplain would be negligible, this topic was dismissed from further analysis

Paleontology

Paleontological resources within the project area at known fossil sites near Roaring Springs and Manzanita are limited to the Tapeats, Bright Angel, and Muav geological formations. These layers typically contain the highest diversity assemblage of trace fossils and trilobites in GRCA, and also yield brachiopods, hyolithids, eocrinoids, and sponge spicules. Paleontological resources within the project area on the North Rim are limited to the Kaibab and Toroweap Formations, which contain marine invertebrate material including coiled nautiloids, brachiopods, corals, crinoids, and sponges, as well as vertebrate shark teeth. The project areas on the North Rim do not appear to be within known fossil sites, so far posing minimal impact on paleontological resources. To minimize potential impacts to paleontological resources, a park paleontological monitor would be required for certain

work, and other mitigation measures would also be implemented (see *Appendix B*). With implementation of mitigation measures, adverse effects to paleontological resources are unlikely; therefore, this topic is dismissed from further analysis.

Soils

The Proposed Action alternative would impact soil productivity on up to 29.7 acres through construction activities; however, much of this area is previously disturbed or currently developed. Soil productivity would be permanently lost where new buildings or surfacing (e.g., gravel, concrete pavement) would be constructed; this includes up to 5.9 acres for the new water treatment plant and up to 3½ acres for Ballfield Access Road. Impacts to soils at other areas that would be disturbed by construction but would not have permanent facilities would be temporary and would be restored following construction. Soils would also be impacted on approximately 50 acres at staging and contractor camp areas; however, most of these areas are currently developed or previously disturbed. BMPs and mitigation measures would limit the extent of disturbance to soils and control erosion during construction and revegetation (*Appendix B*). Impacts to subsurface materials and resources are discussed further in *Karst and Hydrogeology*.

Impacts on soil productivity, fertility, and stability are not expected to be substantial because impacts on soils would affect a small portion of the approximately 405-acre Bright Angel Peninsula. Therefore, this topic was dismissed from detailed analysis in this EA.

Vegetation – Ponderosa Pine Forest

A total disturbance of up to 20.4 acres of ponderosa pine (*Pinus ponderosa*) forest within the North Rim Developed area would occur during construction on the North Rim; however, some of these forested areas were impacted by the Dragon Bravo Fire. The disturbed area would be partially revegetated following construction. Restoration to preconstruction conditions would take many decades given the growth rate of ponderosa pine, and areas in the construction zones that would have new permanent facilities (building, pavement, etc.) would remain unforested. Tree removals were minimized through design and further attempts to minimize removals would occur during construction (see *Appendix B*). The rest of the forested areas on the approximately 405-acre Bright Angel Peninsula outside of construction zones would be unaffected by the project. Additionally, the North Rim of the Grand Canyon and surrounding areas contain one of the largest ponderosa pine forests in existence and this plant community is common in the area. Because the loss of ponderosa pine habitat would occur over a relatively small area and would affect a plant community that is abundant in the areas surrounding the construction zones, as well as throughout the park and its surrounding areas, this topic was dismissed from detailed analysis in this EA.

Viewsheds

While an important aspect of the North Rim of the Grand Canyon, viewsheds have been discussed previously in the *Historic Districts* and *Visitor Use and Experience* sections.

Wetlands

An aquatic resources delineation conducted in support of the project (HDR 2024d) identified seven perennial streams and two intermittent streams totaling 1.16 acres (4,461 linear feet) and 36 palustrine wetlands totaling 1.08 acres in the inner canyon study area, and no aquatic resources in the study area on the Bright Angel Peninsula.

The project has been designed to avoid impacts to these resources and no construction would occur within aquatic features. However, there are two locations where construction personnel would need to cross Roaring Creek and its adjacent wetlands – at Roaring Springs Day Use Area to access the construction camp and at Roaring Springs Pumphouse to access the waterline between Roaring Springs Cave and Roaring Springs Pumphouse. To minimize potential degradation of Roaring Creek and adjacent wetlands, the contractor would be required to install temporary footpath bridges (or similar) to span Roaring Creek and adjacent wetlands at the two crossing locations. Additionally, at the Roaring Springs Day Use Area construction camp, the contractor would be required to install silt fencing or other erosion control measures (e.g., wattles) along wetland and creek boundaries to minimize sediment from entering these areas. If the contractor's use of this area degrades the creek or wetlands, they would be required to rehabilitate the degraded aquatic resources. See *Appendix B* for mitigation measures.

Because construction would not occur within and therefore would not directly impact aquatic resources, and because indirect impacts to aquatic resources (e.g., personnel traversing wetlands/creeks) have been mitigated, this impact topic is dismissed from further analysis.

Wildlife

Native Fishes

In the early to mid-20th century, brown and rainbow trout were introduced into Grand Canyon streams, including Bright Angel Creek, resulting in the overpopulation of these non-native species. This introduction, combined with other human-caused habitat changes, has substantially impacted native fish populations in Bright Angel Creek and the Colorado River. Native species have declined considerably in Bright Angel Creek, which historically served as an important spawning area.

To address these impacts, the NPS initiated the Bright Angel Creek Trout Reduction Project, which has successfully removed thousands of non-native trout each season, contributing to the gradual restoration of native fish populations. Continued removal efforts and long-term monitoring remain essential to sustaining these outcomes (NPS 2023d).

The completion of the TCWL and implementation of the Proposed Action would reduce the amount of water withdrawn from Roaring Springs Cave. Currently, water is diverted from the cave to meet potable water needs at the North Rim, inner canyon corridor, and South Rim. After completion of the TCWL project, a portion of this water intake—serving Phantom Ranch, Havasupai Garden, rest areas along Bright Angel Trail, and the South Rim—would instead be sourced from Bright Angel Creek at Phantom Ranch, and water from Roaring Springs Cave would be limited to serving the North Rim and inner canyon locations down to Cottonwood Campground. Under the Proposed Action, the North Rim water system would be appropriately sized to meet the new post-TCWL-improvements water demands, resulting in more efficient water withdrawals from the cave.

These actions would reduce the volume of water removed directly from Roaring Springs Cave, which would in turn increase the amount of water flowing into Roaring and Bright Angel Creeks downstream of Roaring Springs Falls and restore more natural flow conditions. The increased water discharge into Roaring and Bright Angel Creeks is expected to improve some conditions for humpback chub and other native fishes by stabilizing the thermal regime and increasing the number of days suitable for growth, as well as slightly increasing juvenile rearing habitat (Bair 2019). However, thermal stabilization may reduce the number of days suitable for spawning. The same

changes would also increase suitability for nonnative brown trout, potentially offsetting benefits to humpback chub and other native fishes through increased predation and competition.

Reducing water withdrawals from Roaring Springs Cave would increase instream baseflow in Bright Angel Creek and provide greater resilience during short-term low-flow conditions. Increased water flows from Roaring Springs could dilute sediment inputs in Roaring and Bright Angel Creeks during low-flow conditions or smaller storm events; however, large runoff events would not be measurably affected. Because native fishes in Grand Canyon are adapted to naturally turbid conditions, the anticipated ecological benefit of these changes would likely be limited. Several times a year, water from the pipelines would be discharged into Roaring Creek to flush sediment out of the water system. These discharges would be automated by a turbidity meter. Material released would be native sediment originally from the spring. During discharges, temporary increased sedimentation and turbidity to Roaring Creek could occur. These impacts would be short term and localized, and as noted, would have a negligible effect on native fish who are adapted to turbid conditions. Additionally, the park could schedule discharges to be during times of least impact or greatest benefit to freshwater species.

As chlorine is unsafe for fish, dechlorination would occur prior to discharging water from the pipelines to avoid adverse effects to fish from chlorine.

Overall, the Proposed Action is anticipated to have beneficial effects on humpback chub by restoring more natural flows to Roaring and Bright Angel Creeks through reduced water withdrawals from Roaring Springs Cave and improving water management flexibility, avoiding flushes during sensitive periods or allowing them to disturb non-native species. Because these impacts are expected to be positive and minimal, humpback chub has been dismissed from further analysis.

Terrestrial Wildlife

Many species of birds, reptiles, and mammals inhabit or are transient in the project area. Most wildlife would be expected to vacate and avoid the project area during construction and, other than being temporarily displaced, would not be measurably affected by construction. However, those species that may be more sensitive to disturbances from construction activities or have higher potential to be affected by the project are discussed below.

Grand Canyon National Park supports 22 bat species, including nine species of special concern. Eight special-status bat species have been documented in the inner canyon corridor. Most bat species in the park occur below the rim in canyon habitats; however, ponderosa pine forests on the rim provide potential roosting habitat for tree-roosting species. Canyon walls in the inner canyon provide abundant roosting habitat for cave- and cliff-dwelling species, while riparian areas along Bright Angel Creek support high insect abundance and serve as foraging habitat.

The Kaibab Squirrel National Natural Landmark, designated in 1965, encompasses approximately 300,000 acres across the North Rim of Grand Canyon National Park and the North District of the Kaibab National Forest. The Kaibab squirrel is endemic to the Kaibab Plateau and relies on ponderosa pine forest habitat. Construction zones on the rim occur within the landmark boundary.

Migratory birds are protected under the Migratory Bird Treaty Act (16 United States Code 703), which prohibits the take of migratory birds, nests, or eggs. The North Rim and Roaring Springs Canyon provide nesting and foraging habitat for a variety of migratory species.

Wildlife habitat in the project area includes approximately 20.4 acres of ponderosa pine forest within the approximately 405-acre Bright Angel Peninsula and the substantially larger (approximately

278,000-acre) ponderosa pine forest extending across the greater North Rim and the Kaibab National Forest – North Kaibab Ranger District. Given the size and continuity of surrounding forested habitat, terrestrial wildlife would retain opportunities to avoid localized construction areas, including Bright Angel Peninsula. Within Roaring Springs Canyon, habitat consists of ponderosa pine and mixed conifer forests at its upper elevations, transitioning to oak and manzanita shrubland and pinyon pine-juniper woodlands as the elevation decreases. Riparian habitat is also present along the Roaring and Bright Angel Creeks corridors. Bright Angel Peninsula and the inner canyon corridor in Roaring Springs Canyon have been developed for more than a century, and wildlife in these areas is generally accustomed to human disturbance.

Construction activities under the Proposed Action potentially affecting wildlife would include ground disturbance, vegetation removal, helicopter operations, use of noise- and vibration-generating equipment, and limited nighttime work and lighting associated with borehole drilling. These activities could disturb wildlife through increased noise, vibration, and human presence; removal of trees or shrubs used for nesting, roosting, rearing, or shelter; alteration of foraging habitat or behavior; or temporary displacement of animals from localized habitat areas in the vicinity of construction zones. Impacts on certain wildlife would vary by season, as activities occurring during colder months, when many bats and birds have migrated or are less active on the rim, would result in reduced potential for disturbance (NPS 2023b). Most impacts would be temporary and cease upon project completion; however, tree removals would have longer-term impacts due to the regeneration rate of ponderosa pine but, as noted above, ponderosa pine forest habitat is abundant on the Bright Angel Peninsula and surrounding areas.

To minimize impacts on wildlife, the project would implement BMPs and mitigation measures consistent with National Park Service (NPS) Management Policies. These measures include scheduling vegetation removal outside the primary breeding and rearing season to the greatest extent practicable; conducting pre-construction nesting and denning surveys if seasonal avoidance is not feasible; establishing buffers around active nests or dens; minimizing the duration and extent of disturbance; and using dark-sky-compliant lighting for permanent exterior lighting. Additional mitigation measures are described in *Appendix B*.

Given the extent of suitable habitat surrounding the project area, and with implementation of BMPs and mitigation measures, impacts to terrestrial wildlife would be minimal and localized relative to the scale of available habitat in the surrounding area. Therefore, this topic was dismissed from further analysis.

Wilderness: Opportunities for Solitude or a Primitive and Unconfined Recreation

While no designated wilderness exists at the park, approximately 1,143,918 acres of the park are proposed for wilderness designation. For purposes of applying the wilderness resource management policies contained in *NPS Management Policies 2006, Chapter 6: Wilderness Preservation and Management* (§ 6.3.1), DO 41, and RM 41, proposed wilderness is treated as designated wilderness. Under these policies, proposed wilderness is managed for the protection of wilderness character, which is defined by five qualities: *natural*, *undeveloped*, *untrammeled*, *opportunities for solitude or a primitive and unconfined recreation,* and *other* (e.g., cultural resources).

All construction, staging areas, contractor camps, helicopter landing areas, and proposed infrastructure would be outside of proposed wilderness. However, helicopter flights to support construction would occur over proposed wilderness.

Noise from helicopter support would have intermittent adverse effects on the wilderness character of *solitude or a primitive and unconfined type of recreation* during flyovers. As noted in *Visitor Use and Experience*, although characterization of the impact is difficult and dependent on several factors, it is likely that visitors in backcountry areas outside development zones, such as proposed wilderness, would expect a level of solitude and more natural soundscape; therefore, the presence of helicopters in these backcountry areas is likely adverse. Specifically, the additional helicopter flights and associated noise during construction would negatively impact wilderness users' opportunities to experience quiet and solitude in proposed wilderness areas that are in the vicinity of flight paths. However, these soundscape impacts, and therefore their impacts upon the opportunity for solitude, would be of short duration and intermittent, and would cease upon completion of construction. While noise from helicopters would affect users of proposed wilderness, these impacts were discussed extensively in the *Soundscapes and Noise* and *Visitor Use and Experience* sections; therefore, helicopter-related noise impacts on proposed wilderness were dismissed from further analysis.

In addition to the soundscape impacts, helicopters supporting the project would also be visible from wilderness intermittently and for short durations during construction, thereby also impacting the wilderness quality of *solitude or a primitive and unconfined type of recreation*. The impacts from the visibility of helicopters in proposed wilderness would be similar to the soundscape impacts resulting from helicopter noise. However, due to the quick flyover time at any given location, it is likely that helicopter noise would be more readily distinguishable compared to seeing a helicopter; if not for the noise, one could otherwise be unaware that a helicopter is flying overhead. The degree or intensity of this impact would be largely subjective, depending on individual preference/perception of helicopters and would depend on the location of the wilderness user.

While construction of the Proposed Action would temporarily increase helicopter flights over wilderness, long-term, routine flights to operate and maintain the improved North Rim water system would be reduced, thereby having a long-term benefit to the wilderness quality of *solitude or a primitive and unconfined type of recreation*.

Additionally, borehole drilling, which would occur 24/7 throughout the drilling period, would result in temporary audible and visual impacts to proposed wilderness areas in relative proximity to the borehole entry and exit sites. Based on the noise study conducted for this project, noise from drilling is expected to extend into proposed wilderness. Noise impacts during construction would be mitigated to the extent feasible. See the *Soundscapes and Noise* section for additional information.

Depending on the vantage point, borehole drilling could also result in temporary visual impacts to proposed wilderness due to the 150- to 175-foot-tall drill rig, which would extend above the tree line, and nighttime lighting at the bore entry and exit sites. Measures would be taken to minimize light spillover, such as ensuring lights are downcast and, if possible, shielded.

Noise and visual disturbances resulting from construction, particularly from drilling, would negatively impact wilderness users' opportunities to experience quiet and solitude in proposed wilderness areas that are in the relative vicinity of the borehole entry and exit sites. However, these impacts would be temporary and would cease upon completion of construction.

In summary, because the audible and visual impacts to the wilderness quality of *solitude or a primitive and unconfined type of recreation* resulting from construction and associated helicopter support would be temporary and cease upon completion of the project, because the visual and audible impacts of construction and helicopter support on soundscapes and visitor use and experience (including in proposed wilderness) were also analyzed in previous sections, and because implementation of the Proposed Action would result in fewer flights in the long term to operate and

maintain the improved North Rim water system, this topic was considered but dismissed from further consideration.

Appendix D: Past, Present, and Reasonably Foreseeable Actions

Project Name	General Description	Status
Transcanyon Waterline Replacement, Intake Relocation, and Water Treatment Plants Construction	Slip-lining the Bright Angel waterline from the South Rim to its bore exit along the Bright Angel Trail, replacing the TCWL from the Bright Angel waterline to Phantom Ranch, abandoning the segment of TCWL from Phantom Ranch to Cottonwood, slip-lining the TCWL between Roaring Springs Pumphouse and Cottonwood Campground, relocating the TCWL water intake to Bright Angel Creek at Phantom Ranch, constructing new water treatment plants at the South Rim and Phantom Ranch, expanding the South Rim Helibase, and creating a contractor staging and operations areas south of the South Rim Helibase and at "South Gate."	Past and present; construction is anticipated to be completed in late 2026 or early 2027
North Rim Wastewater Collection System Replacements	Replacement of existing Lodge Lift Station and select sewer lines throughout Bright Angel Peninsula, including tree removals and surface restoration.	Reasonably Foreseeable
North Rim Wastewater Treatment Plant Replacement	Reconstruction of WWTP complex, including installation of a temporary treatment system and a new secondary access road.	Reasonably Foreseeable
Power Distribution on the North Rim	Installation of new transformers, junction enclosures, standby generator in power distribution center (PDC) building, and diesel fuel storage adjacent to PDC.	Reasonably Foreseeable
Replace Overhead Powerline between North Rim and Roaring Springs Pumphouse	Replacement of overhead powerline and addition of a fiber optic line, demolition of existing wood poles, installation of steel poles, installation of aerial marker balls, and underground connections.	Reasonably Foreseeable
Install Underground Fiber Optic Conduit and Cabling between Power Poles near Visitor Center Parking Lot and EMS Building	Trench fiber optic conduit and cabling in existing trails, largely within the Bridle Path.	Reasonably Foreseeable

Project Name	General Description	Status
Replace Powerline between Roaring Springs Pumphouse and Manzanita	Replace existing powerline that is attached to the TCWL.	Reasonably Foreseeable
Cottonwood Campground Solar Canopy	Installation of a solar photovoltaic system on a newly constructed shade structure.	Reasonably Foreseeable
2023 Emergency Repair of North Rim Waterline	Replace approximately 400 linear feet of the North Rim waterline that was destroyed by a rockslide. The replacement location was in steep terrain, approximately 600 feet below the Rim.	Past
North Entrance Road Striping	Re-apply pavement markings (e.g., centerline and road edge striping) on North Entrance Road.	Reasonably Foreseeable
North Rim Entrance Station Rehabilitation	Rehabilitate and construct an addition to the existing entrance station building; construct two new buildings adjacent to the existing entrance station building; construct sidewalks between the buildings; install a fee kiosk; rehabilitate, realign, and construct new roads at the entrance station; and upgrade and install new utilities.	Reasonably Foreseeable
Various Park and Concessioner Routine Building Improvements (e.g., repairs, rehabilitation, etc.)	Includes actions such as replacing roofs, siding, windows, doors; interior and exterior painting; interior rehabilitation/remodeling/renovation and winterizing; etc.	Past, Present, and Reasonably Foreseeable
Various Park and Concessioner Routine Utility, Road, Trail, and Grounds Improvements	Includes actions such as maintenance and repairs to utility lines and associated equipment (e.g., electrical lines, transformers, water and wastewater piping, etc.), installing signs, road and trail maintenance, and similar activities.	Past, Present, and Reasonably Foreseeable
Grand Canyon Telecommunications Plan/EA	The Telecommunications Plan/EA identified CC Hill and Lindbergh Hill as suitable locations for telecommunications towers at the North Rim.	Reasonably Foreseeable

Project Name	General Description	Status
Dragon Bravo Fire Suppression and Emergency Stabilization/Rehabilitation	Emergency response to Dragon Bravo Fire, including suppression and mitigation such as tree removals, constructing fire breaks, earth moving, etc. Emergency stabilization/rehabilitation post-fire, such as stabilizing buildings and soils, hazardous tree and materials removals, and revegetation.	Past, Present, and reasonably foreseeable
North Rim Recovery Post-Dragon Bravo Fire	Any rebuilding/redevelopment efforts beyond emergency stabilization/rehabilitation that may result from the Dragon Bravo Fire are not considered reasonably foreseeable actions for purposes of NEPA because the concept, timing, and scale of any such efforts are currently unknown and are unable to be analyzed in any meaningful detail.	N/A

Appendix E: Consultation and Coordination

Agency Consultation

Advisory Council on Historic Preservation (ACHP)	Arizona State Historic Preservation Officer (SHPO)
United States Fish and Wildlife Service (USFWS)	

Section 106 consultation was initiated with SHPO on May 9, 2024. A notice of intent to prepare a Programmatic Agreement was provided to SHPO and ACHP on September 3, 2024. Virtual presentations of the Proposed Action were given to SHPO on August 2, 2023 and October 7, 2024. A Programmatic Agreement (PA), attached under separate cover, has been developed for the project and consultation with SHPO is ongoing. The ACHP will also be provided the opportunity to participate in the PA. The PA will be released concurrently with this EA for public review.

USFWS was informed of the proposed project and the intent to prepare a Biological Assessment (BA) on January 7, 2026, and informal consultation is ongoing. The BA was transmitted to USFWS on February 19, 2026. NPS anticipates USFWS to issue a Biological Opinion (BO) in May 2026.

Tribal Consultation

Havasupai Tribe	The Hopi Tribe
Hualapai Tribe	Kaibab Band of Paiute Indians
Las Vegas Tribe of Paiute Indians	Moapa Band of Paiute Indians
The Navajo Nation	Paiute Indian Tribe of Utah
Pueblo of Zuni	San Juan Southern Paiute Tribe
Yavapai-Apache Nation	

Tribal consultation for the North Rim Utilities Improvement Program followed the Section 106 process. On August 21,2023, tribal designated contacts from the park's 11 associated tribes, which include Tribal Historic Program Officers, archeologists, and cultural resources staff, were sent an email notification of the early planning stages of the project. On December 12, 2024, tribes were sent a formal email letter initiating Section 106 and announcing the intent to develop a project PA. The email requested comments on the proposed approach, and formal consultation included a letter with background information describing the project and soliciting feedback. On January 15, 2025, the Paiute Indian Tribe of Utah requested to be a concurring party on the draft PA. Consultation will continue with tribes that expressed interest in remaining involved or that did not respond.

Tribes were invited to a site visit on July 17, 2025. The site visit was attended by the Navajo Nation THPO; no other tribes participated. During the site visit, the Navajo Nation did not indicate concerns regarding undocumented ethnographic resources (see Ethnographic Resources).

Project information was also presented in person to tribal representatives during two Northern Arizona tribal meetings on October 30, 2024 and February 17, 2026 where the project design, scope, and construction methods were summarized for attendees. Consultation will continue with interested tribes regarding the draft PA and related cultural resource considerations.

Civic Engagement

Two civic engagement periods were offered for the public to review and comment on the preliminary action alternative, which was substantially the same to the Proposed Action presented in this EA. The

primary change from the preliminary action alternative to the Proposed Action is that the raw and potable waterlines would be installed in two separate boreholes rather than in one. The first civic engagement period occurred from June 22 through July 5, 2023, and the second occurred from February 4 through February 17, 2025.

Appendix F: References

Bair et al. (2019). Modeling temperature regime and physical habitat impacts from restored streamflow. *Environmental Management*. Accessed 2/26/2026. Retrieved from https://link.springer.com/article/10.1007/s00267-019-01157-8.

Department of Interior (n.d.). Strategic Hazard Identification and Risk Assessment (SHIRA) Risk Mapper. Accessed 02/26/2026. Retrieved from https://shira.geoplatform.gov/apps/riskmapper/.

Department of Transportation. (1977, April). Helicopter Noise Measurements Data Report, Report No. FAA-RD-77-57.

European Union Aviation Safety Agency. (2022). Type-Certificate Data Sheet for Noise, AS350-EC130, Airbus Helicopters.

Federal Aviation Administration (FAA). (1982). Helicopter Noise Exposure Curves for Use in Environmental Impact Assessment. Report No. DOT-FAA-EE-82-16. November 1982. Accessed 12/31/2025. https://apps.dtic.mil/sti/citations/ADA123467.

Federal Emergency Management Agency. (n.d.). National Flood Hazard Layer (NFHL) Viewer. Retrieved from https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd

GEI Consultants. (2025). North Rim Geophysical Studies – GRCA 318719: Rehabilitate North Rim Utility Infrastructure. Collier Geophysics Geophysical Letter Report, p. 19. Internal Document.

HDR. (2025, March). Constructability Report Design Development Phase. Internal Document.

HDR. (2024a). Final Scope and Cost Validation Report. Internal Document.

HDR. (2024b). North Rim Seasonal Construction Design Stage Value Analysis Report. Internal Document

HDR. (2024c). Noise Report. Attached.

HDR. (2024d, March). Aquatic Resources Delineation Report. Grand Canyon National Park. Rehabilitate North Rim Infrastructure.

Migratory Bird Treaty Act of 1918, as amended. (1918, July 13). 16 USC § 703-712: Chapter 128.

NASA. (2021, July). Medium Sized Helicopter Noise Abatement Flight Test Data Report, Report TM-20210011459

National Council on Aging. 2024. Decibel Chart: What You Need to Know. Accessed 06/05/2025. https://www.ncoa.org/adviser/hearing-aids/decibel-levels/

NPS. (2026, January 18). E. Brennan, Cultural Resources Program Manager, personal communication.

NPS. (2026, February). Status of the North Rim. Grand Canyon National Park. Accessed 02/03/2026. Retrieved from https://www.nps.gov/grca/northrimstatus.htm.

NPS. (2026). Reference Manual 41: Wilderness Stewardship. Accessed February 26, 2026. https://www.nps.gov/subjects/wilderness/rm41.htm

NPS. (2025a, January 16). H. Chambless, Hydrologist. Personal communication.

NPS. (2025b, February 6). K. Brown, GRCA Water Utilities Coordinator. Personal communication.

NPS. (2025c, September). Burned Area Emergency Response Plan. Internal Document.

NPS. (2025d, December). J. Boyd, Park Aviation Manager. Personal communication.

NPS. (2025e). Mexican Spotted Owl Summary. GRCA Internal Document.

NPS. (2024a, May). Cave/ Karst Systems. Grand Canyon. Accessed 12/28/24. https://www.nps.gov/grca/learn/nature/weather.htm.

NPS. (2024b, June). Air Quality at Grand Canyon National Park. Grand Canyon. Accessed 12/26/2024. https://www.nps.gov/grca/learn/nature/airquality.htm.

NPS. (2024c, September). Grand Canyon National Park to Temporarily Close Overnight Hotel Accommodations Beginning August 29. Grand Canyon. Accessed 12/9/2024. https://www.nps.gov/grca/learn/news/temporary-closure-of-hotel-accomodations.htm.

NPS. (2024d, December). NPS Stats. Accessed 12/26/2024. https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Traffic%20Counts?Park=GRCA.

NPS. (2024e, December). NPS Stats – Traffic Counts. Accessed 12/26/2024. https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Traffic%20Counts?Park=GRCA.

NPS. (2024f). Geology. Accessed July 2025. https://www.nps.gov/grca/learn/nature/grca-geology.htm.

NPS. (2024g). Director's Order #41: Wilderness Stewardship. Accessed July 2025. https://www.nps.gov/subjects/policy/upload/DO_41_5-13-2013.pdf.

NPS. (2024h). GRCA 2024 Mexican Spotted Owl Summary. GRCA Internal Document.

NPS. (2024i). National Register Bulletin. Identifying, Evaluating, and Documenting Traditional Cultural Places.

NPS. (2023a, April). North Rim to reopen June 2 for 2023 summer season. Grand Canyon. Accessed 12/26/2024. https://www.nps.gov/grca/learn/news/north-rim-to-reopen-june-2-for-2023-summer-season.htm.

NPS. (2023b). Bats. Grand Canyon. Accessed February 26, 2025. https://www.nps.gov/grca/learn/nature/bats.htm.

NPS. (2023c). Mexican Spotted Owl Program (*Strix occidentalis lucida*) Program in Grand Canyon National Park. 2019-2023 Five-Year Report. Internal Document.

NPS. (2023d). Grand Canyon's Native Fish. Accessed 02/25/2026. https://www.nps.gov/grca/learn/nature/fish-native.htm.

NPS. (2022a). North Rim Entrance Road Historic Designation National Register Form.

NPS. (2018a, October). Transcanyon Water Distribution Pipeline Grand Canyon National Park. Accessed 2/2/2026. https://parkplanning.nps.gov/document.cfm?parkID=65&projectID=52237&documentID=91131.

NPS. (2016b). Park Air Profiles - Grand Canyon National Park. Retrieved from https://nature.nps.gov/air/permits/aris/grca/impacts.cfm.

NPS. (2015). Transcanyon Water Line Historic District National Register Form. Grand Canyon National Park.

NPS. (2014, January). Wilderness Stewardship Plan Handbook.

NPS. (2011). Bright Angel Peninsula Historic District Cultural Landscape Inventory and National Register form. Grand Canyon National Park.

NPS. (2006). Management Policies 2006. https://www.nps.gov/orgs/1548/upload/ManagementPolicies2006.pdf.

NPS. (2005). North Rim Development Plan Environmental Assessment.

NPS. (2004). Draft Procedural Manual #77-2: Procedures for Floodplain Management. Internal Document

NPS. (2003). Partial Parkwide Inventory, South Rim Developed Area. Internal Document.

NPS. (2003). Director's Order #77-2: Floodplain Management. https://www.nps.gov/subjects/policy/upload/DO_77-2_9-8-2003.pdf.

NPS. (1997). National Register Bulletin – How to Apply the National Register Criteria for Evaluation.

NPS. (1995, August). Grand Canyon General Management Plan. Accessed July 2025. Retrieved from: https://www.nps.gov/grca/learn/management/gmp.htm

NPS. (1988). Grand Canyon Backcountry Management Plan. Reformatted version April 2000.

NPS. (1987). Grand Canyon Lodge National Historic Landmark National Register Nomination Form. Grand Canyon National Park.

NPS. (1982a). North Rim Headquarters Area National Register Nomination Form. Grand Canyon National Park.

NPS. (1982b). Grand Canyon Lodge Historic District National Register Nomination Form. Grand Canyon National Park.

NPS. (1982c). Grand Canyon Inn, North Rim Inn, and NPS Campground National Register Nomination Form. Grand Canyon National Park.

Protection of Historic Properties. 36 CFR 800. https://www.federalregister.gov/documents/2000/12/12/00-31253/protection-of-historic-properties#h-96.

USFWS. (2012). Recovery Plan for the Mexican Spotted Owl, First Revision. U.S. Fish and Wildlife Service, Albuquerque, NM. 376 pp.

USFWS. (1996). California Condor Recovery Plan, Third Revision. Portland, OR. 62 pp.

U.S. Fish and Wildlife Service. (1995). Recovery Plan for the Mexican Spotted Owl. Albuquerque, NM. 172 pp.

USGS. (n.d.). National Hydrography Dataset. Downloaded May 28, 2013. Available at https://nhd.usgs.gov/data.html.

Yeh and Associates, Inc. (2015, February). Hydrogeologic Study, Letter of Findings, North Rim, Grand Canyon National Park. Project No. 214-190.

Yeh and Associates, Inc. (2012, November). Hydrologic-Geologic Report, North Rim Waterline Replacement, Grand Canyon National Park, Arizona. YA Project No. 211-197A.

Appendix G: Noise Report

Grand Canyon National Park

Rehabilitate North Rim Infrastructure

FINAL Noise Report

PMIS No. GRCA 318719

May 27, 2024

HDR Project No. 10383673

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The purpose of this study is to support the Rehabilitate North Rim Infrastructure Project (Project) at the Grand Canyon by collecting existing background noise data and evaluating noise associated with the proposed project construction activities, in particular the raw water conveyance bore drilling operation from the North Rim of Grand Canyon National Park (the Park) to the Roaring Springs Pumphouse. The study also evaluates noise mitigation measures for the drilling operation.

HDR measured existing noise at three locations within the Park and analyzed the data from these measurements in conjunction with the data from one other location provided by NPS in order to establish typical existing noise levels and noise sources in areas that may be affected by noise associated with the Project. An average existing ambient background noise level of 25 dBA was established based on these measurements, which was used as noise contour modeling.

HDR established sound levels associated with construction equipment for each phase of Project construction. For the proposed raw water conveyance boring activity, HDR performed detailed noise modeling. HDR modeled a base scenario representing standard noise mitigation only (enclosures and mufflers) and plotted the resulting noise contours to show the extent of the area that stands to be affected by that noise. Further mitigation options including high-performance enclosures and silencers for the generators, mud pumps, compressors, and shakers, mast shielding or an enclosure for the top drive, and a noise barrier around the entire site could be used to reduce noise from the operation as much as is feasible within operational constraints. Noise contours with these mitigation measures applied show a greatly reduced area affected by noise from the boring operation.

Specification 01 11 00 requires that bore drilling activities occur between October 15 and March 31 when the North Rim is closed to overnight visitors. Assuming visitor experience and concessionaire living conditions are the primary concern for noise levels from the drilling activities, it is recommended that standard industry noise mitigation for drilling equipment be included in the construction specifications along with a shroud/enclosure for the top drive, a sound barrier for the drill floor, and an approximately 20-FT high temporary acoustic barrier wall around the site.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

C	Celsius
dB	decibel
dBA	A-weighted decibel
dBL	unweighted decibel
ERT	electrical resistivity tomography
FT	feet
HDR	HDR, Inc.
HP	horsepower
Hz	Hertz
LD 831C	Larson Davis model 831C sound level meter
L_{eq}	equivalent sound pressure level
L_{max}	maximum sound pressure level
L_{min}	minimum sound pressure level
L_{n}	statistical sound pressure level
L_{nat}	natural sound pressure level
L_{W}	sound power level
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPS	National Park Service
Pa	Pascal
Park	Grand Canyon National Park
Project	Rehabilitate North Rim Infrastructure Project
SPL	sound pressure level
SWL	sound power level
USGS	United States Geological Survey
W	Watt

1 INTRODUCTION

The purpose of this study is to support the Rehabilitate North Rim Infrastructure Project (Project) at the Grand Canyon by collecting existing background noise data and evaluating noise associated with the proposed project construction activities, in particular the raw water conveyance bore drilling operation from the North Rim of Grand Canyon National Park (the Park) to the Roaring Springs Pumphouse. The study also evaluates mitigation measures for the drilling operation.

1.1 PROJECT BACKGROUND

The Project will rehabilitate utilities serving the North Rim including water, wastewater, power, and communication systems, including their associated equipment, support structures and all connections to park facilities.

As these improvements are being carried out, temporary construction noise will be generated. The bore drilling operation for the proposed raw water conveyance is expected to be one of the loudest activities, which will be operating 24 hours a day in a fixed location for approximately a two-month period of time. However, specification 01 11 00 requires that drilling activities occur between October 15 and March 31 when the North Rim is closed to overnight visitors thus limiting noise exposure.

1.2 STUDY SCOPE

The objectives of this study include the following:

- Measure existing noise levels at three locations at the North Rim and innercanyon for a continuous 30-day period.
- Analyze the data from those 3 locations and one other location with data provided by NPS.
- Compile a list of construction equipment and associated noise levels for all Project activities.
- Create a three-dimensional noise model using CadnaA environmental noise modeling software to calculate sound propagation from the proposed drill rig and ancillary equipment and develop noise contour maps showing how drilling noise propagates throughout the noise study area.
- Identify and evaluate noise mitigation measures to reduce noise emissions from the drilling operation.

1.3 REGULATORY FRAMEWORK

The National Park Service (NPS) is mandated by Director's Order 47 to articulate NPS operational policies that require, to the fullest extent practicable, protection, maintenance, or restoration of natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources. Natural sounds are intrinsic elements of

the environment often associated with parks and park purposes. They are inherent components of "the scenery and the natural and historic objects and the wildlife" protected by the NPS Organic Act. They are vital to the natural functioning of many parks and may provide valuable indicators of the health of various ecosystems. Intrusive sounds are of concern to the NPS because they sometimes impede the Service's ability to accomplish its mission.

1.4 NOISE TERMINOLOGY

This section defines and provides additional background on noise terminology used in this report.

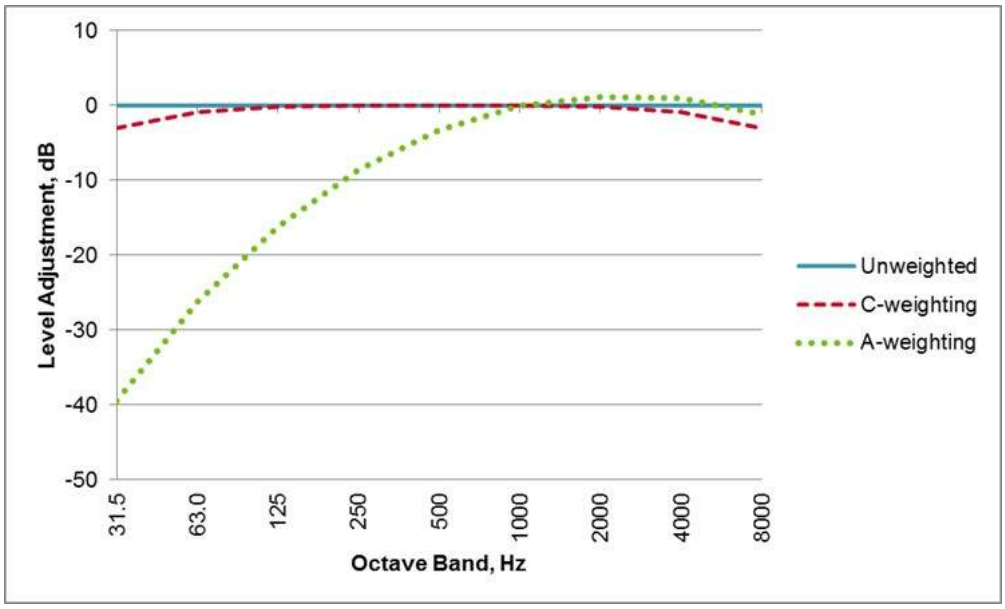
Sound is made of small fluctuations in air pressure, which propagate as longitudinal pressure waves. Sound may be characterized by its amplitude (how loud it is) and frequency (how high or low it sounds). Noise is sometimes defined as unwanted sound, but in this report the terms "sound" and "noise" are used interchangeably.

Within the range of human hearing, sound pressure may vary in amplitude by a factor of over one million. To make this scale more manageable, a logarithmic scale known as the decibel (dB) scale is used. When expressed in dB, sound pressure amplitude is known as the sound pressure level (SPL). This logarithmic scale means that decibel levels cannot be conventionally added and subtracted. If the amplitude of a sound is doubled, for example by adding an identical sound source, the SPL will increase by only 3 dB. A doubling of amplitude does not correlate to a doubling of perceived loudness: a change of 3 dB is considered a just-noticeable difference, a 5 dB change is considered readily perceptible, and a 10 dB change is considered a doubling or halving of loudness.

Frequency is described by hertz (Hz), which is equivalent to the number of sound wave cycles per second. A given sound may include components at many different frequencies, so octave bands are used to describe the frequency content of a sound. An octave is defined by a doubling or halving of frequency, so an octave band includes sound within a given frequency range and is identified by the frequency at the logarithmic center of the band. For example, the octave band with a center frequency of 1000 Hz includes all sound between 710 Hz and 1420 Hz. When a quantity is reported in octave bands, it is referred to as spectral (for example, spectral sound power level). Broadband sound, such as waterfall noise, includes components across a wide range of frequencies, while tonal sound, such as a siren, is concentrated at specific frequencies. Sound with tonal components may be more readily perceptible in the environment than broadband sound of the same SPL.

Since the human ear does not hear all frequencies equally well, the A-weighted decibel (dBA) is used to reflect this sensitivity by giving less weight to less audible components of sound (such as low frequencies), while giving slightly higher weight to components of sound in more sensitive frequencies. Unweighted dB may be specified as using linear weighting (lin). Differences between two sound levels are given in dB regardless of the weighting scheme of the original levels. Figure 1-1 shows the weightings given in each octave band for unweighted dB and dBA (and C-weighted decibels, which are not used

in this report). Table 1-1 provides examples of some common noise sources and their typical dBA levels.



Source: Acoustical Society of America (ASA) 2001.

Figure 1-1. Frequency Weightings

Table 1-1. Typical SPL of Common Noise Sources

Noise source	SPL
Auto horn at 3-FT	120 dBA
Heavy truck at 50-FT	90 dBA
Loud human voice at 3-FT	70 dBA
Air conditioning unit at 20-FT	60 dBA
Light auto traffic at 100-FT	50 dBA
Soft whisper at 15-FT	30 dBA

Source: Environmental Protection Agency (1981).

SPL typically varies over time, so different metrics may be used to concisely report sound measurement results. The equivalent level (L_{eq}) is the mean noise level over a given period of time, representing a constant sound level that contains the same overall energy as the actual, time-varying sound level. Statistical levels (L_n) are used to describe the sound level that is exceeded n percent of the time in a given time period. Thus, the L_{10}, L_{33}, L_{50}, and L_{90} respectively represent the sound levels exceeded for 10, 33, 50, and 90 percent of the time period. L_n descriptors help explain how much sound levels vary (or how consistent they are) during each hour. The L_{50} descriptor is the median noise level, and a comparison of the mean (L_{eq}) and median (L_{50}) is another way to evaluate the amount of variation in sound levels during an hour: if the L_{eq} is much greater than the L_{50}, short and loud noise events were likely raising the L_{eq}, whereas if the L_{eq} and L_{50} are similar, sound levels were likely consistent through the

hour. The L_{90} is often used to represent background noise; since it represents the noise level exceeded 90 percent of a time period, it represents the quietest moments when transient sound sources such as wind gusts or passing vehicles are not present. L_{nat} is a special case of statistical level called the natural sound level, which is described in detail in Section 2.2.1. L_{max} and L_{min} are maximum and minimum instantaneous SPL, respectively. For the purposes of this report, the maximum and minimum 1-second L_{eq} are reported as L_{max} and L_{min}. For an ideal steady and continuous noise source, the L_{eq}, statistical levels, L_{max} and L_{min} would all be the same.

Sound power level (SWL or L_W) is distinct from SPL. SPL describes the amplitude of sound pressure at a given location or distance from a noise source. SWL describes the total amount of sound energy emitted by a noise source and is not location dependent. Although both are reported in dB, the basis of the dB scale is different for each. For SPL, the dB are referenced to a pressure amplitude that represents the threshold of human hearing, 20 micropascals (µPa). However, for SWL, the dB are referenced to 1 picowatt (pW, 10^{-12} watts) since SWL is a measure of energy, not pressure. SWL (specifically spectral SWL, where the SWL is specified in each octave band) is frequently used as input data for noise models, while SPL (L_{eq}) at various locations is a typical noise model output.

2 NOISE MEASUREMENTS

HDR performed long-term unattended noise measurements of the outdoor ambient soundscape at three locations at the North Rim. The measurements began on October 11, 2024, and concluded on November 14, 2024. A subset of 30 days, from October 12 through November 10 (inclusive) was selected for analysis.

Additional data collected by NPS at a fourth location was provided to HDR for analysis. These measurements occurred from August 15-September 21, 2019 and May 26-June 23, 2020. For the 2019 measurements, the subset from August 17-September 20 was analyzed since August 15, 16, and September 21 were incomplete days (also excluding August 20 and 29 for missing or incomplete data) for a total of 33 days. For the 2020 measurements, the subset from May 29-June 22 was analyzed since May 26-28 and June 23 were incomplete days, for a total of 25 days.

The location of each of the measurement sites relative to the Ballfield (proposed bore drilling site) is shown on Figure 2-1.

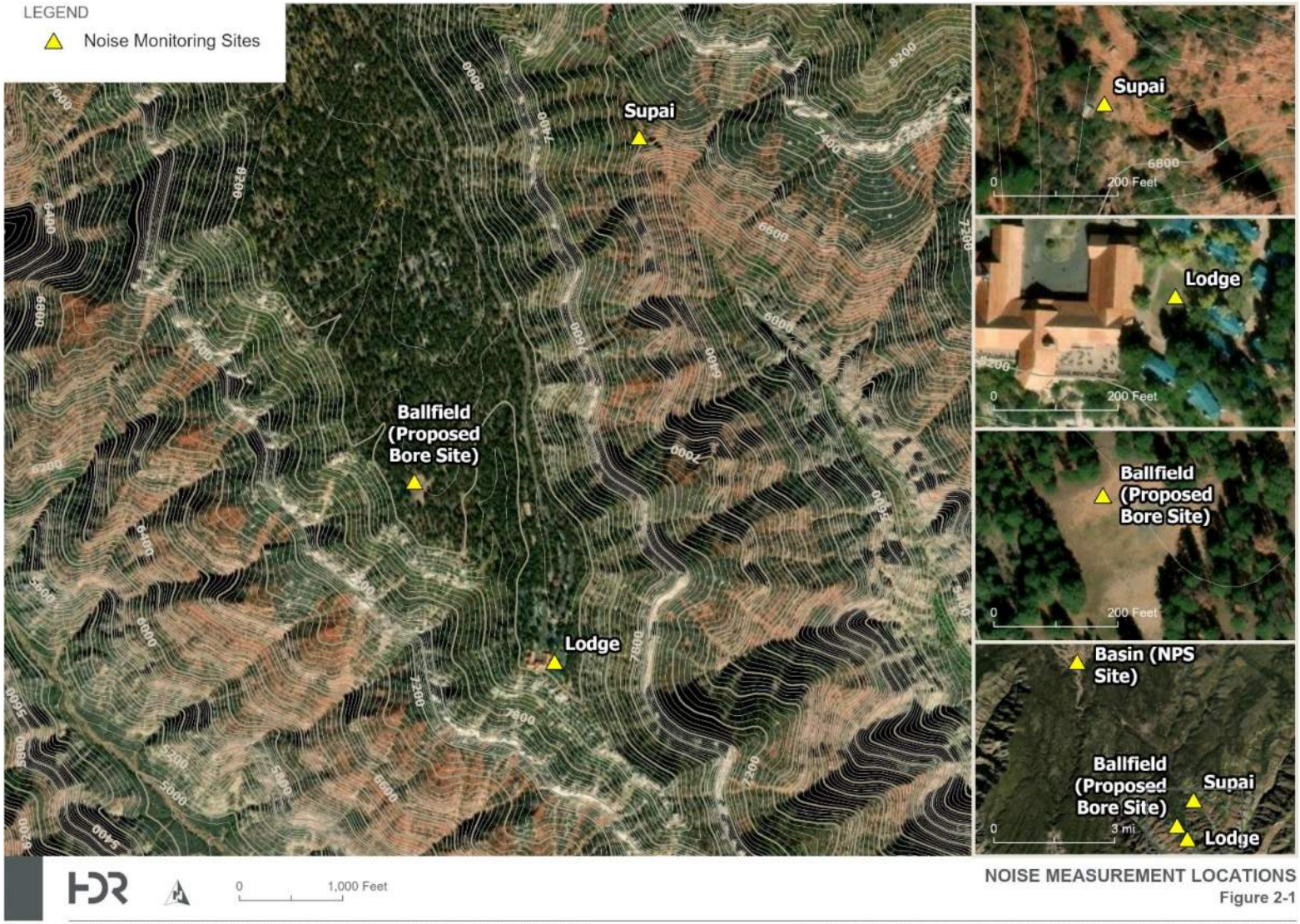


Figure 2-1. Noise Measurement Locations

2.1 EQUIPMENT

At each location, the study team used a Larson Davis Model 831C sound level meter (LD 831C) to measure and store the noise measurement results. The LD 831C also continuously recorded a digital audio file on an external thumb drive for the duration of the measurement. The study team measured wind speed, wind direction, and temperature at each location using a Vaisala digital weather station and stored the weather data in the LD 831C. The analyzer and thumb drive were stored in weather-resistant Pelican cases during deployment. A low-noise microphone system was used at each location to reduce the noise floor, allowing lower sound levels to be accurately captured. The microphone was situated at a height of approximately 5-FT above ground. A windscreen covered the microphone, and the windscreen had a single spike on it to discourage birds from sitting on the windscreen. The power supply consisted of a battery and solar panels. Photos of the setup at each location are included in Appendix A, along with models and serial numbers for the noise monitoring kit components at each location.

2.2 ANALYSIS

The study team processed each hour of the 30-day noise measurement results to produce the following characterizations of hourly outdoor noise levels:

- L_{min};
- L_{max};
- L_{eq}; and
- L_{10}, L_{33}, L_{50}, and L_{90}.

Selective audio review was performed on the digital audio files to identify anthropogenic noises that occurred during the measurement periods. For each day, the study team listened to the hour-long audio file containing the L_{max} for that day and identified the source of the L_{max}. Further audio review was performed in service of determining typical noise sources and the L_{nat}, as described in the following section.

HDR processed the 30-day noise measurement data to remove, when appropriate, certain instances, periods of time, or events from the dataset. These included:

- When the onsite weather station recorded precipitation or wind speeds greater than 11 miles per hour (mph). Per Lynch et. al. (2011), wind speeds over 11 mph contaminate the measurement results, making them unreliable.
- When the sound level meters reported overloads, which happens when measured sound levels exceed the upper level of the overall range of sound levels the meter is capable of processing. Part of the sound level meter configuration file is establishing the overall range of sound levels the meter can

measure. The LD 831C has a standard range from 20 to 140 dB that can be adjusted up or down while still retaining the overall dynamic range of 120 dB[1].

- When project staff were onsite setting up, inspecting, and retrieving the equipment.
- When passers-by interacted with the sound level meters, as determined by audio review. Interactions included actions such as talking or singing directly into the microphone, or reading the notice attached to the equipment case out loud. Passers-by did not vandalize or otherwise affect the equipment functionality.

In these instances, the study team excluded data in increments of seconds (not minutes or hours). However, if any hour had more than 25 percent of its seconds excluded, results from that hour were excluded (NPS 2013).

In addition to calculating metrics for the overall 30-day periods, some sites had subsets of dates that were analyzed separately. These included the following:

- At the Ballfield site, October 12-November 6 was analyzed separately because electrical resistivity tomography (ERT) studies were occurring in the area on November 7-10.
- At the Grand Lodge site, October 12-15 and October 16-November 10 were analyzed separately because overnight stays at the Grand Lodge ended for the season on October 15.

2.2.1 Audio Review and L_{nat}

The L_{nat} is intended to represent noise levels at a site in the absence of human-made (anthropogenic) sounds. For a given hour, the hourly L_{nat} is the sound level exceeded x percent of the time, where:

$$x = H\frac{100-PH}{2H} + H \ ,$$

and P_H is the percentage of samples containing anthropogenic (human-made) sounds for a given hour. In order to determine this percentage, the audio recordings from each site were reviewed following the measurements. HDR reviewed the audio recordings on a basis of 10 seconds of audio for every 2 minutes recorded. For each 10-second audio sample, the source or sources of any noise audible were identified to the best of the reviewer's ability. If any of those sources were anthropogenic in origin, that sample was marked as containing anthropogenic noise. Each individual hour, therefore, has its own percentage basis (P_H) for calculating that hour's L_{nat}.

[1] Given the low noise levels expected for this area, the range was adjusted down to 0 to 120 dB. Noise floors for the equipment were 5-6 dBA. All recorded periods with overload were associated with interactions with the equipment or high winds and would have been excluded regardless.

NPS guidance recommends a minimum of 2.5 percent of recorded audio in a measurement be reviewed (NPS 2013). For the 30-day analysis period, a subset of ten days was selected for audio review. At one 10-second sample every two minutes, each day comprises two hours of audio samples. Ten days makes 20 hours of audio, which is 2.8 percent of the total 720 hours in the measurement. The days selected for audio review were Friday October 13 through Sunday October 15, Monday October 23 through Thursday October 26, and Friday November 3 through Sunday November 5. These days were selected to have a relatively even distribution of weekends and weekdays throughout the measurement period, with a slight preference towards weekends because of increased Park attendance.

Based on the audio review, the noise-free interval was also calculated. The noise-free interval is the longest period in a given measurement in which no anthropogenic noise is heard. Since only one ten-second sample was reviewed for every two minutes, the actual noise-free intervals may be shorter if anthropogenic noise occurred between samples.

Audio recordings for the NPS site were not available, so audio review and L_{nat} calculations were not performed for that site.

2.3 RESULTS

Table 2-1 summarizes the metrics calculated for each location by presenting averages of the hourly values across the entire noise measurement duration at each location, with exclusions applied as described in Section 2.2. Metrics are summarized by three periods, including overall (all valid hours), daytime (all valid hours from 7:00 am through 9:00 pm), and nighttime (all valid hours from 10:00 pm through 6:00 am). Note that the daily L_{max} sources presented in Table 2-1 reflect only the loudest source of noise on a particular day, and do not reflect the frequency with which that noise source occurred at a location at a level less than the L_{max}. Detailed hourly values for each site can be found in Appendix B, and discussion of noise sources and results for each site can be found in Section 2.4.

Table 2-2 summarizes the results of the audio review for each location by presenting the percentage of time that each source is audible.

Table 2-1. Ambient Noise Measurement Results Summary (dBA)

Meas. Location	Duration	Period[1]	Avg. Hourly L_{eq}	Over-all L_{min}	Avg. Hourly L_{min}	Over-all L_{max}	Avg. Hourly L_{max}	Daily L_{max} Sources (Incidences)	Avg. Hourly L_{10}	Avg. Hourly L_{33}	Avg. Hourly L_{50}	Avg. Hourly L_{90}	Avg. Hourly L_{nat}	% Anthro. Noise[2]	Longest Noise-Free Interval (hh:mm)
Supai Tunnel	Oct 12- Nov 10, 2023	Overall	41	9	29	82	58	Hikers (talking/ laughing/ yelling/ etc.) (29); airplane (1)	42	38	36	32	34	36%	9:16
		Daytime	40	9	27	82	60		42	37	35	30	31	50%	
		Nighttime	41	10	34	78	54		43	40	39	37	39	12%	
Ballfield[3]	Oct 12- Nov 10, 2023 (full meas. duration)	Overall	32	6	20	69	46	Nearby vehicle (10), wind (9), airplane (8), bird (2), insect (1), hiker (1)	34	30	28	24	27	30%	5:40
		Daytime	33	6	21	69	48		36	32	30	25	28	33%	
		Nighttime	29	6	19	67	42		31	28	26	22	25	24%	
	Oct 12 – Nov 6 (ERT excluded)	Overall	30	6	19	69	45		33	29	27	23	26	30%	5:40
		Daytime	32	6	20	69	47		35	31	29	24	27	33%	
		Nighttime	27	6	17	65	40		29	26	24	20	23	24%	
Grand Lodge	10, 2023 (full meas. duration)	Overall	37	7	20	89	54	Power tools (10), dog (4), vehicle (cart) (3), garbage lid (3), bird (3), wind (2)	39	34	31	25	26	72%	2:52
		Daytime	40	7	21	89	59		42	36	33	27	27	74%	
		Nighttime	32	7	18	76	46		36	30	27	22	23	69%	
	Oct 12-15 (Grand Lodge open)	Overall	44	17	19	89	77	Dog (2), vehicles (carts) (2)	46	43	36	24	*	100%	0:00
		Daytime	46	23	24	89	77		47	45	38	30	*	100%	
		Nighttime	40	17	19	67	62		46	34	28	22	*	100%	

Meas. Location	Duration	Period[1]	Avg. Hourly L_{eq}	Over-all L_{min}	Avg. Hourly L_{min}	Over-all L_{max}	Avg. Hourly L_{max}	Daily L_{max} Sources (Incidences)	Avg. Hourly L_{10}	Avg. Hourly L_{33}	Avg. Hourly L_{50}	Avg. Hourly L_{90}	Avg. Hourly L_{nat}	% Anthro. Noise[2]	Longest Noise-Free Interval (hh:mm)
	Oct 16- Nov 10 (Grand Lodge closed)	Overall	43	7	10	82	72	Power tools (10), people (4), dog (3) garbage lid (3), bird (3), wind (2), vehicle (cart) (1)	44	36	31	18	22	60%	2:52
		Daytime	44	7	13	82	72		45	37	33	21	25	63%	
		Nighttime	35	7	11	76	57		38	31	27	16	21	56%	
The Basin (NPS Site)	Aug 17- Sep 20, 2019[4]	Overall	39	14	25	90	59	N/A	38	32	31	27	N/A	N/A	N/A
		Daytime	45	14	26	90	65		43	35	33	29	N/A	N/A	
		Nighttime	31	14	24	87	48		30	27	26	25	N/A	N/A	
	May 29- Jun 23, 2020	Overall	34	5	18	80	53	N/A	35	30	28	23	N/A	N/A	N/A
		Daytime	38	5	22	80	57		39	34	32	27	N/A	N/A	
		Nighttime	26	5	13	73	45		27	22	20	16	N/A	N/A	

1 Overall includes all hours; daytime includes the hours from 7:00 am through 9:00 pm; nighttime includes the hours from 10:00 pm through 6:00 am.
2: Anthropogenic noise is any human-caused or human-related sound, including voices, footsteps, pack animals, vehicles, aircraft, machinery, etc.
3: Audio review for the Ballfield site did not include the ERT period, so the % anthropogenic noise and longest noise-free interval are the same for the overall period and the ERT excluded period.
4: August 20 and 29 excluded from this range due to incomplete data.
* The L_{nat} is undefined when the anthropogenic noise is 100% audible.
N/A: Audio recordings for this site were not available, so metrics related to noise source identification could not be calculated.

Table 2-2. Audio Review Results

Meas. Location	Duration	Subset[1]	Percent of Time Audible													
			Human-made (Anthropogenic) Sounds									Natural Sounds				
			Helicopter	Airplane	Vehicles	Mules	Humans	Power Tools	Chiller	Hand Dryer	Unidenti-fiable	Wind	Birds	Insects	Unidenti-fiable	No Audible Sound
Supai Tunnel	Oct 12- Nov 10, 2023	Overall	<1%	4%	*	<1%	33%	*	*	*	0%	59%	8%	12%	<1%	12%
		Daytime	<1%	5%	*	<1%	47%	*	*	*	0%	44%	12%	17%	<1%	12%
Ballfield	Oct 12- Nov 10, 2023[2]	Overall	1%	6%	7%	*	2%	*	*	*	15%	52%	18%	9%	3%	22%
		Daytime	2%	7%	9%	*	3%	*	*	*	13%	57%	25%	13%	4%	14%
		Nighttime	<1%	3%	2%	*	<1%	*	*	*	19%	43%	6%	<1%	<1%	34%
Grand Lodge	Oct 12- Nov 10, 2023 (full meas.	Overall	<1%	6%	7%	*	35%	4%	9%	<1%	39%	51%	15%	2%	0%	<1%
		Daytime	<1%	7%	10%	*	50%	6%	10%	<1%	29%	54%	21%	2%	0%	<1%
		Nighttime	<1%	3%	3%	*	10%	0%	8%	<1%	57%	47%	4%	1%	0%	<1%
	Oct 12-15 (Grand Lodge open)	Overall	<1%	1%	15%	*	61%	0%	30%	1%	61%	4%	9%	3%	0%	0%
		Daytime	<1%	1%	19%	*	81%	0%	32%	2%	55%	4%	13%	2%	0%	0%
		Nighttime	<1%	1%	8%	*	28%	0%	27%	<1%	70%	3%	3%	4%	0%	0%
	Oct 16- Nov 10 (Grand Lodge closed)	Overall	<1%	8%	4%	*	24%	6%	0%	0%	30%	72%	17%	1%	0%	<1%
		Daytime	<1%	9%	6%	*	37%	9%	0%	0%	18%	76%	25%	1%	0%	<1%
		Nighttime	<1%	4%	<1%	*	2%	0%	0%	0%	51%	65%	4%	0%	0%	<1%

1 Overall includes all hours; Daytime includes the hours from 7:00 am through 9:00 pm on all days; Nighttime includes the hours from 10:00 pm through 6:00 am.
2 All audio reviewed for the Ballfield site fell during the "No ERT" period (October 15-November 6), so separate noise source percentages are not presented for the two periods.
*Source not present at this location

2.4 SITE-SPECIFIC NOISE MEASUREMENT RESULTS

This section provides a more detailed breakdown of noise measurement results at each site, including descriptions of the acoustic environment and comparison of noise metrics between sites.

2.4.1 Supai Tunnel

The measurement site at Supai Tunnel was located near the toilets along the edge of the trail. The trail widens into an open area at this location and is a popular place for hikers to pause to admire the view, use the toilets, and rest.

Typical anthropogenic sound sources at the Supai Tunnel site included hikers (footsteps, talking and other vocalizing, accessing the bathroom) and distant aircraft. Mules could occasionally be heard in the early part of the measurement period. Typical natural sounds were wind, birds, and insects.

Daily maximum sound levels at the Supai Tunnel site were due almost exclusively to people talking or laughing near the microphone, although direct interactions with the microphone such as talking about it or talking directly into it were excluded from the analysis. On one day, an airplane overflight was the cause of the daily maximum. One particularly loud and low helicopter flyover was known to be associated with Project work based on date and time of the flyover, so it was excluded from the analysis. Other audible helicopter events were not excluded.

The average hourly L_{90} at Supai Tunnel was the highest of the three HDR sites, at 32 dBA overall, 30 dBA during daytime hours, and 39 dBA during nighttime hours. This site was fairly exposed to wind, so it only rarely was extremely quiet. This site had the longest noise-free interval, at 9 hours 16 minutes without audible anthropogenic noise. The Supai Tunnel site could be considered representative of trail uses at the Park, although noise levels were somewhat elevated due to its popularity as a resting spot.

2.4.2 Ballfield

The Ballfield measurement site was at the proposed drilling site, in the open area at the end of Ballfield Road.

Typical anthropogenic sound sources at the Ballfield site included noise from Park guests using the Transept Trail nearby, vehicles both close to the meter and more distant on the main Park road, and aircraft. There were also an unidentified hum and a rumble that were frequently audible during nighttime and other quiet periods. This could have been noise from trailer generators or heaters in the service area nearby. Typical natural sounds were wind, birds, and insects, with occasional unidentified scratching that could have been a small mammal or non-vocal bird. One instance of interaction with the microphone was excluded, along with one helicopter flyover known to be associated with Project work.

Sources of daily maximum sound levels at the Ballfield included airplanes, nearby vehicles, wind, birds, insects, and nearby talking.

Since ERT testing was taking place at the Ballfield from November 7-10, the period from October 12-November 6 was analyzed separately so extraneous noise from those activities could be excluded. Excluding this period caused most reported metrics to decrease by 1-2 dB. For the overall period/ the period with ERT excluded, the average hourly L_{90} was 27/26 dBA overall, 28/29 dBA daytime, and 25/23 nighttime. The longest noise-free interval was 5 hours 40 minutes, although this coincided with a period of wind that served to mask the unidentified hum/rumble.

2.4.3 Grand Lodge

The Grand Lodge measurement site was in an open space directly to the east of the main lodge building, a well-traveled area in the vicinity of cabins and sidewalks. The Grand Lodge closed to overnight guests on October 15, so in addition to the full measurement period, the periods from October 12-15 and October 16-November 10 were analyzed individually.

Typical anthropogenic sound sources at the Grand Lodge site included noise from Park guests walking and talking near the equipment, vehicles including automobiles and buses in the parking lot and Grand Lodge turnaround as well as groundskeeping vehicles driving near the equipment, helicopters and other aircraft, power tools and noise from the hand dryers in the bathroom facilities. This site was near a chiller for the saloon at the Grand Lodge, which was cycling on and off until the Grand Lodge was closed for the season after October 15. There were also an unidentified hum and a rumble that were frequently audible during nighttime and other quiet periods, similar to those described at the Ballfield site. Here, the sound was likely due to electrical equipment associated with the Grand Lodge or cabins. The rumble was more prevalent while the Grand Lodge was open to overnight visitors, while the hum was more prevalent after the end of the season. While the Grand Lodge was open, the hum/rumble was audible for 100 percent of the time, but after it closed, it was fainter and there were periods where it was inaudible. After the end of the season, power tools of various sorts including chainsaws, blowers, and others that were not readily identifiable were frequently audible during daytime hours. Direct interactions with the noise monitoring equipment were excluded from the analysis. Natural sounds at the Grand Lodge site included primarily wind and birds.

Sources of daily maximum sound levels included dogs and powered carts while the Grand Lodge was open, and after it closed included dogs and carts as well as power tools, people talking, a garbage lid slamming, birds, and wind.

After the Grand Lodge closed, the average hourly L_{90} was the lowest of the sites measured, at 18 dBA overall, 21 dBA daytime, and 16 dBA nighttime. This is likely due to the fact that the proximity of the Grand Lodge building and other buildings made the measurement site more shielded from wind than the other sites, and visitor noise during this period was limited enough to not affect the L_{90}. This demonstrates the strong effect wind can have on measured sound levels. For the overall period/ Grand Lodge open period, the average hourly L_{90} was 25/25 dBA overall, 26/30 dBA daytime, and 22/23 dBA nighttime. The longest noise-free interval at the Grand Lodge site was 2 hours 52 minutes, which occurred after the Grand Lodge had closed. As noted above,

an unidentifiable hum/rumble was constantly audible while the Grand Lodge was open. The Grand Lodge site could be considered representative of developed areas within the Park.

2.4.4 Basin (GRCA 054)

Information about this NPS measurement site was limited. The provided logsheet for the measurement identifies the site name as "The Basin", a backcountry site with 25-50 percent vegetation cover and 0-25 percent canopy cover. The site was approximately 200 meters (650-FT) from the Point Sublime trail, an offroad vehicle trail. The site was chosen for measurements because it is located under an air tour flight corridor. No audio recordings were available for the measurement, so typical noise sources were not able to be identified.

The 2020 measurement, which occurred in May and June, was overall quieter than the 2019 measurement, which occurred in August and September. The average hourly L_{90} for 2019/2020 was 27/23 dBA overall, 29/27 dBA daytime, and 25/16 dBA nighttime. This is comparable to the Ballfield site, although the Basin site is much farther removed from developed areas. Although high overall L_{max} of 90/80 dBA daytime and 87/73 dBA nighttime in 2019/2020 were recorded, the average hourly L_{max} for 2019/2020 were 59/53 dBA overall, 65/57 dBA daytime, and 48/45 dBA nighttime, which is also comparable to the Ballfield site. The Basin site may have been exposed to noise from offroad vehicles, airplanes, wind, or birds at a similar rate, but without audio recordings the sources cannot be definitively identified.

3 CONSTRUCTION NOISE INVENTORY

A list of construction activities associated with the Project is given in Table 3-1. The duration of each activity is given, along with a list of equipment associated with each activity. The sound level given is the L_{max}, which is the maximum instantaneous sound pressure level associated with a given piece of equipment. Most construction equipment is dynamic and does not generate the same noise levels at all times during operations, so the L_{max} represents a "worst case" noise emission level. Sound level data for the table is taken from the Roadway Construction Noise Model version 2.0 (RCNM), issued by the US Federal Highway Administration (FHWA).

Indoor construction activities are not listed here because the building envelope will reduce noise transmitted to the outside, though care should be taken to keep doors and windows closed when possible, to minimize noise transmission. Helicopters are noted in this table when included in a construction activity, but helicopter sound levels are beyond the scope of this analysis.

Table 3-1. Construction Activities and Sound Levels

Activity	Duration	Equipment	Sound Level at 50-FT (L_{max}, dBA)
Raw Water Conveyance Boring (site clearing and tree removal)	2-3 months Daytime hours	Chainsaw	83
		Grader	79
		Excavator	87
		Front End Loader	81
		Dump Truck	92
		Compactor (roller)	82
		Flatbed Truck	74
Raw Water Conveyance Boring	2-3 months 24 hours/day	Oil and gas drilling rig & ancillary equipment	See Section 4
		Flatbed Truck	74
Water Treatment Plant/Wastewater Treatment Plant (building construction)	2 years Daytime hours	Excavator	87
		Front End Loader	81
		Skid Steer	72
		Dump Truck	92
		Compactor (roller)	82
		Crane	76
		Flatbed Truck	74
		Man Lift	73
		Vac-truck	87
		Circular Saw	76
		Vibratory Concrete Mixer	80
		Pneumatic Tools	72
		Concrete Pump Truck	88
		Portable Generator	68
Pipeline	2 years Daytime hours	Excavator	87
		Front End Loader	81
		Grader	79
		Dump Truck	92
		Vac-truck	87
		Skid Steer	72

		Compactor (roller)	
Overhead Power	6-8 months Daytime hours	Small/portable micro-pile drilling rig	80
		Portable Generator	68
		Helicopter	N/A
North Rim Power (Diesel storage fuel tank and transformer replacement)	8 months Daytime hours	Excavator	87
		Skid Steer	72
		Flatbed Truck	74
Inner Canyon Power (power cable along existing pipeline from RSPH to Manzanita)	6 months Daytime hours	Hand tools	66-100
		Portable Generator	68
		Small Track Backhoe	84
Innercanyon Power (shade structure at Cottonwood Campground)	1-2 months Daytime hours	Skid Steer	72
		Backhoe	84
		Compactor (roller)	82
		Portable Generator	68
		Helicopter	N/A
Roaring Springs Pumphouse	6 months Daytime hours	Helicopter	N/A
		Skid Steer	72
		Portable Generator	68
		Small Track Backhoe	84

Source: Burge, 2022
Skid steer noise levels source: CAT 2024

All construction activities will occur during daytime hours, with the exception of the raw water conveyance boring, which will operate 24 hours a day after once drilling commences. Power cable and pipeline activities would not occur in a fixed location for the duration of the activity but will progress along their selected route. More information about the noise generated by the boring activity is given in the next section. The general locations of each construction activity are shown on Figure 3-1.

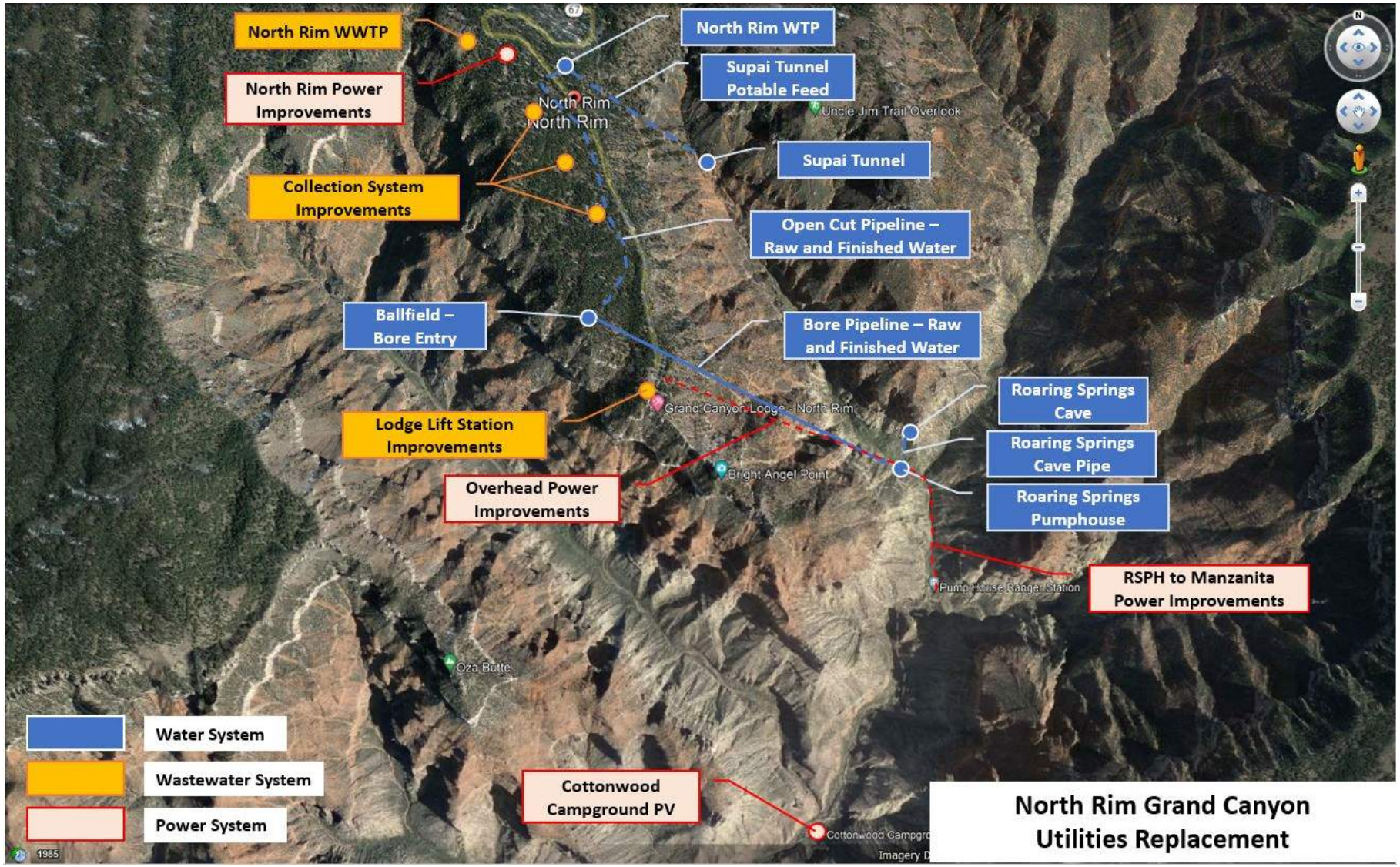


Figure 3-1. North Rim Grand Canyon Utilities Replacement Construction Areas

4 BORING NOISE MODELING

The study team used CadnaA environmental noise modeling software to model noise from noise sources related to the raw water conveyance boring activity. CadnaA incorporates calculations from ISO 9613-2, which is the international acoustical standard for outdoor sound propagation (ISO 1996)[2]. The following sections describe the boring operation, noise sources and settings for the noise model, the resulting noise contours, and potential mitigation measures to reduce noise associated with the boring activity.

4.1 BORING OPERATION DESCRIPTION

Following is a rough schedule for the boring operation as it relates to noise:

- Equipment and Material Mobilization (5-10 days). Multiple semi-trucks constantly moving around the site. 25-35 personnel mobilizing to the Grand Canyon in stages. Generators and light plants will begin operating and the site will be operational 24/7.
- Drilling 35-40 days. At a high level, this will involve drilling and setting casing and cementing the casing in four sequences (four different sized casings are planned to be set).
    - Drilling ~60 percent of operating time. Requires 24/7 operation of the top drive, drill floor, generators, mud pumps (or compressors) and shakers.
    - Set Casing ~30 percent of operating time. Requires 24/7 operation of top drive, drill floor, and generators. Mud pumps, shakers, and compressors will likely be on (still generating some noise) but not operating at full capacity or maximum noise levels.
    - Cement casing ~10% of operating time. Generators running 24/7. Cement is either trucked in or batched onsite. In both cases, large pumps (likely equivalent to one mud pump) will be operating 24/7 to cement the casing.
- Carrier Pipe Installation (10-15 days). This will involve use of the top drive, generators, and drill floor throughout the installation process. The shakers, compressors, and mud pumps will likely be off.
- Carrier Pipe Testing (2 days) – carrier pipe pressure test. Drill equipment demobilizing or on standby.
- Demobilization (4-7 days) – Multiple semi-trucks constantly moving around the site. Drill rig de-constructed and all equipment and material removed from site.

Semi-truck operation during mobilization and demobilization may result in temporarily elevated noise levels along roadways leading to the site and on-site. Traffic associated with operators traveling to and from the site is not expected to meaningfully change

[2] It is important to note inherent limitations in the accuracy of this calculation method. The estimated accuracy given in ISO 9613-2 is ±3 dB over 1 kilometer (0.6 miles) over relatively flat ground. No estimate of accuracy is given for distances greater than this limit, so noise results should be taken as informational only.

noise levels compared to typical Park traffic, except for potentially along the proposed access roadway between the bore site and SR67, which is not heavily traveled under normal circumstances.

4.2 NOISE MODEL INPUTS

Noise sources and sound level inputs for the noise model were developed based on information provided by Lithos Engineering/GEI, in combination with data from HDR's library of similar projects, publicly available data, and textbook methods for sound level estimation.

Noise sources included in the model include the generators, shaker/suction tanks, drill top drive, drill floor, and light plants. Additionally, depending on whether drilling is occurring with mud or with air/foam at a given time, mud pumps or compressors and boosters may be operating, but they will not operate simultaneously with one another. The compressors and boosters were selected for modeling since their quantity was greater than the mud pumps with the same individual sound power per unit.

Table 4-1 lists the modeled noise sources, their quantities, their octave-band and overall sound power levels, and the data source and/or basis for those sound power levels. These sound power levels were used as inputs to the CadnaA noise model.

Note that some basic acoustical mitigations may already be present as part of the drilling operator's typical package. The sound levels reported here were intended to represent a basic level of mitigation – for example, the generator may be equipped with a standard silencer and enclosure by default, but a higher-performance silencer and enclosure may be available as part of a special low-noise package.

Table 4-1. Noise Model Sound Power Level Inputs

Noise Source	Quantity	Sound Power Level (L_w) by Octave Band (in Hz), dBL (re 10^{-12} W)									Overall L_w, dBA	Data Source
		31.5	63	125	250	500	1000	2000	4000	8000		
Generators	3	102	101	117	108	108	108	107	104	100	114	Generic drilling generator (eNoise Control, 2024)
Mud Pumps	2 [a]	101	105	104	101	97	93	101	93	82	104	KCA Deutag T-208 Wirth TPK-1600 mud pumps, 1,600 HP (Xodus, 2015)
Compressors and Boosters	9 [a]	94	90	95	94	92	95	100	97	90	104	Generic rotary screw compressor spectrum[b]
Shaker/Suction Tanks	2	119	108	105	101	101	99	94	94	93	104	KCA Deutag T-49 Thule VSM 300 shaker (Xodus, 2015)
Top Drive	1	93	98	99	97	95	94	92	86	78	99	Boldon Rig 92 Varco IDS 4 AC Top Drive (Xodus, 2015)
Drill Floor	1	115	102	106	106	110	102	96	88	80	109	KCA Deutag T-49 Bentec E-1250-DC Draw-works (1,250 HP) (Xodus, 2015)
Light Plant	3	94	98	96	92	86	87	85	81	74	92	Generic light plant (eNoise Control, 2024)

Notes:
General: The given sound power levels are for each individual piece of equipment, quantities are not reflected in the reported levels.
[a] Either the mud pumps or the compressors and boosters will be operating; they will not operate simultaneously. Compressors/boosters were chosen for modeling since their quantity was higher than the mud pumps.
[b] Calculated using compressor/booster spectrum shape from Bies and Hansen (2009), dBA L_w matched to mud pump level per information from Lithos

Although certain noise sources will cycle on and off for various periods during the operation, there will be periods of 1-2 continuous hours throughout the operation when all noise sources will be operating at once, and these may occur multiple times per day, at any time of day. The model represents the worst-case scenario when all noise sources are operating at once, with the mud pump/compressor exception noted above. Outside of this worst-case scenario, the equipment operating at a given time will vary depending on the phase of drilling, but there will not be any periods where no noise sources are operating.

The layout of the boring site as modeled is shown on Figure 4-1.

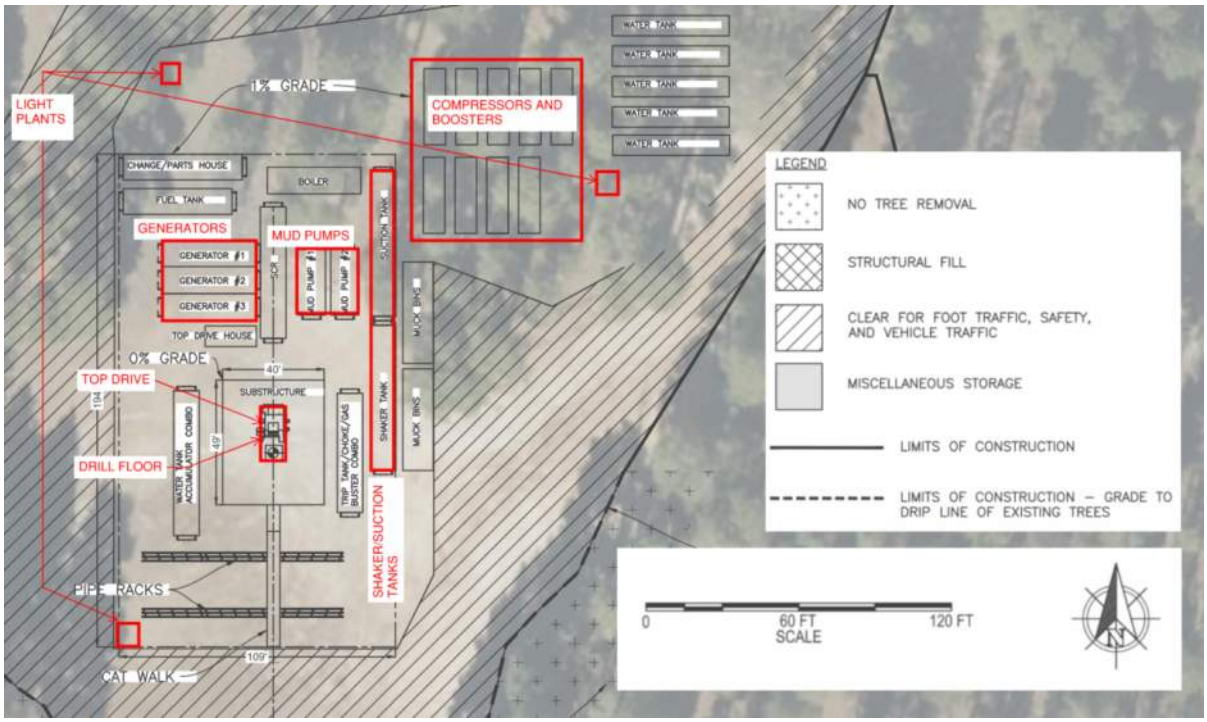


Figure 4-1. Boring Site Layout

All noise sources were modeled as point sources, with the exception of the top drive. All noise sources were modeled with heights of 10-FT above ground, with the exception of the light plants (5-FT), drill floor (25-FT), and top drive. The top drive will travel from 90-FT down to the height of the drill floor over the course of 1-2 hours, so it was modeled as a line source extending from 90-FT down to 25-FT.

4.2.1 CadnaA Settings

The noise model included terrain out to 5 miles from the drilling site. The terrain was imported using 40-FT United States Geological Survey (USGS) contour lines. One limitation of the CadnaA model and ISO 9613-2 is that reflections from ground are accounted for only as a factor in noise propagation. The calculation method does not account for reflections from steep, acoustically reflective ground, such as a cliff face or canyon wall. To account for this limitation, 3-D reflector objects were created in

areas of the canyon with slopes steeper than 3:1. First-order reflections from these cliff faces were able to be accounted for with the inclusion of these reflector objects.[3]

Ground surface cover types vary throughout the study area; therefore ground zones were used in the model to delineate more absorptive areas and more reflective areas. Ground absorption factors range from 0 for fully reflective surfaces to 1 for fully absorptive surfaces. The canyon interior was assigned a ground factor of 0.1, while flat areas above the canyon were assigned a ground factor of 0.5. Foliage zones with a height of 25-FT above ground were modeled in areas near the boring site and North Rim facilities where foliage cover appeared dense on aerial imagery.

Meteorological settings in CadnaA were configured based on typical conditions for the area of 10 degrees Celsius (°C) and a humidity of 50 percent[4]. By default, CadnaA calculates sound propagation under moderate downwind conditions from every noise source to every receiver, and a mild atmospheric temperature inversion, which are ideal (i.e., conservative) conditions for long-distance sound propagation.

4.3 NOISE MODEL RESULTS

The CadnaA noise modeling software calculates Project-related noise from the noise sources at each intersection throughout a Cartesian coordinate grid, accounting for factors that affect sound propagation such as terrain, atmospheric absorption, and ground surface cover types. Using those results, CadnaA creates noise contours which are overlaid upon base maps to create noise contour figures. The noise contours represent noise during the periods when all noise sources are operating and are calculated at a height of 5-FT above ground level. Contours were calculated out to 25 dBA, which represents the background ambient sound level of the area (the average measured hourly L_{90} across the four noise monitoring sites was 26 dBA). The unmitigated noise contour is shown in a broad view in Figure 4-3 and in a view focused on the developed North Rim area in Figure 4-3. Selected locations are identified as receivers in the figures, and sound levels at those locations are given in Table 4-2.

[3] One further limitation of this method is that barrier objects are capable only of specular (mirror-like) reflection, where the angle of incidence of a sound is equal to the angle of reflection. In reality, a rough canyon wall would reflect sound in many different directions. Although this cannot be accounted for in CadnaA/ISO 9613-2, using the reflector objects to capture the first-order reflection should give a better representation of actual noise behavior than not accounting for canyon wall reflections at all.

[4] While the temperature and humidity may vary throughout the drilling period, the degree to which this will affect sound propagation is small (differences of less than 1 dBA). The temperature and humidity selected as modeling parameters are associated with low atmospheric sound absorption, and thus result in conservative sound levels.

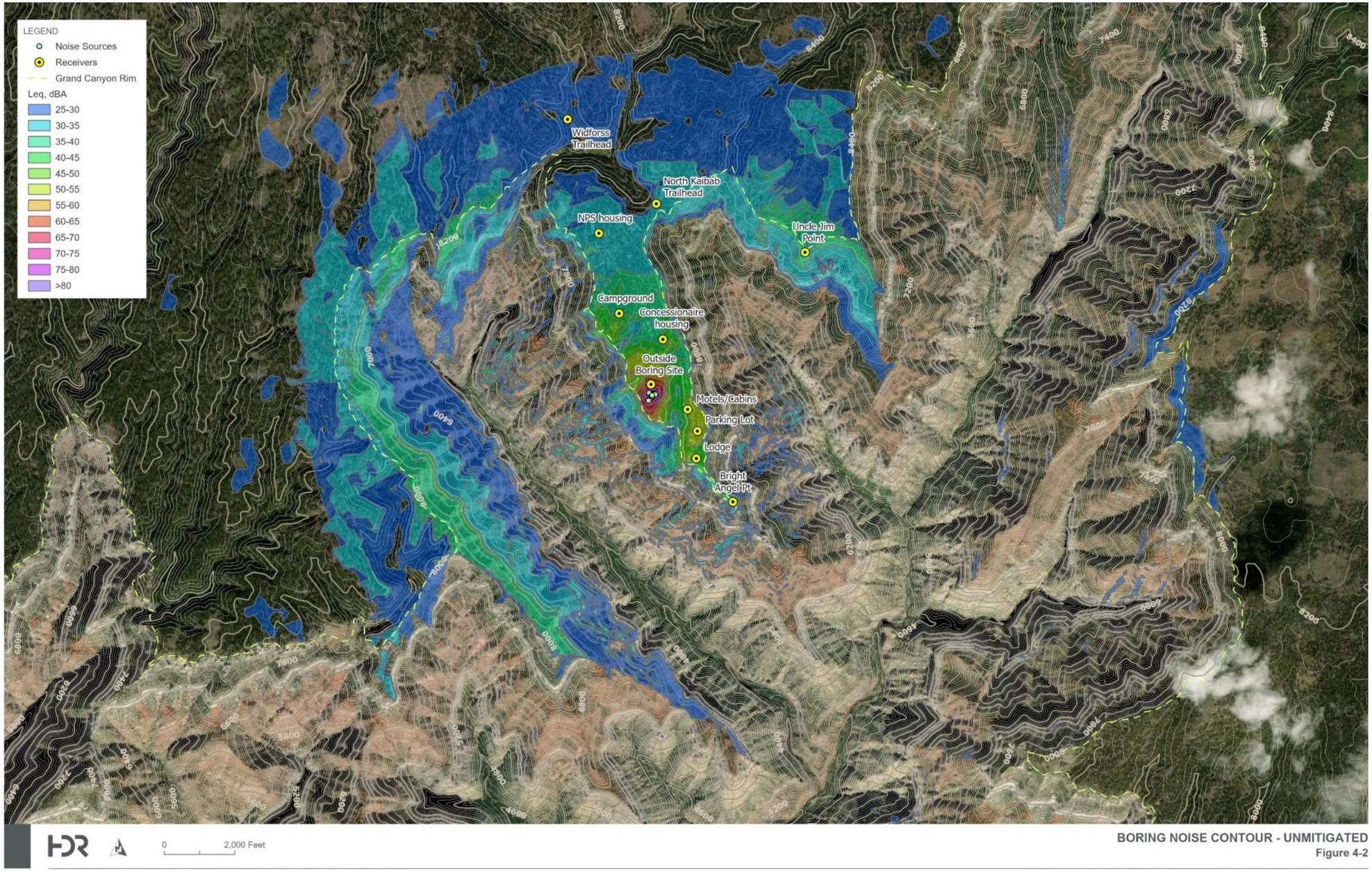


Figure 4-2. Unmitigated Noise Contour (Wide View)

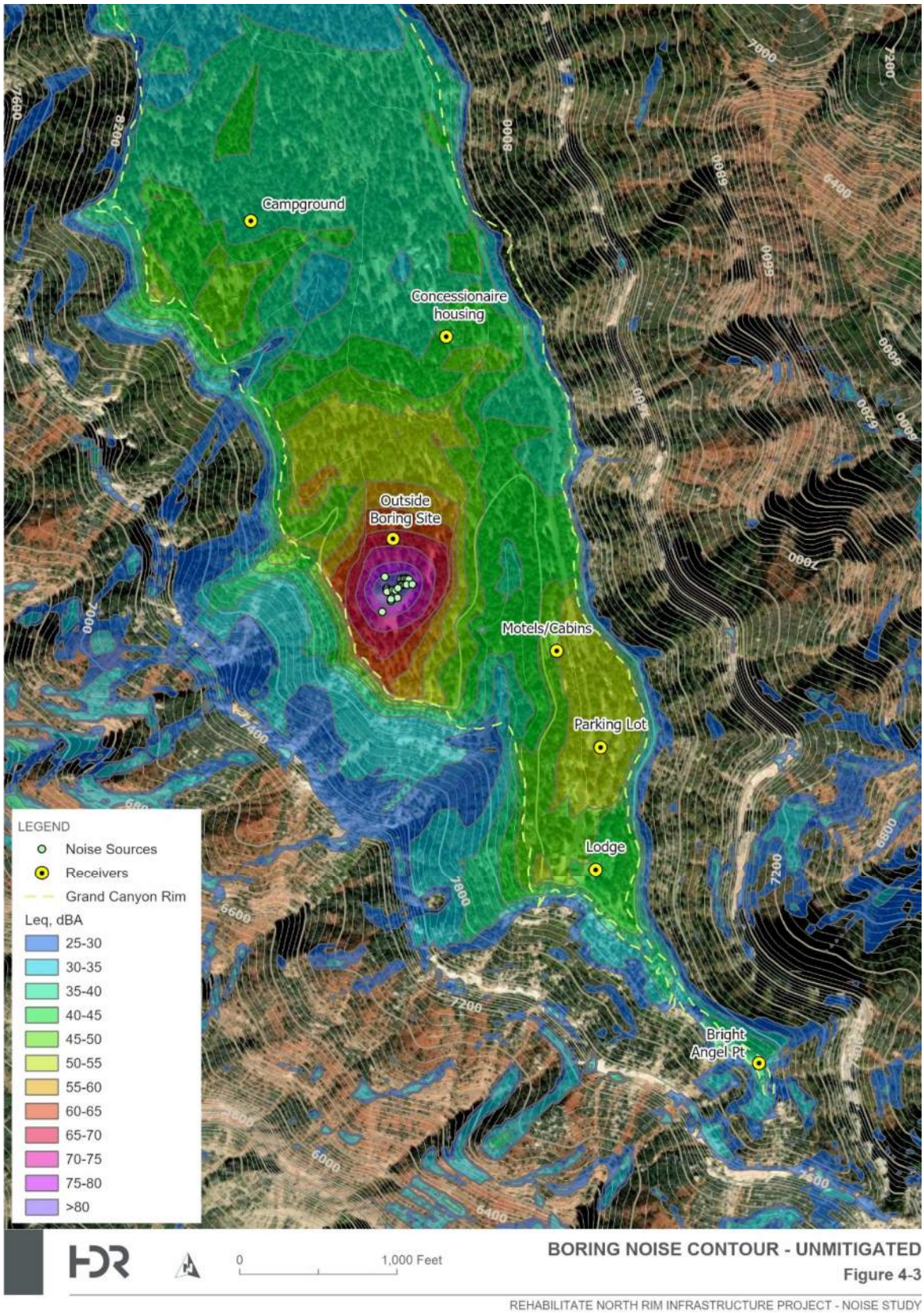


Figure 4-3. Unmitigated Noise Contour (Developed Area)

Table 4-2. Base Noise Model Results

Receiver Location	Distance from Borehole (FT)	Calculated Sound Level (dBA)
Outside Boring Site	380	68
Motels/Cabins	1100	50
Parking Lot	1630	51
Concessionaire housing	1700	43
Grand Lodge	2160	43
Campground	2570	39
Bright Angel Pt	3760	37
NPS housing	4900	32
North Kaibab Trailhead	5520	31
Uncle Jim Point	6040	40
Widforss Trailhead	8280	27

The figures and table show that unmitigated noise from the boring activity would be 35 dBA or higher through most of the developed North Rim area, reaching around 50 dBA in certain areas of the cabins and the main parking lot. Although 35 dBA is not particularly loud as far as everyday sound levels go[5], it would be perceived as twice as loud as the average existing background level of 25 dBA, and be readily noticeable in otherwise quiet moments. Levels of 50 dBA would be fairly obtrusive given the quiet background, similar to a nearby road with continuous light traffic. Levels within the Canyon are generally below 25 dBA because of shielding from the terrain, although some areas within the canyon show levels between 25-30 dB because of reflections from the canyon walls.[6] Noise levels across adjacent side canyons may reach 25-40 dBA, and even reach 25 dBA three miles to the east across the main canyon where the line of sight is unobstructed. Note that noise from the drilling rig may be audible even when below 25 dBA, depending on ambient conditions and depending on the frequency content of the drilling noise.

[5] See Table 1-1 for a list of SPL values for common noise sources.

[6] Due to the limitations in reflection calculation noted above, the contour shading within the canyon should not be taken as prediction of the exact locations where noise from the drilling will be increased, but should be interpreted as indicating the likely existence of some such areas.

4.4 MITIGATION

A number of options are available to reduce noise from the drilling operations, if determined to be required. These include treatments for individual noise sources such as enclosures and silencers, and a noise barrier to shield the entire operation. Treatments for individual sources may be part of a drilling operator's standard offerings, or they may need to be specially required in the construction specifications. With the sources modeled as described above, the generators and compressors are generally the loudest noise sources. Different mitigation options are described in more detail below.

This mitigation discussion is intended to serve as a general overview of sources to be addressed, measures that may be taken, and expected noise reduction from those measures. Specific noise mitigation design should be undertaken in collaboration with the drilling operator during the equipment selection process so that low-noise options for each piece of equipment can be selected, and enclosures/silencers/etc can be tailored to the noise characteristics of the selected equipment to achieve the maximum reasonable noise reduction while maintaining performance needs such as airflow and cooling.

4.4.1 Enclosures and Silencers

High-specification enclosures can be used for the generators, mud pumps, compressors, and shaker/suction tanks. For the mud pumps, compressors, and shaker/suction tanks, both the driving engine (if present) and the pump/compressor itself can be enclosed. For generators and other equipment where an engine is present, high-specification silencers can be used for the exhaust.

Note that while only compressors and boosters were modeled, a similar level of mitigation may also be provided to the mud pumps so that mitigated levels are still achieved while the rig is operating with mud, as two unmitigated mud pumps have the potential to be louder than nine mitigated compressors.

It is expected that reductions of at least 10 dB in the source sound power level can be achieved through properly designed enclosures and silencers. If any equipment cannot be enclosed with an acoustic enclosure, local screening may be an option. Equipment could be screened by other, non-noise generating equipment, or by acoustic barriers or blankets. These methods would be expected to reduce the noise contribution from treated sources by 3-5 dB.

4.4.2 Top Drive

Although the top drive is not as loud as most other sources, its elevation gives it an unobstructed path for the sound to propagate to the surroundings. Depending on the mast configuration and top drive design, mast-mounted attenuation such as suspended barriers could be used to shield top drive noise, or an enclosure for the top drive itself

could be used. These methods would be expected to reduce top drive noise contributions by approximately 5 dB.

4.4.3 Other Sources

Mitigation for the light plants was not evaluated since they are a relatively low contributor to overall noise levels.

The drill floor was modeled in the base scenario as being open to the surroundings, but it will likely be screened by other structures. If the drill floor will be open to the surroundings, screening in the form of a barrier mounted to the floor can be considered. For the mitigated scenario, the drill floor was modeled as being screened by a 10-FT barrier open to the south, to represent screening by structures, as shown on Figure 4-4. A barrier taller than 10-FT would not provide substantially greater mitigation than a 10-FT barrier unless it was tall enough to fully enclose the top drive path as well, which would be more feasibly applied as the mast-mounted shielding described in the previous section.

4.4.4 Barrier

A noise barrier can be erected around the drilling site to block noise from all ground level equipment. Barrier panels, if specified, should have an acoustical performance of at least Sound Transmission Class (STC) 25 with sound absorption for the side of the barrier facing the equipment to avoid noise buildup in the work area. This usually takes the form of a perforated metal facing over a porous interior material. If possible, the barrier should be aligned with an overlap at the entrance so that noise sources are not visible from any point outside the barrier envelope. Placing non-noise-generating structures such as offices and tanks between noise sources and the entrance can also help keep noise from escaping. See Figure 4-4 for an example barrier layout.

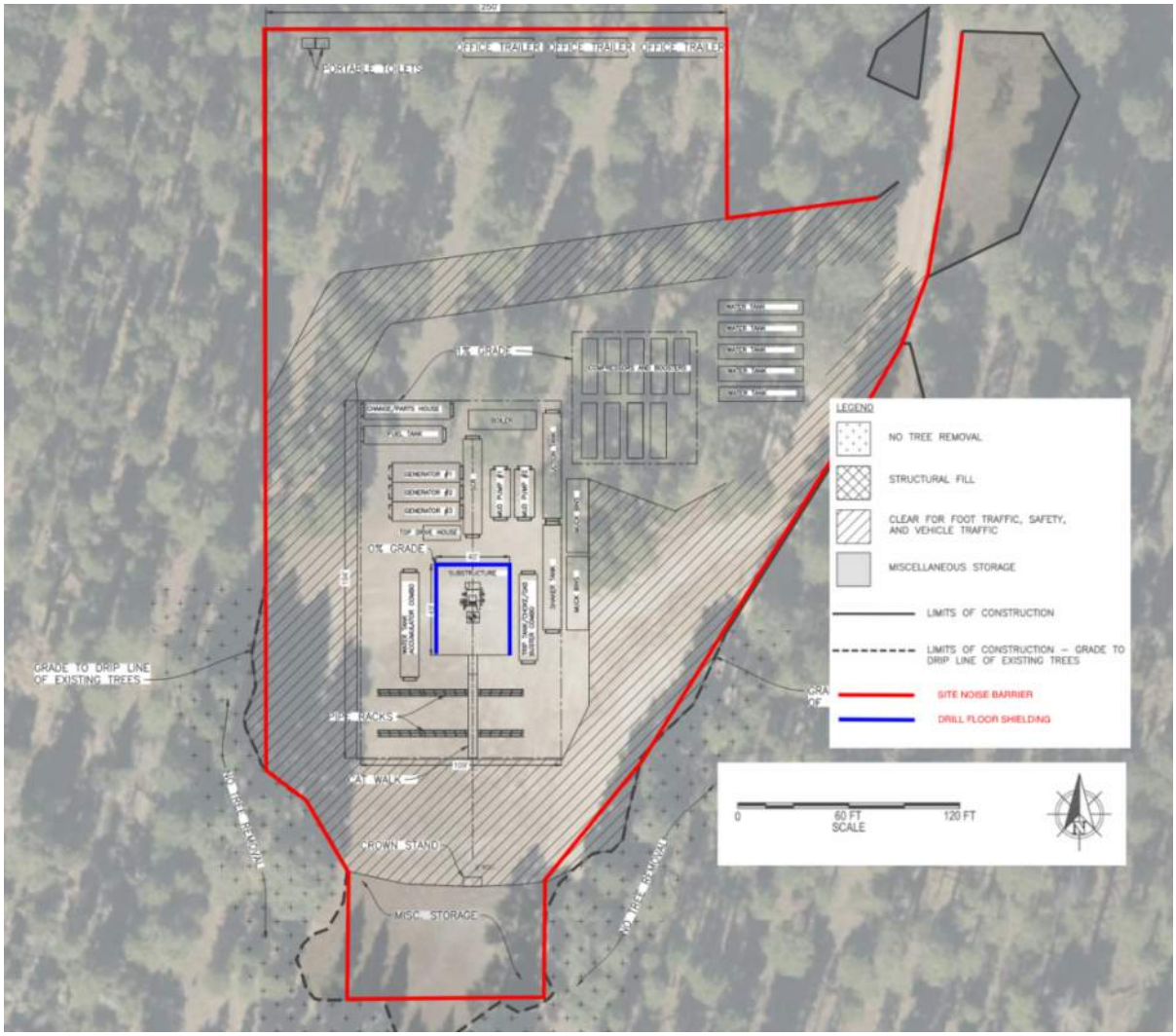


Figure 4-4. Noise Barrier Layout

Unlike enclosures and silencers, where the reduction in noise is the same regardless of receiver distance from the noise source, a noise barrier's effect is spatially dependent. In the immediate surroundings of the barrier, the noise reduction may be 10-15 dB. However, at greater distances, the reduction may be as low as only 3-5 dB. This is due to sound refracting over the top of the barrier: near the barrier, the refraction angle between the top of the barrier and the receiver is large, so noise cannot travel to the receiver as easily, whereas at greater distances the angle is smaller, and refraction is easier.

Temporary barriers are often used to block noise from short-term construction activities. Depending on wind loading requirements, freestanding barriers may reach up to 20-FT in height, while barriers with support from driven piles may reach 40-FT.

See Figure 4-5 for example images of these barrier types.[7] While a 40-FT barrier would be more effective, reducing noise by 9 dB near the site and 4 dB far from the site relative to a 20-FT barrier, installing the necessary supports would increase installation time, as well as increase temporary noise during installation and deinstallation of the barrier due to the need to drive or otherwise install piles for support. Additional tree clearing may also be needed for appropriate clearance between the barrier and drilling site features. Duration and magnitude of noise during installation and deinstallation should be discussed with any barrier supplier and weighed against the predicted noise reduction from a taller wall.

Figure 4-5. Example Freestanding Barrier (L) and Ground-Mounted Barrier (R)

Noise barriers may have the additional effect of shielding some light from the drilling operation. Illuminating lights on trailers and equipment will likely be 10 to 15-FT high and will receive the greatest shielding from a noise barrier. Lights on the derrick, including both illuminating lights and Federal Aviation Administration-required red aircraft warning lights will be mounted too high for the barriers to shield.

4.5 MITIGATION MODEL INPUTS AND RESULTS

Noise mitigation for the generators and shaker/suction tanks was modeled based on data for actual enclosed units. Mitigation for the mud pumps and compressors was modeled with a flat 10-dB reduction, and mitigation for the top drive was modeled as a flat 5-dB reduction. The drill floor was modeled with a 10-FT barrier mounted to the floor and surrounding it on 3 sides, although this screening may already be naturally present depending on the drill rig configuration. Noise barriers were modeled with a conservative sound absorption spectrum on the interior based on typical acoustical barriers for industrial sites. A summary of mitigation measures as applied in the noise model is given in Table 4-3.

[7] Freestanding barrier image source: https://environmental-noise-control.com/products/k-rail-mounted-temporary-sound-wall/
Mounted barrier image source: https://environmental-noise-control.com/products/temporary-sound-walls/

Table 4-3. Mitigated Noise Model Inputs

Noise Source	Quantity	Sound Power Level (L_w) by Octave Band (in Hz), dBL (re 10^{-12} W)									Overall L_w, dBA	Data Source
		31.5	63	125	250	500	1000	2000	4000	8000		
Generators	3	103	106	106	96	89	86	80	72	55	94	Drillmec HH-220 CAT 3512B genset, hi-spec enclosure and silencer (Xodus, 2015)
Mud Pumps	2 [a]	Enclosures and silencers: 10 dB reduction										Xodus, 2015
Compressors and Boosters	9 [a]											
Shaker/Suction Tanks	2	114	96	92	88	90	89	86	85	83	94	KCA Deutag T-208 Enclosed Thule VSM 300 shaker (Xodus, 2015)
Top Drive	1	Mast-mounted barriers or top drive enclosure: 5 dB reduction										Xodus, 2015
Drill Floor	1	10-FT screening barrier around 3 sides of drill floor (may already be screened by structures)										N/A
Light Plant	3	No mitigation										N/A
Site		20- or 40-FT barrier around site perimeter with absorptive interior										N/A

Notes:
[a] Either the mud pumps or the compressors and boosters will be operating; they will not operate simultaneously. Compressors/boosters were chosen for modeling since their quantity was higher than the mud pumps.
[b] Compressor/booster spectrum shape from Bies and Hansen (2009), dBA L_w matched to mud pump level per information from Lithos

For the mitigation modeling, a series of five mitigation scenarios were modeled:

- Equipment-based mitigation only
- 20-FT site barrier only
- 20-FT site barrier and equipment-based mitigation
- 40-FT site barrier only
- 40-FT site barrier and equipment-based mitigation

Equipment-based mitigation includes mitigation for the generators, shaker/suction tanks, mud pumps and compressors, drill floor and top drive. The results are not broken out by individual mitigation items because if any individual piece of equipment is left unmitigated, the overall noise reduction will be greatly compromised.

Table 4-4 shows results from each of the mitigation scenarios as well as the base scenario at selected locations throughout the North Rim. Results from the 20- and 40-FT barriers with no equipment mitigation show that in certain directions and at certain distances, the noise reduction from the base case may be negligible. Equipment mitigation without a barrier gives around 10 dB of reduction at most locations, although certain locations experience somewhat less reduction due to exposure to the unshielded side of the drill floor (see modeled shielding layout in Figure 4-4). The greatest noise reductions are seen with equipment mitigation in combination with a site barrier, with reductions of 7-18 dB for a 20-FT barrier and 11-18 dB for a 40-FT barrier (not counting the location directly outside the boring site, which experiences even greater reduction due to being situated in the barrier's shadow. The combined equipment mitigation and 40-FT barrier would be expected to bring boring noise levels to levels similar to the average existing ambient level of 25 dBA at medium-distant locations such as the campground and Bright Angel Point, although levels in the parking lot and some cabins would be near 10 dB above this level. Note that boring noise may be audible even when below 25 dBA, depending on ambient conditions and depending on the frequency content of the drilling noise.

Table 4-4. Mitigated Noise Model Results

Location	Distance from Borehole (FT)	Base (no mitigation or barrier)	20-FT barrier, no equipment mitigation		40-FT barrier, no equipment mitigation		Equipment mitigation only, no barrier		Equipment mitigation with 20-FT barrier		Equipment mitigation with 40-FT barrier	
		Sound Level (dBA)	Sound Level (dBA)	Change from Base (dB)	Sound Level (dBA)	Change from Base (dB)	Sound Level (dBA)	Change from Base (dB)	Sound Level (dBA)	Change from Base (dB)	Sound Level (dBA)	Change from Base (dB)
Outside Boring	380	68	54	-14	49	-19	58	-10	46	-22	40	-28
Motels/Cabins	1100	50	47	-3	42	-8	46	-4	41	-9	37	-13
Parking Lot	1630	51	45	-6	40	-11	43	-8	38	-13	35	-16
Concessionaire housing	1700	43	43	0	41	-2	32	-11	32	-11	29	-14
Lodge	2160	43	40	-3	32	-11	36	-7	35	-8	28	-15
Campground	2570	39	39	0	38	-1	28	-11	28	-11	26	-13
Bright Angel Pt	3760	37	35	-2	30	-7	30	-7	30	-7	26	-11
NPS housing	4900	32	32	0	32	0	20	-12	20	-12	21	-11
North Kaibab Trailhead	5520	31	30	-1	28	-3	19	-12	18	-13	17	-14
Uncle Jim Point	6040	40	32	-8	32	-8	27	-13	24	-16	22	-18
Widforss Trailhead	8280	27	22	-5	19	-8	14	-13	9	-18	9	-18

Figure 4-6 and Figure 4-7 show broad and focused views of a noise contour with all the equipment mitigation and the 40-FT barrier applied. The selected locations highlighted in Table 4-4 are also shown for reference. (Noise contour maps for the other mitigation cases are located in Appendix C). In comparison with the unmitigated noise contour, the extent covered by the mitigated contour is much smaller, only reaching across the canyon to the northeast with some scattered patches due to reflections within the canyon. Levels within the developed areas of the North Rim are also much lower.

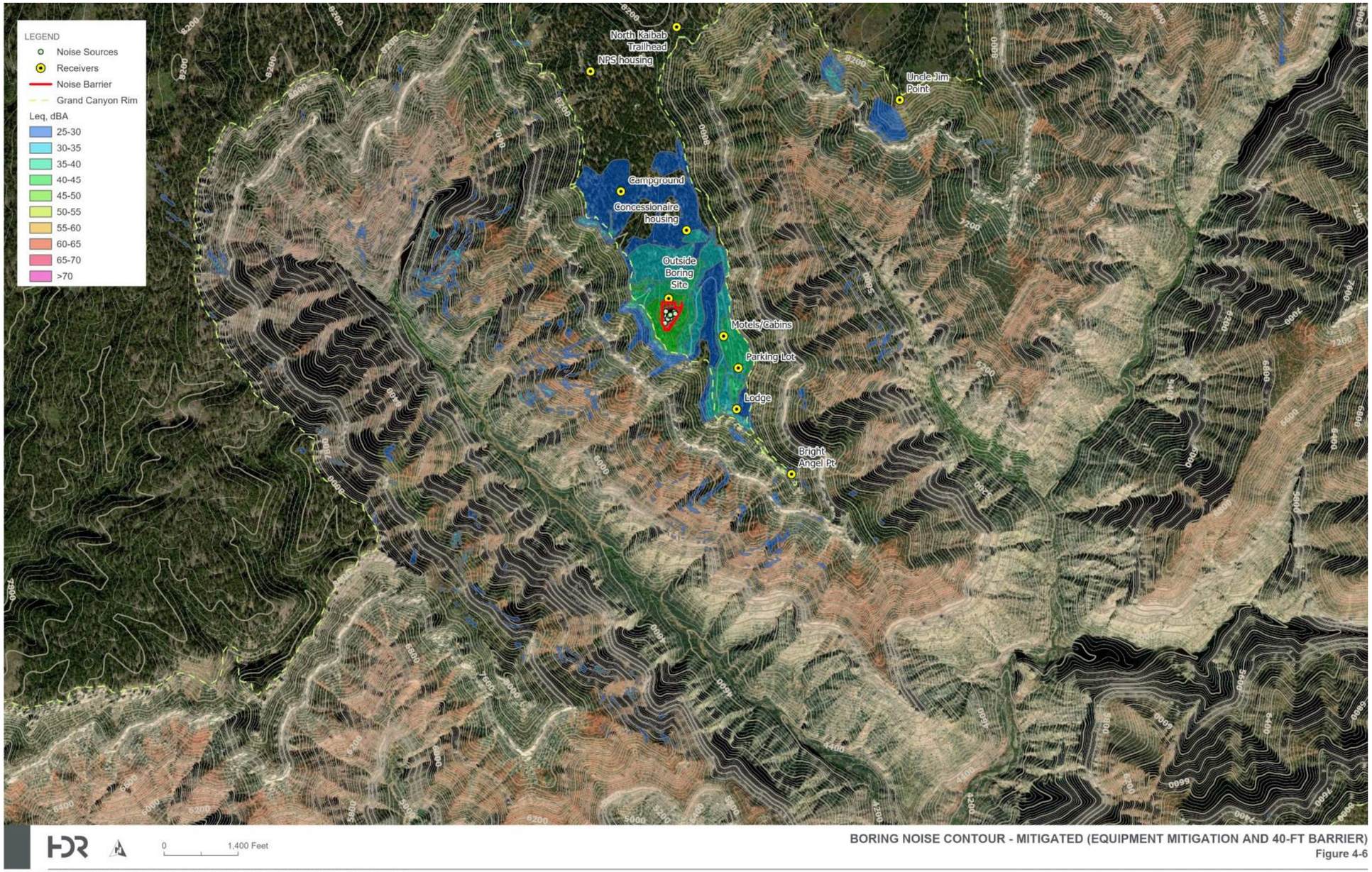


Figure 4-6. Mitigated Noise Contour (Wide View)

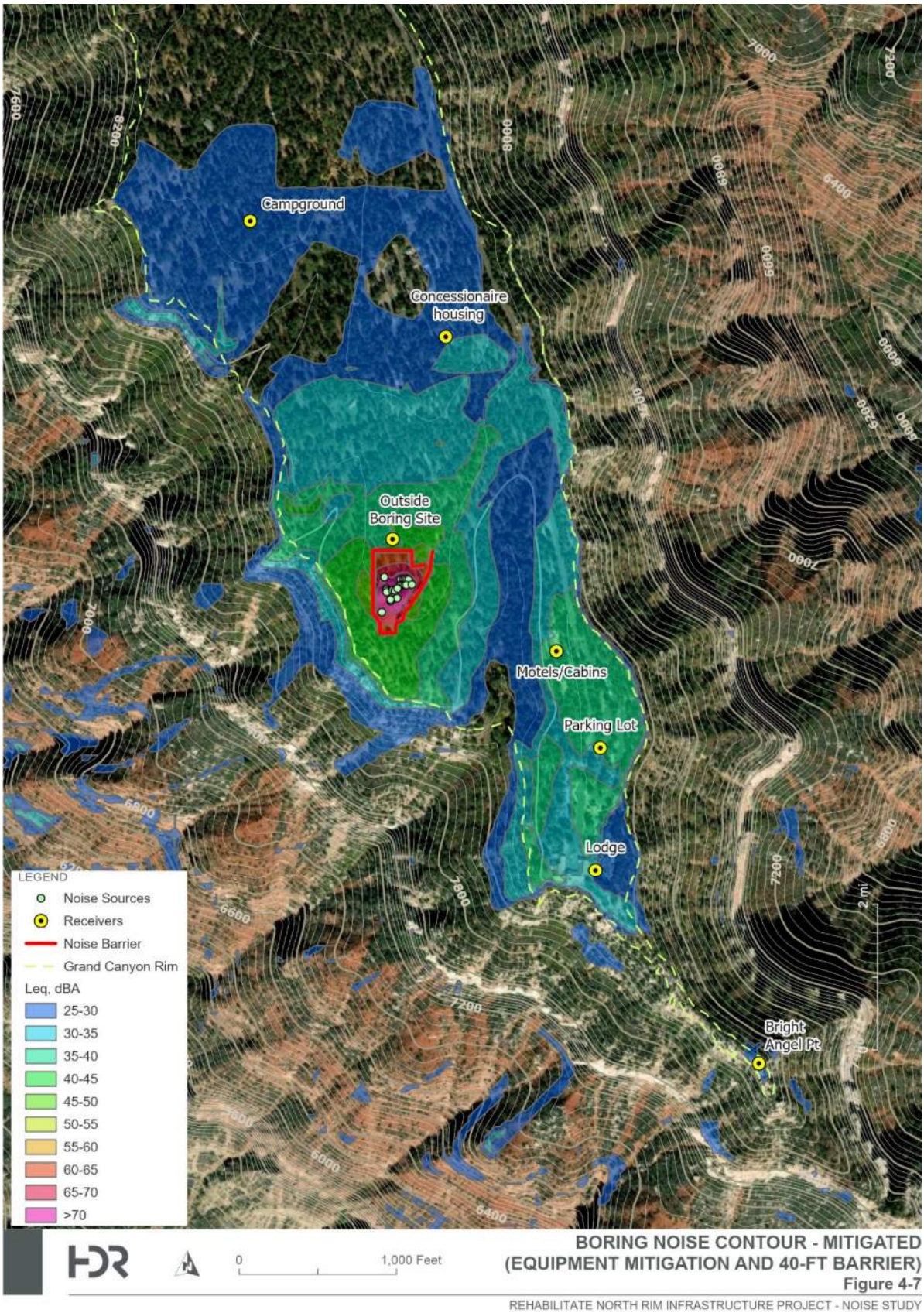


Figure 4-7. Mitigated Noise Contour (Developed Area)

5 CONCLUSIONS AND RECOMMENDATIONS

HDR measured existing noise at three locations within the Park and analyzed the data from these measurements in conjunction with the data from one other location provided by NPS in order to establish typical existing noise levels and noise sources in areas that may be affected by noise associated with the Project.

HDR modeled noise emissions from the proposed raw water conveyance boring activity in a base (unmitigated) scenario and plotted the resulting noise contours to show the extent of the area that stands to be affected by that noise. Potential mitigation options including high-performance enclosures and silencers for the generators, mud pumps, compressors, and shakers, mast shielding or an enclosure for the top drive, and a noise barrier around the entire site could be used in order to reduce noise from the operation as much as is feasible within operational constraints. Noise contours with these mitigation measures applied show a greatly reduced area affected by noise from the boring operation.

Specification 01 11 00 requires that bore drilling activities occur between October 15 and March 31 when the North Rim is closed to overnight visitors. Assuming visitor experience and concessionaire living conditions are the primary concern for noise levels from the drilling activities, it is recommended that standard industry noise mitigation for drilling equipment be included in the construction specifications along with a shroud/enclosure for the top drive, a sound barrier for the drill floor, and an approximately 20-FT high temporary acoustic barrier wall around the site.

6 REFERENCES

Acoustical Society of America (ASA). 2001. Design Response of Weighting Networks for Acoustical Measurements. ANSI/ASA S1.42-2001 (Reaffirmed 2011).

CAT. 2024. Skid Steer Loaders 272D3 XE. https://www.cat.com/en_US/products/new/equipment/skid-steer-and-compact-track-loaders/skid-steer-loaders/30056688550099.html

eNoiseControl. 2024. Sound Barrier for Horizontal Directional Drilling. https://www.enoisecontrol.com/sound-barrier-horizontal-directional-drilling/

Bies, David A. and Hansen, Colin H. 2009. Engineering Noise Control: Theory and Practice. Fourth Edition.

Burge, Paul, C. Martin and R. Wayson. 2022. Using updated Roadway Construction Noise Model (RCNM) 2.0 acoustical noise data for simplified construction noise predictions. INTER-NOISE and NOISE-CON Congress and Conference Proceedings, NOISE-CON22, Lexington, Kentucky. Pp. 608-615(8).

International Standards Organization (ISO). 1996. ISO 9613-2:1996, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation.

Lynch, Emma, D. Joyce and K. Fristrup. 2011. An assessment of noise audibility and sound levels in U.S. National Parks. Landscape Ecology (2011) 26:1297–1309.

National Park Service (NPS). 2013. Acoustic Monitoring Training Manual. National Park Service. U.S. Department of the Interior. Natural Sounds and Night Skies Division, Fort Collins, Colorado.

U.S. Environmental Protection Agency (EPA). 1981. Noise and its Measurement. OPA 22/1. Washington, D.C.

Xodus Group. 2015. Noise Assessment - Springs Road, Proposed Exploratory Wellsite https://www.nottinghamshire.gov.uk/planningsearch/DisplayImage.aspx?doc=cmVjb3JkX251bWJlcj02Njc0JmZpbGVuYW1lPVxcbnMwMS0wMDI5XGZpbGVkYXRhMiRcREIwMy0wMDMwXFNoYXJlZEFwcHNcRExHU1xQbGFuc1xQTEFOTklOR1xFUy0zMzc5XEFwcGVuZGl4IEIgTm9pc2UgMjAxNS0wOS0xNS5wZGYmaW1hZ2VfbnVtYmVyPTUyJmltYWdlX3R5cGU9cGxhbm5pbmcmbGFzdF9tb2RpZmllZF9mcm9tX2Rpc2s9MTMvMTAvMjAxNSAxNjo0NToxOQ==

APPENDICES

Appendix A. Noise Monitoring Site Photos and Equipment

Supai Monitoring Site Looking West Towards Toilets (top) and South Along Trail (bottom)

Ballfield Site Looking East (top) and South (bottom)

Grand Lodge Site Looking North Towards Cabins (top) and East Toward Main Building (bottom) – Note Chiller Circled in East View

Equipment Serial Numbers

Site	Equipment	Model	Serial #
All HDR Sites	Calibrator	LD Cal 200	3722
Supai	Sound Level Meter	LD 831C	11570
	Microphone/Preamp	387A04	145792
Ballfield	Sound Level Meter	LD 831C	11572
	Microphone/Preamp	387A04	150763
Grand Lodge	Sound Level Meter	LD 831C	11616
	Microphone/Preamp	387A04	150766
Basin (NPS site)[a]	Sound Level Meter	LD 831	1545
	Microphone/Preamp	377B02/PRM831	107195/012163

a: NPS logsheet available for 2019 Basin measurement only, same equipment presumed used for 2020 measurement as well

Appendix B. Hourly Noise Monitoring Results

The tables in this Appendix present calculated results for each hour of the day, calculated across all days in the measurement period. Results are presented as both the "overall" metric, which is calculated from all non-excluded 1-second data for a given hour across the measurement, and the average hourly, which is the hourly metric for that hour averaged across the measurement.

Table B-1. L_{max} (dBA) by Hour

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{max} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
0:00	**63**	52	**63**	44	**63**	42	**61**	46	**50**	48	**61**	45	**84**	48	**64**	43
1:00	**64**	52	**61**	41	**56**	39	**61**	44	**47**	47	**61**	44	**85**	48	**71**	40
2:00	**61**	51	**60**	41	**59**	39	**62**	45	**52**	48	**62**	44	**84**	46	**66**	39
3:00	**65**	50	**65**	42	**65**	41	**63**	45	**48**	47	**63**	45	**87**	47	**57**	39
4:00	**77**	56	**67**	39	**63**	37	**64**	44	**49**	48	**64**	43	**82**	43	**62**	53
5:00	**75**	62	**62**	41	**58**	39	**73**	46	**62**	56	**73**	45	**84**	47	**57**	50
6:00	**78**	63	**65**	45	**56**	43	**67**	52	**67**	58	**66**	51	**62**	49	**65**	50
7:00	**82**	66	**64**	45	**58**	44	**69**	56	**66**	64	**69**	55	**66**	49	**65**	52
8:00	**78**	63	**62**	48	**61**	47	**76**	61	**70**	66	**76**	60	**87**	73	**69**	54
9:00	**76**	63	**63**	49	**61**	48	**82**	63	**76**	68	**82**	62	**85**	73	**71**	64
10:00	**82**	64	**65**	49	**61**	48	**80**	63	**72**	68	**80**	62	**84**	73	**79**	60
11:00	**75**	64	**69**	52	**63**	50	**71**	63	**67**	65	**71**	62	**87**	72	**72**	62
12:00	**75**	64	**67**	51	**67**	50	**75**	63	**69**	64	**75**	63	**90**	73	**71**	63
13:00	**72**	64	**69**	51	**69**	51	**74**	62	**70**	64	**74**	62	**83**	70	**79**	61
14:00	**72**	62	**65**	52	**63**	51	**89**	65	**89**	71	**81**	64	**86**	71	**80**	64
15:00	**77**	60	**69**	51	**67**	50	**80**	62	**71**	66	**80**	61	**83**	70	**72**	61

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{max} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly

Table B-2. L_{min} (dBA) by Hour

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{min} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
0:00	**13**	34	**6**	18	**6**	17	**7**	18	**19**	21	**7**	17	**14**	24	**5**	13
1:00	**12**	34	**6**	19	**6**	16	**7**	18	**18**	20	**7**	18	**14**	24	**5**	13
2:00	**10**	33	**6**	19	**6**	17	**7**	18	**17**	21	**7**	17	**14**	23	**5**	11
3:00	**11**	33	**6**	19	**6**	18	**7**	18	**17**	21	**7**	18	**14**	23	**5**	10

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{min} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
4:00	**12**	33	**6**	18	**6**	17	**7**	19	**21**	22	**7**	18	**14**	23	**5**	11
5:00	**15**	34	**6**	18	**6**	17	**7**	18	**22**	22	**7**	18	**14**	23	**8**	14
6:00	**13**	34	**6**	19	**6**	18	**7**	19	**22**	23	**10**	20	**15**	24	**7**	14
7:00	**15**	30	**9**	20	**9**	20	**10**	20	**23**	25	**11**	20	**15**	24	**9**	17
8:00	**13**	23	**11**	19	**11**	19	**11**	21	**25**	25	**15**	23	**16**	25	**13**	22
9:00	**15**	25	**14**	21	**14**	21	**15**	23	**25**	26	**14**	22	**16**	26	**12**	24
10:00	**17**	26	**15**	21	**15**	21	**14**	23	**27**	27	**15**	22	**17**	28	**15**	25
11:00	**18**	26	**15**	22	**15**	22	**15**	23	**28**	28	**15**	23	**21**	29	**15**	26
12:00	**16**	26	**14**	23	**14**	23	**15**	23	**27**	28	**15**	22	**20**	28	**14**	26
13:00	**15**	25	**14**	22	**14**	22	**15**	23	**28**	29	**12**	22	**17**	28	**16**	26
14:00	**9**	22	**11**	23	**11**	24	**12**	23	**28**	29	**11**	22	**17**	27	**16**	25
15:00	**9**	22	**10**	23	**10**	23	**11**	23	**28**	29	**9**	21	**16**	26	**15**	26
16:00	**10**	21	**7**	20	**12**	20	**9**	22	**26**	27	**9**	18	**16**	27	**15**	24
17:00	**11**	22	**7**	19	**7**	18	**9**	19	**27**	28	**7**	17	**15**	27	**12**	23
18:00	**14**	28	**6**	19	**7**	18	**7**	19	**26**	27	**7**	17	**15**	26	**8**	21
19:00	**15**	33	**7**	20	**7**	19	**7**	18	**25**	26	**7**	16	**14**	26	**8**	17
20:00	**14**	34	**6**	19	**7**	17	**7**	17	**24**	25	**7**	17	**14**	25	**6**	15
21:00	**16**	35	**6**	19	**6**	18	**7**	18	**24**	24	**7**	17	**14**	25	**5**	14
22:00	**14**	35	**6**	19	**7**	17	**7**	18	**22**	23	**7**	17	**14**	24	**5**	14
23:00	**13**	35	**6**	18	**6**	16	**7**	18	**19**	22	**7**	10	**14**	25	**5**	14

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{min} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly

Table B-3. L_{eq} (dBA) by Hour

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{eq} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
0:00	**46**	40	**40**	30	**38**	27	**39**	32	**41**	40	**39**	30	**42**	31	**36**	22
1:00	**46**	41	**39**	29	**37**	27	**41**	31	**39**	39	**41**	30	**42**	31	**39**	21
2:00	**46**	40	**41**	29	**40**	27	**42**	32	**40**	40	**42**	31	**41**	29	**37**	19
3:00	**46**	39	**41**	29	**40**	27	**42**	33	**40**	40	**42**	31	**42**	29	**30**	19
4:00	**47**	41	**40**	27	**40**	26	**43**	32	**41**	40	**43**	30	**39**	28	**39**	38
5:00	**49**	44	**40**	28	**37**	26	**43**	33	**40**	40	**43**	32	**39**	31	**36**	35
6:00	**49**	44	**41**	31	**38**	29	**43**	36	**41**	41	**43**	35	**38**	33	**33**	33
7:00	**50**	45	**41**	31	**39**	30	**43**	37	**42**	42	**43**	37	**39**	32	**37**	35
8:00	**45**	41	**39**	33	**37**	32	**45**	40	**45**	45	**45**	40	**52**	51	**39**	37
9:00	**43**	40	**40**	33	**38**	33	**52**	43	**46**	46	**53**	42	**53**	52	**44**	43
10:00	**46**	43	**41**	34	**38**	33	**48**	43	**46**	46	**48**	43	**53**	52	**44**	41
11:00	**45**	43	**41**	36	**41**	35	**47**	43	**44**	44	**47**	43	**51**	50	**45**	43

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{eq} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
12:00	**46**	43	**41**	36	**41**	35	**50**	43	**44**	44	**50**	43	**50**	49	**45**	43
13:00	**45**	43	**42**	35	**42**	35	**47**	42	**45**	45	**47**	42	**49**	49	**45**	42
14:00	**44**	41	**43**	36	**42**	35	**52**	45	**50**	48	**53**	44	**50**	49	**46**	44
15:00	**41**	38	**44**	36	**44**	35	**55**	43	**48**	47	**56**	43	**49**	47	**45**	43
16:00	**40**	36	**41**	34	**40**	33	**48**	43	**46**	46	**48**	42	**50**	49	**44**	41
17:00	**42**	35	**39**	32	**38**	31	**47**	41	**45**	45	**47**	40	**50**	48	**43**	40
18:00	**41**	37	**39**	31	**37**	30	**42**	36	**45**	44	**41**	34	**42**	35	**41**	36
19:00	**43**	40	**39**	31	**37**	30	**41**	34	**44**	44	**40**	32	**42**	35	**39**	34
20:00	**45**	40	**40**	31	**38**	30	**39**	33	**43**	43	**39**	32	**44**	37	**38**	29
21:00	**46**	42	**42**	30	**41**	28	**42**	34	**47**	46	**41**	32	**42**	33	**38**	25
22:00	**47**	41	**42**	30	**39**	28	**42**	32	**41**	41	**42**	31	**42**	32	**37**	24
23:00	**47**	41	**41**	29	**37**	27	**41**	32	**41**	41	**41**	30	**42**	32	**36**	24
Daytime	**46**	41	**41**	32	**40**	30	**47**	37	**44**	44	**48**	43	**48**	39	**42**	34
Nighttime	**45**	40	**41**	33	**40**	32	**49**	40	**46**	46	**49**	44	**49**	45	**43**	38
Overall	**47**	41	**41**	29	**39**	27	**42**	32	**40**	40	**42**	35	**41**	31	**37**	26

Table B-4. L_{10} (dBA) by Hour

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{10} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
0:00	**50**	41	**44**	32	**43**	30	**45**	35	**46**	46	**45**	33	**46**	31	**38**	21
1:00	**50**	42	**44**	32	**41**	29	**46**	35	**46**	46	**45**	33	**47**	29	**40**	21
2:00	**50**	42	**46**	32	**44**	29	**46**	36	**46**	46	**46**	34	**46**	28	**37**	19
3:00	**50**	41	**45**	31	**44**	29	**46**	36	**46**	46	**46**	34	**46**	28	**33**	18
4:00	**51**	42	**45**	30	**44**	28	**46**	35	**46**	46	**47**	34	**44**	28	**42**	42
5:00	**52**	45	**44**	30	**41**	28	**46**	36	**45**	45	**46**	34	**43**	31	**40**	39
6:00	**52**	45	**44**	34	**42**	32	**46**	39	**45**	45	**46**	37	**43**	35	**37**	36
7:00	**51**	46	**44**	34	**43**	33	**46**	39	**46**	46	**45**	38	**43**	35	**41**	38
8:00	**44**	42	**43**	35	**41**	34	**46**	41	**46**	46	**46**	40	**52**	50	**42**	39
9:00	**45**	41	**43**	36	**41**	35	**50**	45	**47**	47	**52**	44	**54**	51	**46**	42
10:00	**46**	45	**42**	37	**41**	36	**48**	44	**47**	47	**48**	43	**54**	53	**47**	43
11:00	**47**	45	**44**	38	**44**	38	**49**	45	**47**	47	**50**	45	**51**	47	**47**	44
12:00	**48**	45	**45**	38	**45**	38	**48**	45	**47**	47	**49**	44	**50**	44	**48**	44
13:00	**48**	44	**44**	38	**43**	37	**47**	44	**47**	47	**48**	44	**50**	46	**48**	43
14:00	**46**	43	**44**	38	**44**	38	**49**	46	**47**	47	**50**	46	**50**	46	**49**	43
15:00	**42**	38	**46**	38	**46**	38	**50**	45	**48**	48	**50**	45	**49**	44	**49**	44
16:00	**41**	36	**44**	37	**42**	36	**49**	44	**47**	47	**50**	44	**49**	47	**48**	42
17:00	**40**	36	**43**	35	**42**	34	**47**	42	**47**	47	**47**	42	**49**	43	**47**	41

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{10} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly

Table B-5. L_{33} (dBA) by Hour

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{33} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
0:00	**46**	40	**36**	27	**28**	25	**34**	29	**35**	34	**34**	29	**38**	27	**23**	18
1:00	**47**	40	**35**	28	**31**	26	**34**	28	**28**	26	**35**	28	**35**	27	**21**	17
2:00	**46**	39	**38**	29	**35**	26	**37**	29	**35**	29	**37**	29	**34**	26	**13**	16
3:00	**46**	39	**36**	28	**34**	26	**35**	30	**34**	29	**35**	30	**34**	26	**12**	14
4:00	**46**	40	**34**	27	**31**	25	**36**	30	**35**	37	**36**	29	**33**	26	**37**	37
5:00	**47**	41	**32**	26	**29**	24	**37**	29	**33**	33	**37**	29	**33**	27	**32**	32
6:00	**47**	41	**35**	29	**33**	28	**37**	34	**37**	36	**37**	33	**34**	30	**31**	30

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{33} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
7:00	**44**	41	**35**	31	**33**	29	**37**	33	**38**	38	**36**	32	**34**	30	**34**	32
8:00	**36**	36	**33**	31	**32**	30	**38**	36	**44**	43	**37**	35	**41**	36	**36**	34
9:00	**37**	35	**34**	32	**34**	32	**40**	39	**45**	43	**39**	38	**42**	38	**38**	36
10:00	**41**	38	**33**	33	**33**	32	**39**	38	**46**	43	**39**	37	**43**	38	**40**	38
11:00	**41**	39	**35**	34	**35**	34	**40**	39	**43**	43	**39**	38	**43**	39	**41**	38
12:00	**42**	39	**35**	34	**35**	34	**40**	40	**43**	43	**40**	39	**39**	38	**41**	39
13:00	**40**	38	**35**	34	**35**	33	**40**	39	**45**	44	**39**	38	**40**	38	**40**	39
14:00	**37**	35	**36**	35	**36**	34	**41**	40	**46**	46	**41**	39	**40**	38	**41**	38
15:00	**32**	31	**36**	35	**36**	35	**41**	40	**46**	46	**40**	39	**40**	38	**41**	39
16:00	**31**	30	**34**	32	**33**	32	**41**	39	**46**	46	**40**	38	**42**	38	**40**	37
17:00	**32**	31	**34**	30	**32**	29	**39**	37	**45**	45	**38**	36	**41**	35	**39**	36
18:00	**38**	36	**33**	29	**29**	28	**37**	32	**43**	43	**36**	31	**37**	32	**36**	33
19:00	**44**	39	**34**	30	**32**	29	**36**	32	**40**	41	**35**	30	**37**	32	**32**	30
20:00	**46**	40	**34**	29	**32**	28	**34**	31	**45**	43	**33**	29	**37**	30	**26**	24
21:00	**47**	42	**36**	28	**31**	27	**36**	32	**45**	43	**35**	30	**36**	29	**22**	19
22:00	**47**	41	**35**	29	**29**	27	**37**	30	**45**	39	**36**	29	**33**	27	**22**	18
23:00	**47**	41	**33**	27	**28**	25	**35**	29	**45**	39	**35**	27	**37**	28	**24**	19
Daytime	**43**	38	**35**	30	**33**	29	**38**	34	**44**	43	**38**	36	**38**	32	**35**	30
Nighttime	**40**	37	**35**	32	**34**	31	**39**	36	**45**	45	**38**	37	**40**	35	**38**	34
Overall	**47**	40	**35**	28	**31**	26	**36**	30	**35**	34	**36**	31	**34**	27	**29**	22

Table B-6. L_{50} (dBA) by Hour

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{50} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
0:00	**43**	39	**23**	26	**20**	23	**25**	26	**27**	27	**25**	26	**22**	27	**9**	16
1:00	**44**	39	**25**	26	**22**	24	**24**	26	**24**	24	**24**	26	**21**	26	**9**	16
2:00	**43**	38	**25**	27	**20**	25	**25**	27	**26**	26	**24**	27	**19**	25	**8**	14
3:00	**43**	38	**25**	26	**19**	24	**26**	27	**25**	26	**26**	27	**18**	25	**8**	13
4:00	**42**	39	**23**	25	**20**	24	**27**	27	**27**	27	**27**	27	**19**	25	**35**	35
5:00	**43**	40	**23**	24	**21**	23	**28**	27	**28**	28	**27**	27	**23**	26	**29**	29
6:00	**43**	40	**26**	27	**24**	26	**30**	30	**32**	32	**30**	29	**29**	28	**27**	27
7:00	**40**	39	**27**	29	**25**	28	**30**	30	**33**	33	**30**	30	**29**	28	**30**	29
8:00	**32**	33	**27**	28	**26**	28	**33**	32	**35**	35	**32**	32	**35**	33	**32**	32
9:00	**32**	32	**29**	30	**28**	30	**35**	36	**38**	37	**35**	35	**37**	35	**35**	34
10:00	**37**	35	**29**	31	**29**	30	**35**	36	**38**	39	**34**	35	**37**	35	**36**	35
11:00	**38**	37	**31**	32	**31**	32	**35**	36	**37**	37	**35**	35	**37**	36	**36**	36
12:00	**37**	36	**31**	32	**31**	32	**36**	37	**37**	37	**36**	36	**35**	36	**37**	37
13:00	**36**	35	**31**	32	**31**	32	**36**	36	**39**	39	**35**	35	**36**	35	**36**	36
14:00	**32**	32	**32**	33	**32**	33	**37**	37	**41**	41	**36**	36	**36**	35	**36**	36
15:00	**30**	29	**32**	33	**32**	33	**36**	36	**41**	42	**35**	36	**36**	36	**37**	37
16:00	**29**	28	**29**	30	**29**	30	**36**	36	**42**	42	**35**	35	**36**	36	**35**	35
17:00	**30**	29	**27**	28	**26**	27	**34**	33	**40**	41	**33**	32	**34**	33	**34**	33
18:00	**35**	35	**26**	28	**25**	26	**30**	29	**37**	37	**27**	28	**31**	31	**31**	31
19:00	**40**	38	**27**	28	**26**	27	**30**	29	**35**	34	**27**	28	**32**	30	**26**	27

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{50} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly

Table B-7. L_{90} (dBA) by Hour

Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{90} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
0:00	**20**	36	**10**	22	**10**	19	**11**	22	**22**	23	**11**	21	**15**	25	**6**	14
1:00	**22**	37	**10**	22	**9**	20	**11**	22	**20**	22	**11**	21	**14**	25	**6**	14
2:00	**22**	36	**9**	23	**9**	21	**11**	22	**20**	23	**10**	22	**14**	24	**5**	12
3:00	**20**	35	**9**	22	**8**	21	**10**	22	**22**	22	**10**	22	**14**	24	**6**	11
4:00	**22**	36	**8**	21	**8**	20	**10**	22	**23**	23	**9**	22	**14**	24	**20**	20
5:00	**25**	37	**9**	20	**8**	19	**9**	23	**24**	24	**9**	22	**15**	24	**20**	21
6:00	**26**	37	**13**	22	**12**	21	**14**	23	**26**	26	**13**	23	**18**	26	**18**	20
7:00	**27**	33	**17**	25	**17**	24	**17**	25	**28**	28	**17**	24	**18**	26	**20**	23
8:00	**24**	26	**18**	24	**18**	23	**21**	26	**29**	29	**20**	26	**21**	28	**23**	26

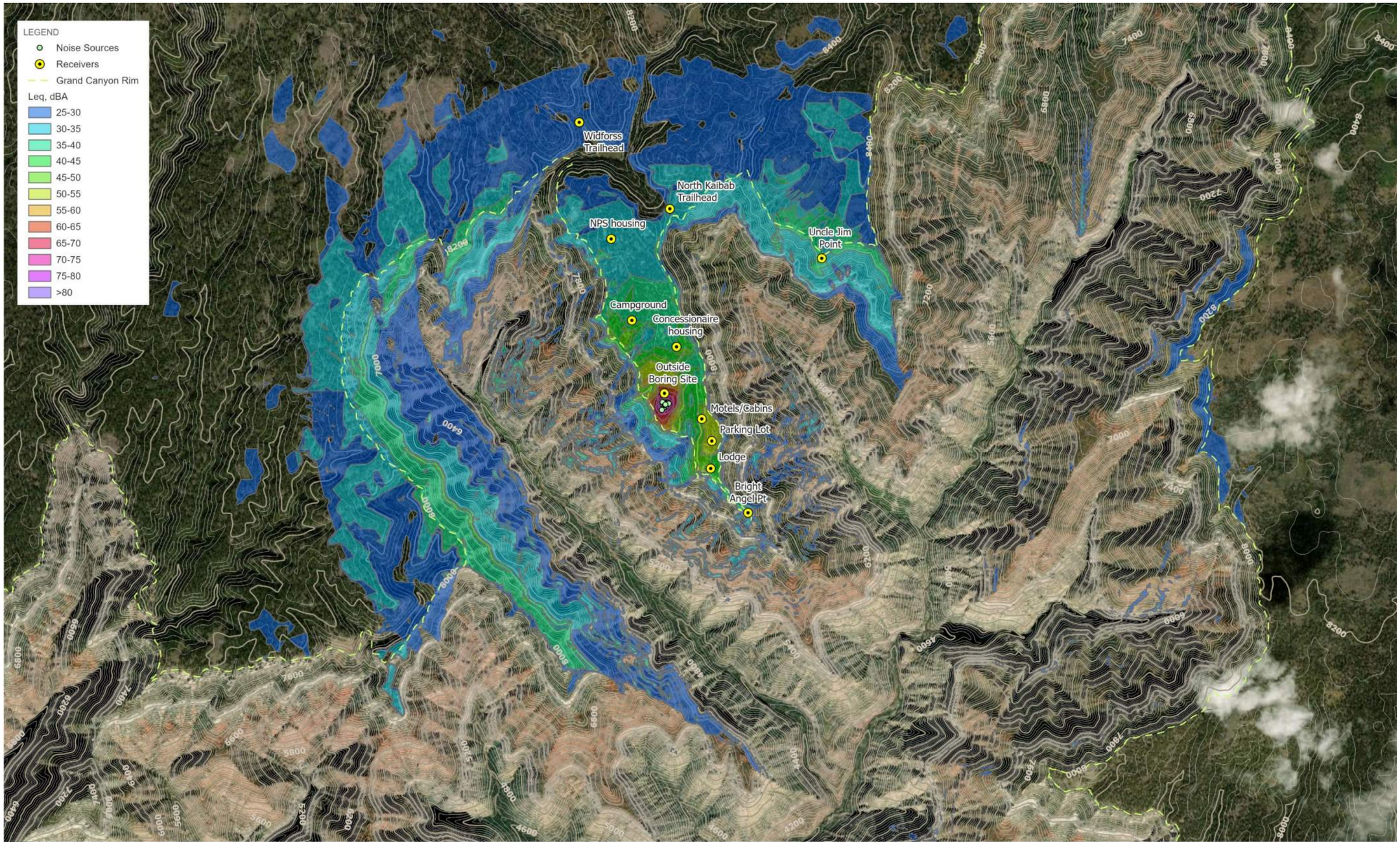
Site:	Supai		Ballfield		Ballfield (no ERT)		Grand Lodge		Grand Lodge (open)		Grand Lodge (closed)		Basin (2019)		Basin (2020)	
L_{90} (dBA)	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly	Overall	Avg. Hourly
9:00	**24**	28	**21**	25	**20**	25	**24**	29	**30**	31	**23**	29	**24**	30	**24**	29
10:00	**25**	30	**22**	26	**22**	25	**25**	29	**31**	31	**25**	29	**26**	31	**26**	30
11:00	**26**	30	**23**	27	**23**	27	**26**	29	**32**	32	**25**	29	**27**	32	**27**	31
12:00	**25**	30	**23**	27	**23**	27	**26**	30	**32**	32	**25**	29	**27**	31	**27**	31
13:00	**25**	29	**22**	27	**22**	27	**24**	29	**33**	33	**24**	28	**27**	31	**27**	31
14:00	**21**	26	**22**	28	**22**	28	**25**	30	**34**	34	**24**	29	**26**	30	**26**	31
15:00	**19**	24	**22**	28	**22**	28	**24**	29	**34**	34	**23**	29	**26**	30	**26**	31
16:00	**19**	24	**19**	25	**20**	25	**23**	28	**31**	31	**23**	28	**24**	30	**24**	29
17:00	**22**	25	**16**	23	**16**	22	**19**	25	**32**	32	**18**	24	**22**	29	**22**	28
18:00	**26**	31	**16**	23	**16**	22	**15**	23	**31**	31	**14**	22	**18**	27	**20**	26
19:00	**28**	35	**15**	24	**16**	22	**14**	23	**29**	30	**13**	22	**16**	27	**15**	21
20:00	**26**	37	**13**	22	**13**	21	**13**	22	**28**	28	**12**	21	**15**	26	**8**	17
21:00	**29**	38	**12**	23	**13**	21	**12**	22	**26**	27	**11**	22	**15**	26	**7**	15
22:00	**26**	38	**12**	22	**12**	21	**12**	22	**25**	25	**12**	22	**15**	25	**6**	15
23:00	**27**	38	**10**	21	**11**	19	**11**	21	**23**	23	**11**	21	**15**	25	**6**	15
Daytime	**23**	32	**14**	24	**13**	23	**14**	25	**24**	24	**13**	18	**15**	27	**7**	23
Nighttime	**24**	30	**18**	25	**18**	24	**19**	27	**30**	30	**19**	21	**19**	29	**19**	27
Overall	**23**	37	**10**	22	**9**	20	**11**	22	**22**	22	**10**	16	**14**	25	**6**	16

Table B-8. L_{nat} (dBA) and Percent Anthropogenic Noise by Hour

Site:	Supai			Ballfield			Grand Lodge			Grand Lodge (open)			Grand Lodge (closed)		
L_{nat} (dBA)	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise
0:00	**43**	39	2	**18**	25	28	**12**	22	76	N/A	N/A	100	**13**	23	65
1:00	**43**	39	5	**19**	25	27	**12**	22	76	N/A	N/A	100	**13**	22	66
2:00	**43**	38	1	**19**	26	18	**11**	22	80	N/A	N/A	100	**12**	23	71
3:00	**43**	38	2	**19**	25	14	**12**	23	69	N/A	N/A	100	**16**	24	55
4:00	**40**	38	13	**18**	24	19	**11**	23	67	N/A	N/A	100	**14**	24	53
5:00	**36**	38	31	**20**	24	18	**13**	24	54	N/A	N/A	100	**21**	25	34
6:00	**32**	38	49	**21**	26	29	**20**	25	54	N/A	N/A	100	**24**	27	35
7:00	**31**	35	54	**23**	28	27	**20**	26	64	N/A	N/A	100	**22**	27	48
8:00	**28**	28	55	**24**	27	28	**22**	27	70	N/A	N/A	100	**25**	28	57
9:00	**26**	29	67	**25**	28	45	**25**	29	76	N/A	N/A	100	**27**	30	66
10:00	**27**	31	66	**26**	29	43	**24**	28	86	N/A	N/A	100	**26**	29	80
11:00	**26**	31	75	**27**	30	39	**24**	28	87	N/A	N/A	100	**25**	29	82
12:00	**25**	31	78	**28**	31	34	**24**	28	89	N/A	N/A	100	**25**	29	84
13:00	**27**	31	66	**27**	30	31	**24**	29	82	N/A	N/A	100	**26**	29	74
14:00	**24**	27	61	**29**	31	34	**25**	30	78	N/A	N/A	100	**27**	31	69
15:00	**23**	25	63	**29**	32	27	**25**	30	73	N/A	N/A	100	**27**	31	61
16:00	**23**	25	57	**25**	28	35	**25**	29	71	N/A	N/A	100	**28**	30	59
17:00	**26**	27	39	**21**	26	39	**20**	26	75	N/A	N/A	100	**22**	26	64
18:00	**32**	34	27	**22**	26	27	**17**	24	70	N/A	N/A	100	**19**	24	57
19:00	**37**	37	18	**22**	26	33	**18**	25	66	N/A	N/A	100	**20**	25	51

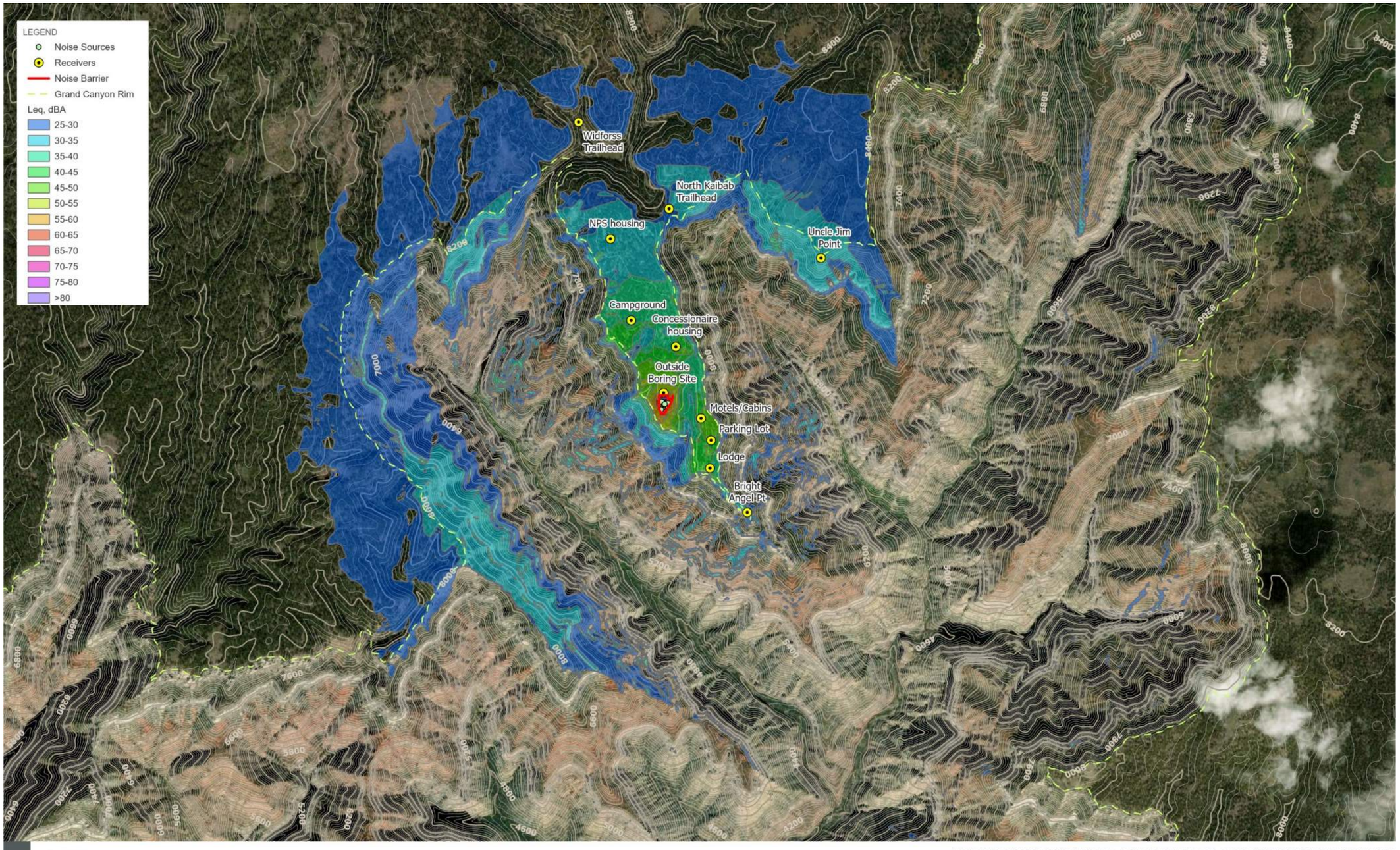
Site:	**Supai**			**Ballfield**			**Grand Lodge**			**Grand Lodge (open)**			**Grand Lodge (closed)**		
L_{nat} (dBA)	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise	Overall	Avg. Hourly	% anthro. noise
20:00	**38**	39	17	**21**	26	28	**15**	23	64	N/A	N/A	100	**19**	23	49
21:00	**43**	41	7	**19**	26	22	**15**	24	63	N/A	N/A	100	**19**	24	47
22:00	**43**	40	4	**19**	25	27	**14**	23	65	N/A	N/A	100	**16**	24	50
23:00	**44**	40	2	**16**	23	37	**11**	21	80	N/A	N/A	100	**12**	22	71
Daytime	**31**	34	36	**23**	27	30	**17**	26	72	N/A	N/A	100	**20**	22	60
Nighttime	**29**	31	50	**25**	28	33	**21**	27	74	N/A	N/A	100	**24**	25	63
Overall	**41**	39	12	**19**	25	24	**13**	23	69	N/A	N/A	100	**15**	21	56

Appendix C. Noise Contour Figures



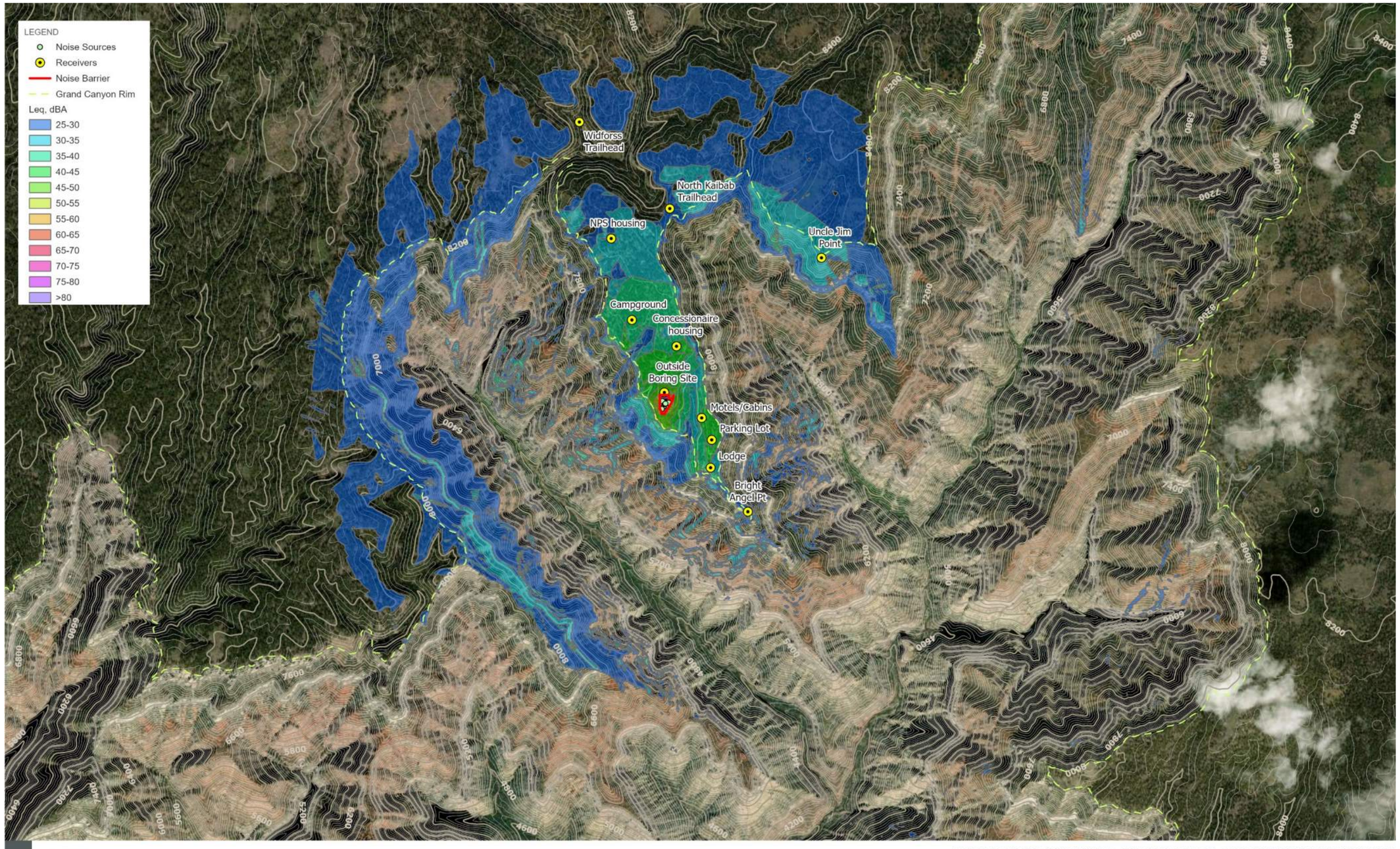
0 2,000 Feet

BORING NOISE CONTOUR - UNMITIGATED (BASE)
Figure C-1

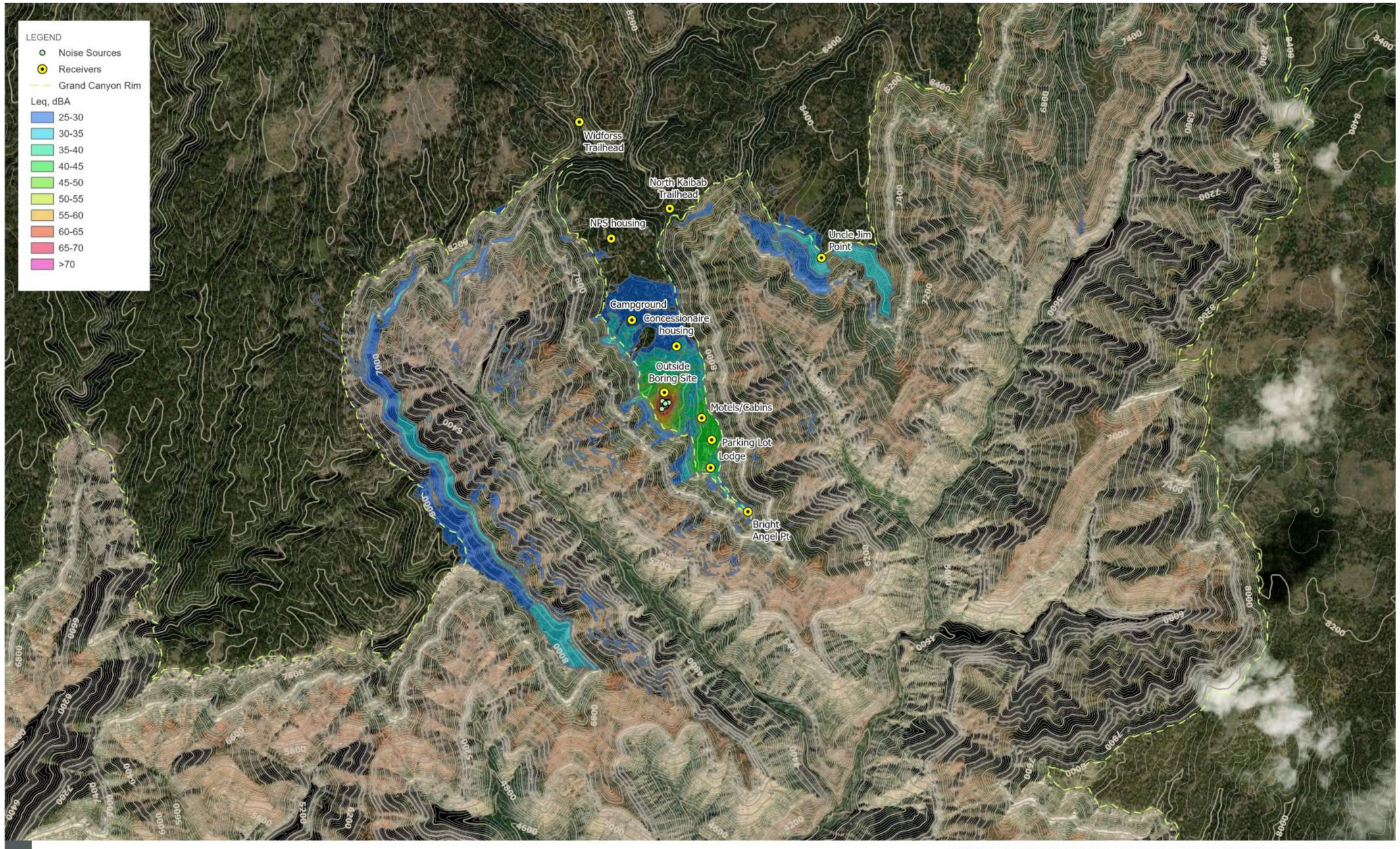


BORING NOISE CONTOUR - 20-FT BARRIER, NO EQUIPMENT MITIGATION

Figure C-2



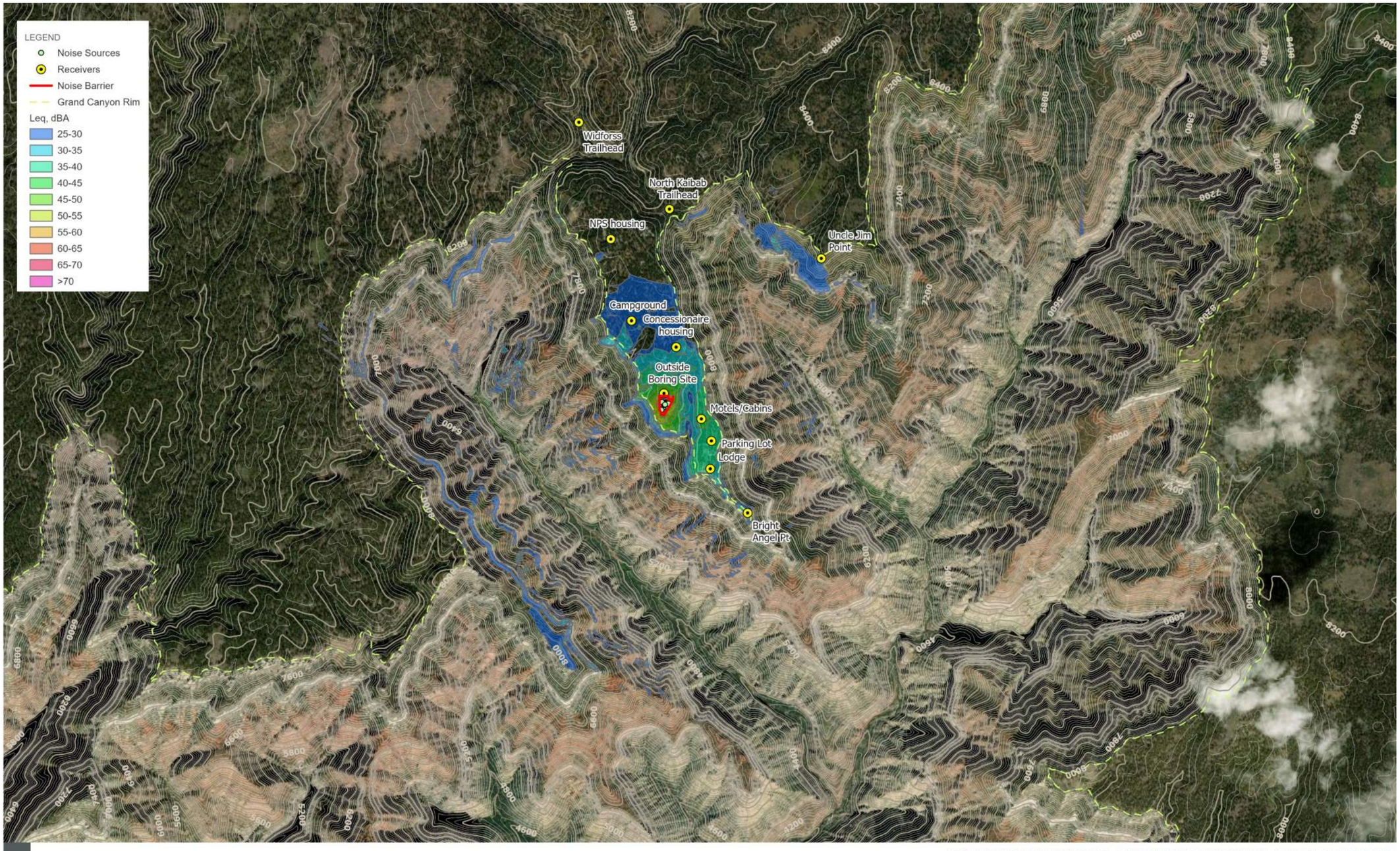
BORING NOISE CONTOUR - 40-FT BARRIER, NO EQUIPMENT MITIGATION
Figure C-3



0 2,000 Feet

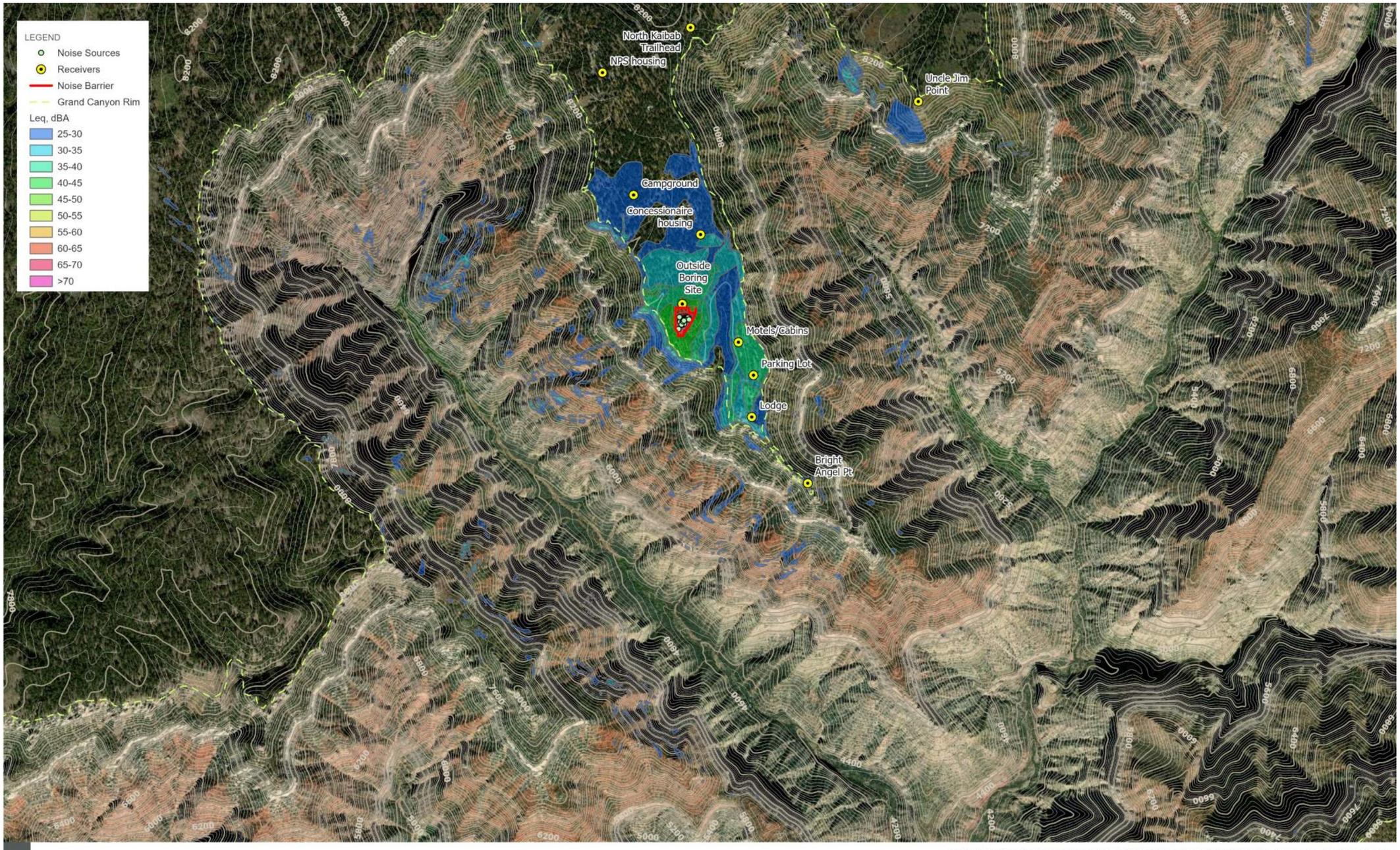
BORING NOISE CONTOUR - EQUIPMENT MITIGATION ONLY, NO BARRIER
Figure C-4

\\MSPE-SRV1\MPLSDATA\GISPROJ\NPS\10383673\7.2_WIP\MAP_DOCS\NPS_GRCA_NOISE.APRX DATE: 5/22/2024



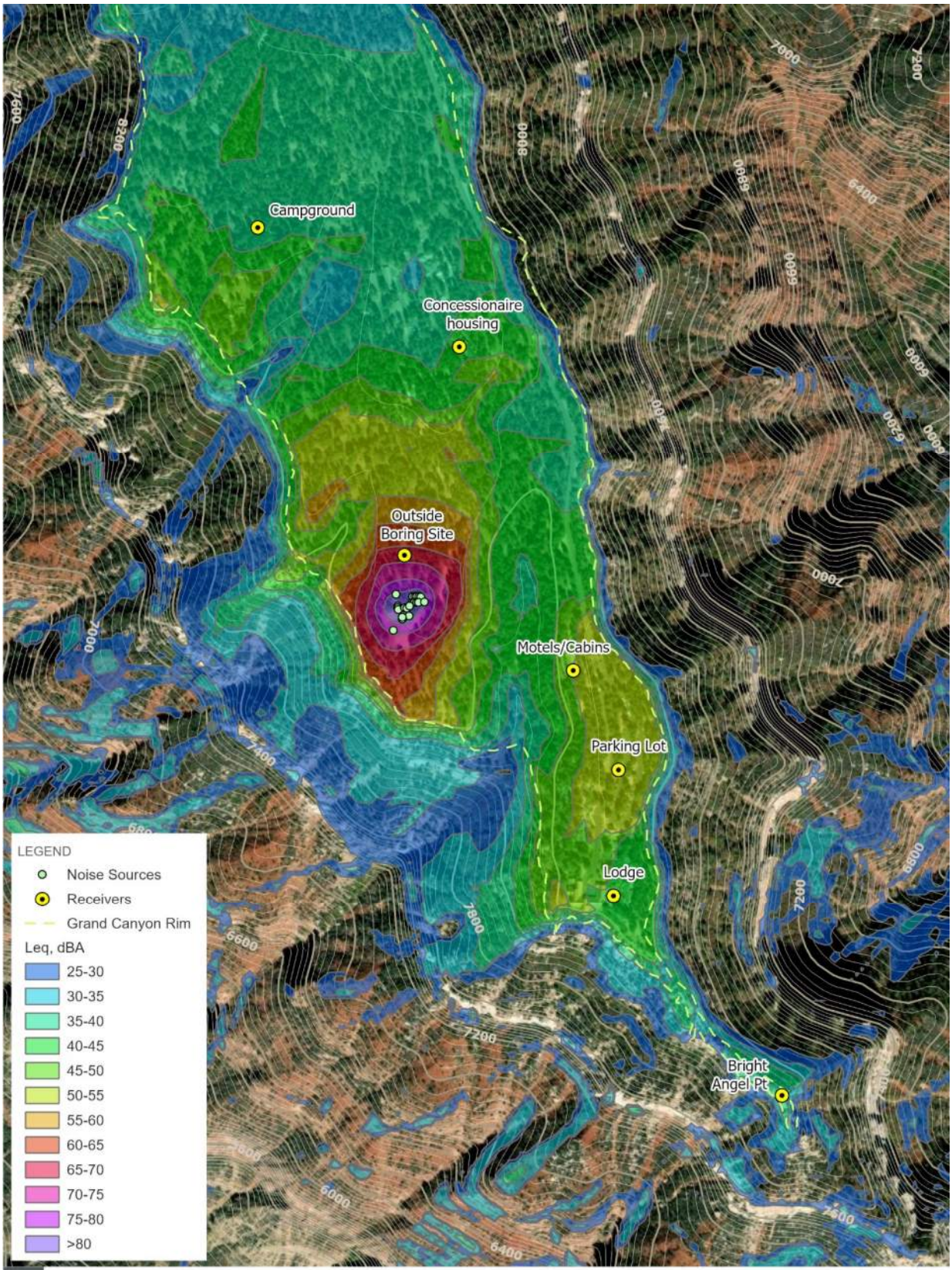
0 2,000 Feet

BORING NOISE CONTOUR - EQUIPMENT MITIGATION AND 20-FT BARRIER
Figure C-5



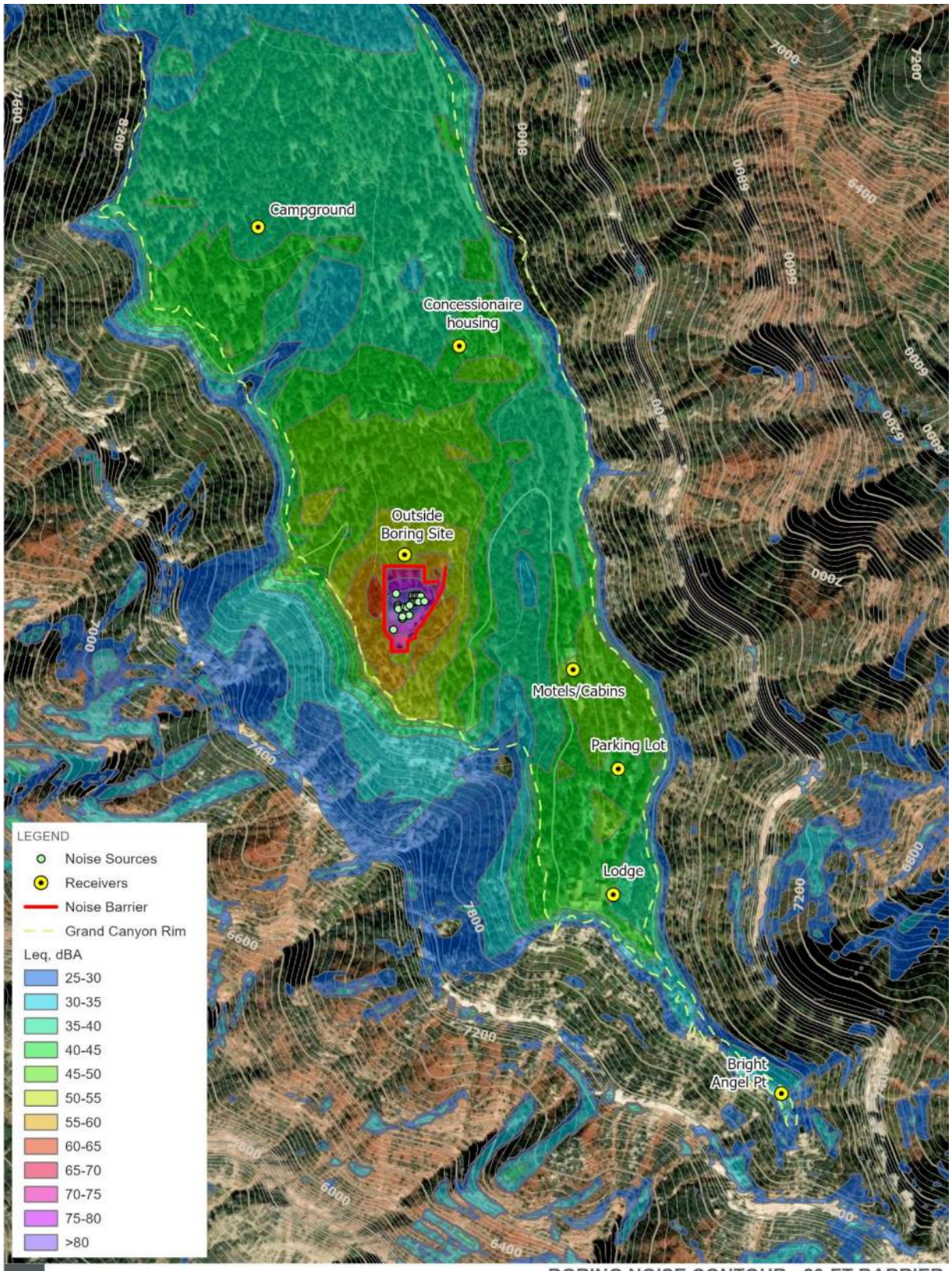
0 2,000 Feet

BORING NOISE CONTOUR - EQUIPMENT MITIGATION AND 40-FT BARRIER
Figure C-6



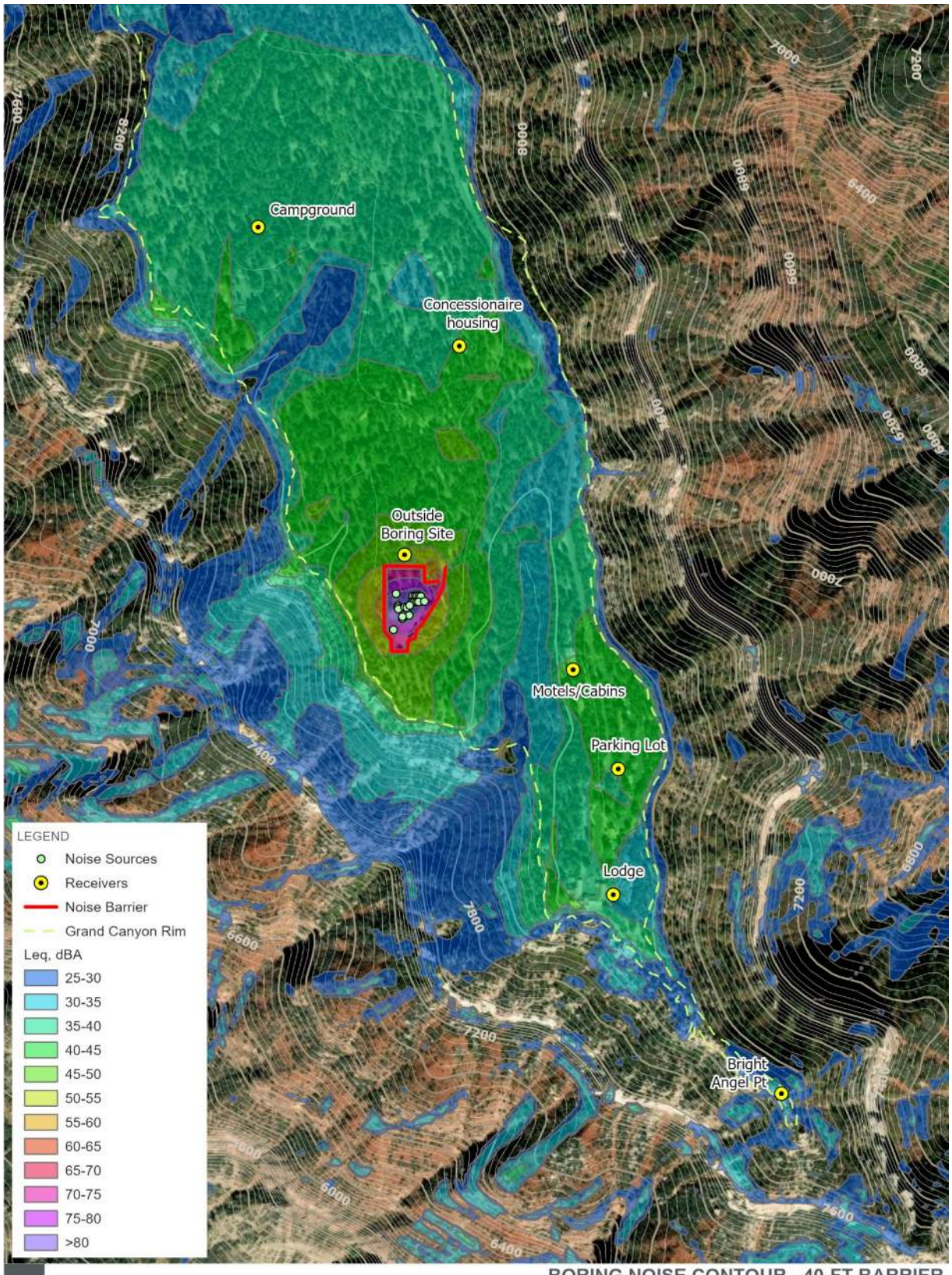
BORING NOISE CONTOUR - UNMITIGATED (BASE)

Figure C-7



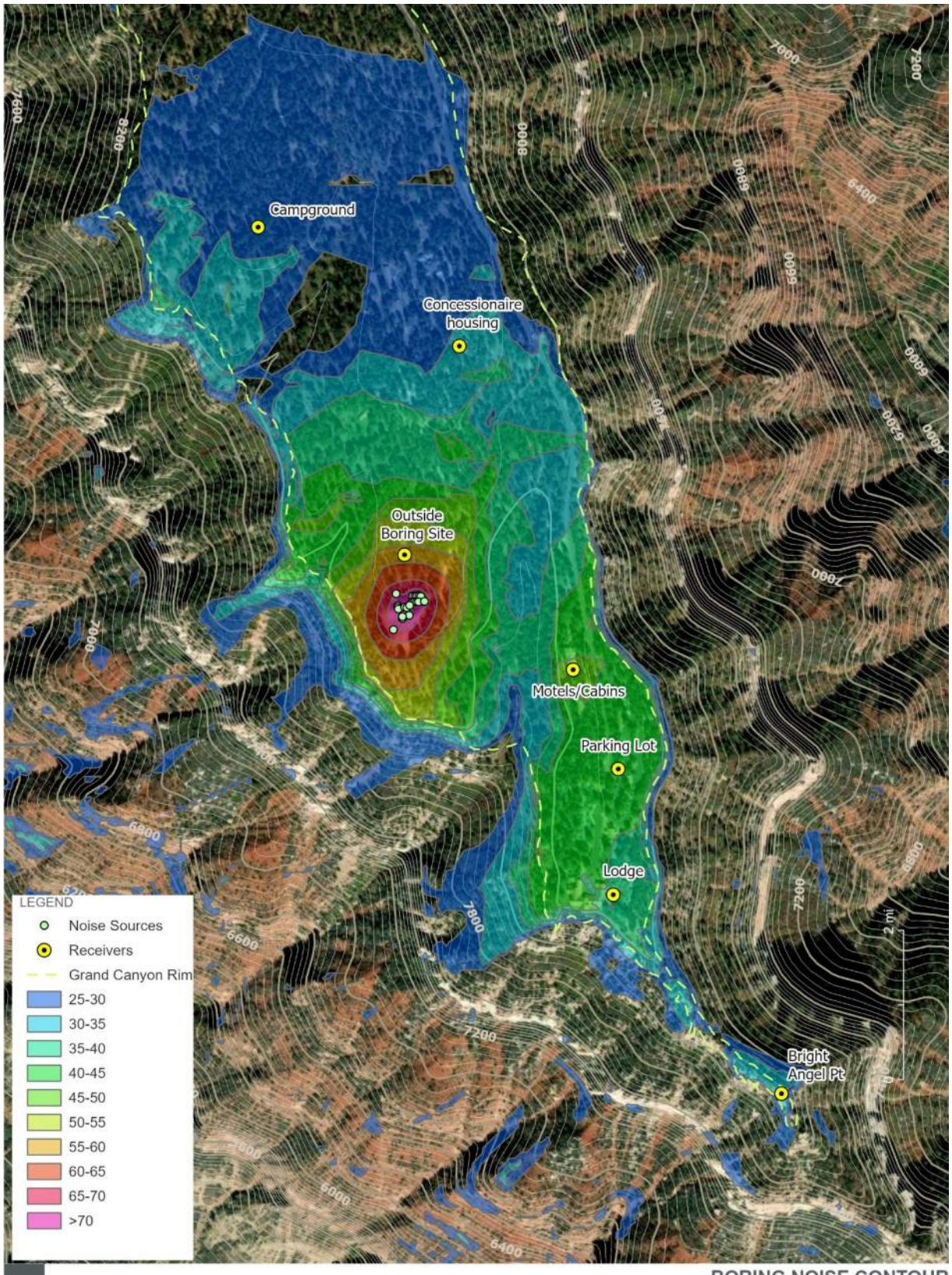
BORING NOISE CONTOUR - 20-FT BARRIER, NO EQUIPMENT MITIGATION

Figure C-8

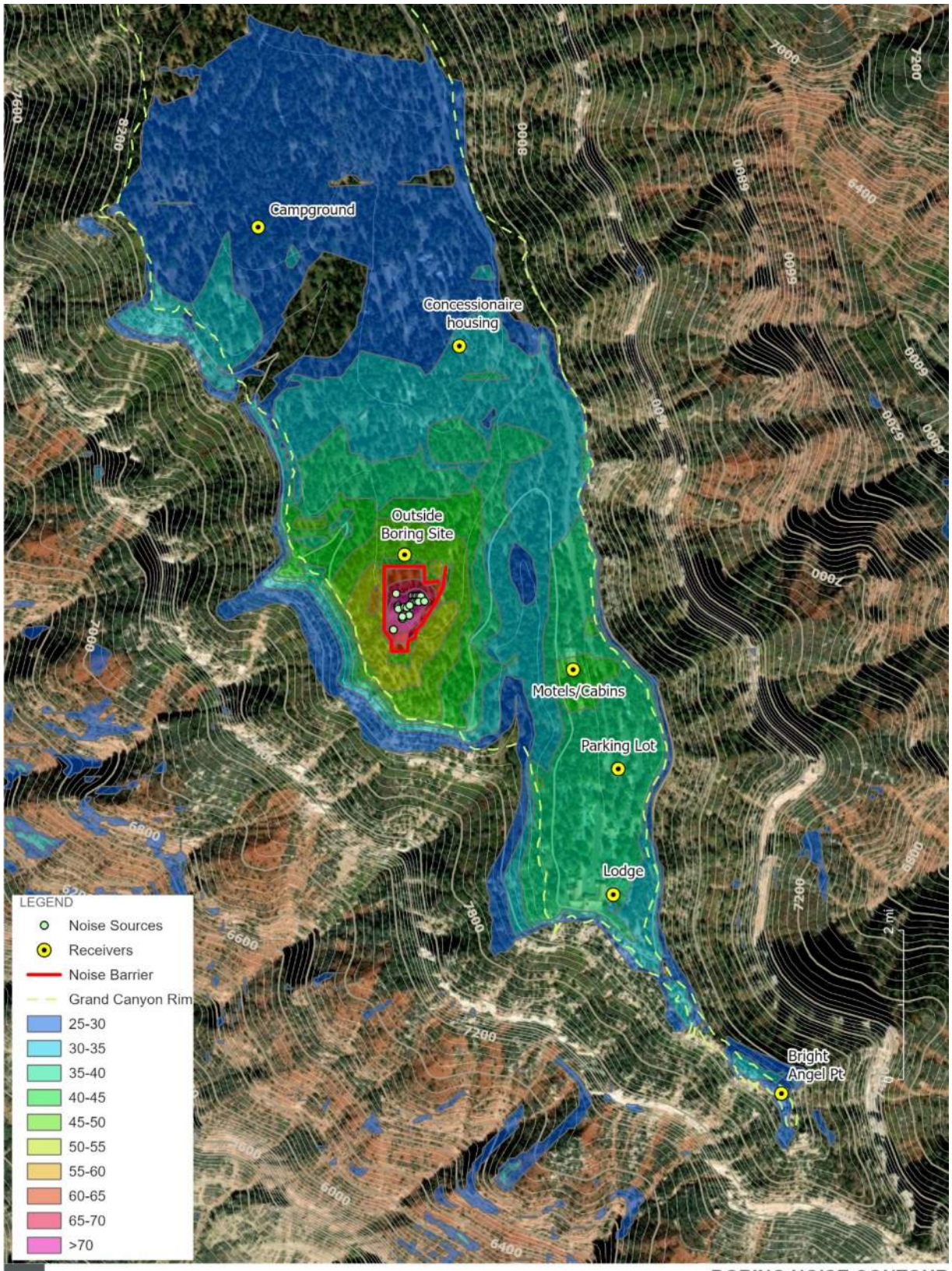


BORING NOISE CONTOUR - 40-FT BARRIER, NO EQUIPMENT MITIGATION

Figure C-9

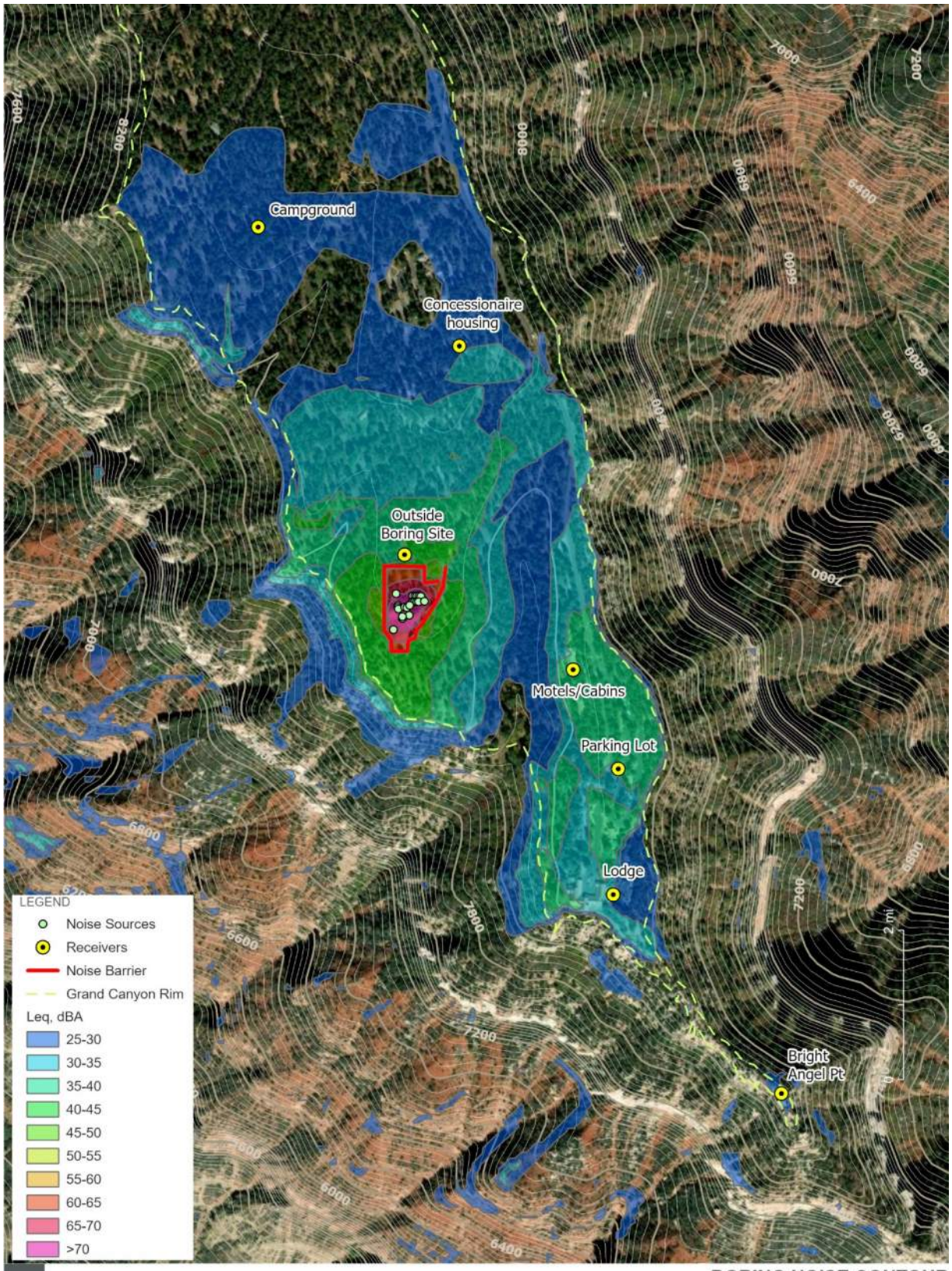


BORING NOISE CONTOUR
EQUIPMENT MITIGATION, NO BARRIER
Figure C-10



BORING NOISE CONTOUR
EQUIPMENT MITIGATION AND 20-FT BARRIER
Figure C-11

REHABILITATE NORTH RIM INFRASTRUCTURE PROJECT - NOISE STUDY



BORING NOISE CONTOUR
EQUIPMENT MITIGATION AND 40-FT BARRIER
Figure C-12

REHABILITATE NORTH RIM INFRASTRUCTURE PROJECT - NOISE STUDY