# Technical Appendix 11

## Cultural Resources

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# Acronyms and Abbreviations

| Acronym or Abbreviation | Full Phrase |
|---|---|
| 2007 Interim Guidelines | Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead |
| ADOT | Arizona Department of Transportation |
| APE | area of potential effect |
| ASPT | Arizona State Parks and Trails |
| BLM | Bureau of Land Management |
| CCS | Continued Current Strategies |
| CFR | Code of Federal Regulations |
| DEM | digital elevation model |
| DOE | Department of Energy |
| EOCY | end-of-calendar year |
| EOWY | end-of-water year |
| EPNG | El Paso Natural Gas Company |
| FWS | United States Fish and Wildlife Service |
| GCNP | Grand Canyon National Park |
| HFE | High-Flow Experiment |
| LADWP | Los Angeles Department of Water and Power |
| LB Priority | Lower Basin Priority |
| LB Pro Rata | Lower Basin Pro Rata |
| LCRO | Lower Colorado River Office |
| MWD | Metropolitan Water District of Southern California |
| NHA | National Heritage Area |
| NHL | National Historic Landmark |
| NHPA | National Historic Preservation Act |
| NHT | National Historic Trail |
| NIB | Northerly International Boundary |
| NPS | National Park Service |
| NRA | National Recreation Area |
| NRHP | National Register of Historic Places |
| NVCRIS | Nevada Cultural Resources Inventory System |

| | |
|---|---|
| Reclamation | Bureau of Reclamation |
| SCE | Southern California Edison |
| SHPO | State Historic Preservation Officer |
| SIB | Southerly International Boundary |
| SWGC | Southwest Gas Corporation |
| TCP | traditional cultural place |
| THPO | Tribal Historic Preservation Officer |
| U.S. | United States |
| USGS | United States Geological Survey |
| WAPA | Western Area Power Administration |
| WY | water year |

# TA 11. Cultural Resources

## TA 11.1 Affected Environment

Cultural resources are the physical manifestations of the activities of past or present cultures, including archaeological sites, historic-era buildings and structures, objects, trails, landforms, and other places of traditional, cultural, or religious importance. Cultural resources can be human-made or natural features and are, for the most part, unique, finite, and nonrenewable.

Of the many laws, regulations, executive orders, and policies concerning cultural resources, the most pertinent to this project is Section 106 of the National Historic Preservation Act (NHPA; 54 United States [U.S.] Code 306108), as amended, and its implementing regulations (36 Code of Federal Regulations [CFR] 800). The NHPA and its implementing regulations require federal agencies to take into account the effects of their undertakings (federal undertakings or federally permitted or funded undertakings) on historic properties. Historic properties are defined as any district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP); these include properties of traditional religious and cultural importance to an Indian Tribe or Native Hawaiian organization that meet the NRHP criteria (36 CFR 800.16(l)(1)). As such, they are a subset of cultural resources.

Management and ownership of the land through which the Colorado River runs is multifaceted. Bureau of Reclamation (Reclamation) manages river water operations. In southern Utah, northern Arizona, and southeastern Nevada, the river runs through the Grand Canyon National Park (GCNP), Lake Mead National Recreation Area (NRA), and the Glen Canyon NRA which are managed by the National Park Service (NPS). In western Arizona and eastern California south of Nevada, the river runs through Bureau of Land Management (BLM), Reclamation, U.S. Fish and Wildlife Service (FWS), state, tribal, municipal, and private lands.

The study area for the analysis runs from the northern extent of Lake Powell to the Southerly International Boundary (SIB), and consists of the Colorado River channel from bank to bank except from Glen Canyon Dam to Lake Mead, where it stretches from canyon rim to canyon rim, as well as a 0.5-mile buffer on either side of the riverbank or canyon rim. The study area coincides with the search area used for the Class I records search conducted for this analysis (Tremblay, Griset, and Rawson 2024; Tremblay, Lemoine, et al. 2024; Eddy et al. 2024; Winslow et al. 2024; Eskenazi 2024). The study area covers a total of 2,735,066 acres in Arizona, California, Nevada, and Utah.

Currently, Reclamation is consulting with the Arizona, California, Nevada, and Utah State Historic Preservation Officers (SHPOs), land managing agencies, affected tribes, and other consulting parties to develop a project-specific programmatic agreement under Section 106 of the NHPA and its implementing regulations (36 CFR 800.14). The development of the programmatic agreement includes the definition of the area of potential effect (APE). The APE often coincides with the

National Environmental Policy Act study area; however, as the APE is under development, the Class I search area will be used for analysis in lieu of an APE.

### TA 11.1.1 Identification Efforts

A Class I cultural resources record search was conducted for the study area in Arizona, California, Nevada, and Utah (Tremblay, Griset, and Rawson 2024; Tremblay, Lemoine, et al. 2024; Eddy et al. 2024; Winslow et al. 2024; Eskenazi 2024). Data was collected on archaeological sites, built environment resources, historic-era trails, special designations (National Historic Landmarks [NHLs]), congressionally designated areas (National Heritage Areas [NHAs] and National Historic Trails [NHTs]), traditional cultural places (TCPs), and resources of traditional cultural and religious importance to Native American peoples. Data was provided by the NPS (GCNP, Glen Canyon NRA, and Lake Mead NRA), National and State Registers of Historic Places, NHL and state landmark records, SHPO records, and the NPS Heritage Documentation Programs of the Historic American Building Survey, the Historic American Engineering Record, and the Historic American Landscapes Survey archives. Additionally, historical maps and aerials were checked for all states.

In Arizona, data was obtained from state databases and sources such as AZSITE, Arizona State Museum Archaeological Records Office, and Arizona Department of Transportation, the Forest Service (Kaibab National Forest), and records searches conducted at BLM field offices or data provided by the BLM (Arizona Strip District Office including Grand Canyon-Parashant National Monument, Kingman Field Office, Lake Havasu Field Office, and Yuma Field Office).

In California, data was obtained from the California Historical Resources Information System at three different Information Centers (South Coastal Information Center, South Central Coastal Information Center, and Eastern Information Center). Cultural resource data was also obtained from the California Points of Historical Interest list, the California Historical Landmarks list, the Archaeological Determinations of Eligibility list, and the California State Historic Resources Inventory list.

In Nevada, cultural resources were identified through the Nevada Cultural Resources Inventory System (NVCRIS), Southern Nevada Archaeological Archive, and BLM records. In Utah, Utah Division of State History's (now known as the Utah Historical Society) Sego database and Historic Utah Building database were searched.

Information on TCPs and resources of traditional and religious concern to Native American peoples were gathered through ethnographic research and data provided by Reclamation and NPS. Historic General Land Office and topographic maps were also checked for potential cultural resources. Data on sites on tribal lands was not collected for this effort. Data about ancestral sites located on tribal lands is sensitive and confidential. Reclamation concluded that data collected from state and federal sources would be sufficient to characterize the overall numbers and types of resources that may be affected.

The Class I records search shows that much of the study area has not been surveyed for cultural resources. This is particularly true in the vicinity of Lake Mead and less for Lake Powell as neither of these reservoirs were fully surveyed before inundation began behind Hoover Dam in 1934 and behind Glen Canyon Dam in 1963. Because survey coverage for both reservoirs is very low, there is potential for additional yet-to-be identified (i.e., undiscovered) sites to exist in the study area. The following discussion concerns only previous recorded archaeological sites and built environment resources, as well as built environment resources found on aerial photographs. Additional resources may be, and are likely to be, present in the areas not covered by previous surveys. It is important to note that resource information presented herein was acquired in August 2023 for the Class I records search and the 2023 datasets incorporated into the analysis may or may not reflect current agency databases.

### TA 11.1.2 Section 106 of the National Historic Preservation Act and Tribal Consultation

Per Section 106 of the NHPA and its implementing regulations (36 CFR 800), Reclamation is consulting with the Arizona, California, Nevada, and Utah SHPOs; Tribal Historic Preservation Officers (THPOs); affected tribes without THPOs; and consulting parties regarding the effects of the undertaking on historic properties. Reclamation is developing a project specific programmatic agreement, in consultation with the SHPOs, THPOs, tribes without THPOs, cooperating agencies, and other consulting parties per 36 CFR 800.14 to outline a process to resolve any adverse effect on historic properties from Reclamation's operation of the Glen Canyon and Hoover dams under the new operating guidelines for annual releases.

### TA 11.1.3 Cultural Background

The Colorado River and its surrounding landscape holds significance for many peoples today and has for thousands of years. Indigenous peoples have a strong connection to the river which plays an important role in their histories and lives. Indigenous peoples' relationship and kinship with the Colorado River is complex and is discussed further in the Tribal Resources (see **TA 13**, Tribal Resources). The following presentation of cultural resources data is from a Western viewpoint and Reclamation acknowledges that this is a partial picture and stems from the viewpoint of Western archaeologists and federal regulations largely promulgated by non-indigenous peoples. For many Indigenous peoples, archaeological sites are sacred places inhabited in the past and today by ancestors.

Western archaeologists view the human history of the Colorado River and its surrounding landscape in terms of three general temporal components: precontact (including the Paleoindian, Archaic, and Formative cultural periods), ethnohistoric, and postcontact (historic-era). Indigenous concepts of time are also different from Western ideas. For example, the Zuni provided text describing the Zuni concept of time, beginning with their emergence in the Grand Canyon (see **TA 13**, Tribal Resources).

## TA 11.1.4 Class I Results

#### Arizona

Overall, 870 cultural resource investigations (projects) have been conducted in the study area for an overall survey coverage of approximately 4 percent (Tremblay, Lemoine, et al. 2024). This number includes both the non-NPS and NPS datasets and accounts for duplicate records between the datasets. The Class I records search of non-NPS data sources showed that 363 projects have been conducted in the study area in Arizona; however, these projects only cover approximately 2 percent of the study area, and the majority of those projects are over 10 years old. Projects include block and linear surveys, data recovery, and monitoring projects associated with gas pipelines, fiber-optic lines, transmission lines, road and highway construction, mining operations, and numerous development projects, and land transfers. The Class I records search of NPS data sources demonstrated that 521 projects had been conducted resulting in coverage of approximately 3 percent of the study area. Like projects outside the parks, the projects consist of block and linear intensive archaeological surveys, monitoring, and data recovery treatments associated with recreational development, vegetation management, post-fire assessments, land and timber transfers, graffiti removal, and a number of "documentation as preservation" surveys.

**California**

Within the study area in California, 216 archaeological projects have been conducted (Eddy et al. 2024). Previously conducted projects include survey, data recovery, monitoring, literature reviews, and planning documents. Of the 216 previously conducted archaeological investigations, 161 were surface surveys, covering approximately 11 percent of the study area in California. Projects were conducted in support of a variety of projects including but not limited to transmission lines, water infrastructure, fiber optics installation, pipelines, residential and commercial development, highway projects, prescribed burns and fuel breaks, and agricultural projects.

**Nevada**

Within the Nevada study area, 605 archaeological projects have been conducted; 408 of the surveys are from the NPS dataset (Winslow et al. 2024). Most of these projects were surveys in support of improvements at Lake Mead NRA, other recreational projects, utility installation, and road improvements. Previous survey covers approximately 5 percent of the study area in Nevada.

**Utah**

In total, 135 previous survey projects have been conducted within the Utah study area covering 37 percent of the Utah study area (Eskenazi 2024). These surveys were conducted in support of research and improvements to facilities in the Glen Canyon NRA, road improvements, transmission lines, land exchanges, and movie sets.

### *Archaeological Sites*

**Arizona**

A total of 4,246 archaeological sites were identified in the study area in Arizona based on the Class I records search (Tremblay, Lemoine, et al. 2024). This number includes both non-NPS and NPS data accounting for duplicates between the two datasets. **Table TA 11-1** summarizes the NRHP status and temporal components of all archaeological sites within the study area in Arizona.

**Table TA 11-1**
**Summary Counts of Previously Recorded Sites in the Study Area in Arizona**

| | | Overall Study Area |
|---|---|---|
| **Count (Sites)** | | **4,246** |
| **NRHP** | NRHP Listed | 13 |
| | Determined Eligible | 3,059 |
| | Recommended Eligible | 41 |
| | Determined Ineligible | 144 |
| | Recommended Ineligible | 92 |
| | Unevaluated | 897 |
| **Temporal Component** | Precontact | 3,231 |
| | Ethnohistoric | 50 |
| | Postcontact | 458 |
| | Multicomponent | 282 |
| | Unknown | 225 |

Source: Tremblay, Lemoine, et al. 2024
Notes: The information presented in this table incorporates NPS and non-NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

*Non-NPS Dataset*

The record search of non-NPS data identified 1,246 archaeological sites in the study area (Tremblay, Lemoine, et al. 2024). Seventeen sites in the study area are listed in the NRHP; 12 of the 17 listed sites are within the Ripley Intaglio Complex Historic District. Of the 1,246 sites, 345 are determined and recommended eligible for the NRHP and 126 are determined or recommended not eligible. The remaining 758 sites are unevaluated for the NRHP or of unknown NRHP status.

Of the 1,246 sites, 985 are precontact sites, 107 are postcontact (historic-era) sites, two are ethnohistoric sites, and 56 are multicomponent sites (i.e., used during more than one temporal period). The temporal affiliations of the remaining 96 sites are unknown. Precontact sites or site components could be attributed to the Paleoindian and Archaic period cultures, as well as the Basketmaker and Ancestral Puebloan cultures. Ethnohistoric sites or site components are affiliated with Mohave, Southern Paiute, Hopi, Diné (Navajo), and indeterminate Indigenous peoples. Postcontact (historic-era) component sites are overwhelmingly associated with Euro-American culture; however, a few historic-era sites are attributed to Havasupai, Mohave, Diné (Navajo), Pai, Southern Paiute, Ute, and indeterminate Indigenous peoples.

**Table TA 11-2** presents a summary of site function for sites in the non-NPS dataset. For precontact sites and site components, limited activity artifact scatters were the most abundant, but both long- and short-term habitation sites, resource procurement and processing sites, lithic reduction sites, and petroglyph/pictograph sites were well-represented. Although in smaller numbers, agricultural and water management sites, storage sites or caches, ceremonial or special use sites, and trails were also present. Site functions for ethnohistoric sites or site components are similar to those from precontact component sites and include limited activity sites, an agricultural site, temporary camps, long-term habitations, resource processing sites, special use sites, and a trail. The most common function of historic sites and site components is waste management (refuse piles). Other functions include mining, ranching, agriculture, permanent habitations, temporary camps, public utilities, and water management, as well as numerous transportation features, including roads, trails, and ferry crossings.

**Table TA 11-2**
**Summary of Site Functions within the Study Area in Arizona (Non-NPS Data Only) by Temporal Component**

| Site Function | Count | Temporal Component | | |
|---|---|---|---|---|
| | | Precontact | Ethnohistoric | Postcontact |
| Limited Activity (artifact scatters) | 236 | 233 | 3 | 0 |
| Habitation | 206 | 186 | 2 | 18 |
| Temporary Habitations/Camps | 155 | 133 | 2 | 20 |
| Resource Procurement/Processing | 167 | 163 | 2 | 2 |
| Agriculture | 52 | 47 | 1 | 4 |
| Lithic Reduction | 113 | 113 | 0 | 0 |
| Storage/Cache | 36 | 35 | 0 | 1 |
| Ceremonial/Religious/Special Use | 28 | 25 | 0 | 3 |
| Petroglyphs/Pictographs | 161 | 150 | 2 | 9 |
| Water Management | 15 | 12 | 0 | 3 |
| Waste Management (Refuse piles) | 24 | 0 | 0 | 24 |
| Transportation (Roads/Trails/Ferries/etc.) | 16 | 1 | 0 | 15 |
| Utility | 2 | 0 | 0 | 2 |
| Livestock/Ranching | 11 | 0 | 0 | 11 |
| Mining | 18 | 0 | 0 | 18 |
| Industrial | 2 | 0 | 0 | 2 |
| Government | 5 | 0 | 0 | 5 |
| Military | 2 | 0 | 0 | 2 |
| Commerce | 4 | 0 | 0 | 4 |
| Unknown | 22 | 16 | 0 | 6 |

Source: Tremblay, Lemoine, et al. 2024

Notes: 1) Some sites have multiple functions identified for individual components, such that total site function counts in this table will exceed the total number of individual sites/components within each temporal category; 2) Table does not include sites/components where temporal affiliations were not available. The information presented in this table incorporates non-NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current databases.

*NPS Dataset*

As stated above, data provided by the NPS will be presented separately where applicable. This means that some sites are found in both the non-NPS and NPS databases. Counts of NPS sites presented below are based on the complete NPS dataset. Duplicate sites are accounted for above in **Table TA 11-1**.

A total of 3,158 previously recorded archaeological sites are found in the NPS dataset for the study area. One site is listed in the NRHP (the remnants of the Charles H. Spencer Steamboat). Another 2,941 sites have been determined or recommended eligible, 22 determined or recommended not eligible, and 194 are unevaluated. See **Table TA 11-3** for eligibility by park unit.

**Table TA 11-3**
**Summary Counts of Previously Recorded Sites for NPS Data by Park Unit in Arizona**

| | | Park Unit | | | Total |
|---|---|---|---|---|---|
| | | GCNP | Lake Mead NRA | Glen Canyon NRA | |
| **Total Count (Sites)** | | **2,887** | **174** | **97** | **3,158** |
| NRHP | NRHP Listed | 0 | 0 | 1 | **1** |
| NRHP | Determined Eligible | 2,887 | 7 | 8 | **2,902** |
| NRHP | Recommended Eligible | 0 | 15 | 24 | **39** |
| NRHP | Determined Ineligible | 0 | 0 | 6 | **6** |
| NRHP | Recommended Ineligible | 0 | 9 | 7 | **16** |
| NRHP | Unevaluated | 0 | 143 | 51 | **194** |

Source: Tremblay, Lemoine, et al. 2024
Notes: The information presented in this table incorporates NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current park unit databases.

Precontact sites or site components from the NPS dataset are attributed to time periods that archaeologists identify as Paleoindian and Archaic period, Basketmaker, Ancestral Puebloan, Cohonina, Patayan, and Cerbat cultures and peoples (**Table TA 11-4**). Ancestral Puebloan sites are most common, and indeterminate Indigenous peoples are second-most common. Ethnohistoric sites or site components are attributed to the Havasupai, Hopi, Diné (Navajo), Pai, and Southern Paiute peoples. For postcontact (historic-era) sites or site components, sites attributed to Euro-American sites are most common; however, several sites are attributed to Havasupai, Hopi, Diné (Navajo), Pai, Southern Paiute peoples, or unspecified Indigenous native cultures.

**Table TA 11-4**
**Summary of Cultural Affiliations in NPS Dataset by Park Unit in Arizona**

| | Park Unit | | | Total |
|---|---|---|---|---|
| | GCNP | Lake Mead NRA | Glen Canyon NRA | |
| **Cultural Affiliation – Precontact** | | | | |
| Paleoindian | 2 | 1 | 1 | 4 |
| Archaic | 12 | 0 | 1 | 13 |
| Basketmaker | 17 | 0 | 1 | 18 |
| Ancestral Puebloan | 1,346 | 8 | 33 | 1,387 |
| Patayan | 2 | 13 | 0 | 15 |
| Cohonina | 302 | 0 | 0 | 302 |
| Cerbat | 35 | 0 | 0 | 35 |
| Indigenous Native Culture | 759 | 71 | 38 | 868 |
| Unknown | 0 | 2 | 0 | 2 |
| **Cultural Affiliation – Ethnohistoric** | | | | |
| Pai | 29 | 0 | 0 | 29 |
| Southern Paiute | 64 | 0 | 0 | 64 |
| Hopi | 20 | 0 | 0 | 20 |
| Diné (Navajo) | 7 | 0 | 0 | 7 |
| Havasupai | 4 | 0 | 0 | 4 |
| Indigenous Native Culture | 10 | 0 | 0 | 10 |
| **Cultural Affiliation – Postcontact** | | | | |
| Euro-American | 401 | 28 | 12 | 441 |
| Diné (Navajo) | 24 | 0 | 3 | 27 |
| Havasupai | 16 | 0 | 0 | 16 |
| Southern Paiute | 8 | 1 | 1 | 10 |
| Pai | 2 | 0 | 0 | 2 |
| Hopi | 6 | 0 | 0 | 6 |
| Indigenous Native Culture | 38 | 3 | 0 | 41 |
| Unknown | 7 | 0 | 0 | 7 |

Source: Tremblay, Lemoine, et al. 2024
Notes: The information presented in this table incorporates NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current park unit databases.

Precontact site functions include agricultural, ceremonial/religious/special use, habitation, temporary habitation/camp, limited activity, lithic reduction, resource procurement/processing, petroglyphs/pictographs, storage/cache, transportation (trails), and water management sites (**Table TA 11-5**). Among these, longer-term habitations, resource processing sites, and temporary habitations were the most common. Ethnohistoric site and site component functions are similar to those of precontact sites and include agriculture, habitation, temporary habitation/camp, ceremonial/religious/special use, limited activity, lithic reduction, resources procurement/processing, storage/cache, and petroglyphs/pictographs. Historic site or site component functions consist of temporary habitations/camps, mining, ranching, agriculture, utilities, and water management, as well as numerous sites associated with transportation, such as ferry crossings.

**Table TA 11-5**
**Summary of Site Functions for NPS Dataset by Park Unit in Arizona**

| | Park Unit | | | Total |
|---|---|---|---|---|
| | GCNP | Lake Mead NRA | Glen Canyon NRA | |
| **Site Function – Precontact** | | | | |
| Limited Activity (Artifact scatters) | 231 | 14 | 24 | **269** |
| Habitation | 709 | 23 | 3 | **735** |
| Temporary Habitations/Camps | 465 | 21 | 6 | **492** |
| Resource Procurement/Processing | 535 | 9 | 4 | **548** |
| Agriculture | 123 | 0 | 0 | **123** |
| Lithic Reduction | 108 | 16 | 13 | **137** |
| Storage/Cache | 128 | 0 | 1 | **129** |
| Ceremonial/Religious/Special Use | 82 | 1 | 1 | **84** |
| Petroglyphs/Pictographs | 98 | 6 | 21 | **125** |
| Water Management | 4 | 1 | 0 | **5** |
| Unknown | 56 | 1 | 7 | **64** |
| **Site Function – Ethnohistoric** | | | | |
| Limited Activity (artifact scatters) | 4 | 0 | 0 | **4** |
| Habitation | 9 | 0 | 0 | **9** |
| Temporary Habitations/Camps | 35 | 0 | 0 | **35** |
| Resource Procurement/Processing | 48 | 0 | 0 | **48** |
| Agriculture | 3 | 0 | 0 | **3** |
| Lithic Reduction | 1 | 0 | 0 | **1** |
| Storage/Cache | 4 | 0 | 0 | **4** |
| Ceremonial/Religious/Special Use | 5 | 0 | 0 | **5** |
| Petroglyphs/Pictographs | 17 | 0 | 0 | **17** |
| Water Management | 1 | 0 | 0 | **1** |
| **Site Function – Postcontact** | | | | |
| Limited Activity (Artifact scatters) | 85 | 2 | 0 | **87** |
| Habitation | 48 | 4 | 2 | **54** |

| | Park Unit | | | Total |
|---|---|---|---|---|
| | GCNP | Lake Mead NRA | Glen Canyon NRA | |
| Temporary Habitations/Camps | 122 | 2 | 1 | **125** |
| Resource Procurement/Processing | 33 | 0 | 1 | **34** |
| Agriculture | 5 | 2 | 0 | **7** |
| Lithic Reduction | 1 | 0 | 0 | **1** |
| Storage/Cache | 7 | 0 | 0 | **7** |
| Ceremonial/Religious/Special Use | 38 | 0 | 2 | **40** |
| Petroglyphs/Pictographs | 12 | 3 | 8 | **23** |
| Water Management | 4 | 0 | 1 | **5** |
| Waste Management (Refuse piles) | 18 | 3 | 1 | **22** |
| Transportation (Roads/Trails/Ferries/etc.) | 27 | 5 | 2 | **34** |
| Utility | 2 | 2 | 0 | **4** |
| Livestock/Ranching | 32 | 1 | 0 | **33** |
| Mining | 39 | 4 | 1 | **44** |
| Government | 0 | 2 | 0 | **2** |
| Unknown | 23 | 3 | 2 | **28** |

Source: Tremblay, Lemoine, et al. 2024
Notes: The information presented in this table incorporates NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current park unit databases.

**California**

A total of 551 previously recorded archaeological resources were identified within the study area in California as a result of the Class I records search (Eddy et al. 2024). Of the 551 previously recorded archaeological resources, 493 are classified as archaeological sites, and 58 are classified as isolated occurrences. For the previously recorded archaeological resources (both sites and isolated occurrences), 4 are listed in the NRHP, 22 are recommended or determined eligible for the NRHP, 13 are recommended or determined ineligible or non-significant, and 512 are unevaluated or of unknown NRHP status. Of the 493 archaeological sites, 372 are precontact sites, 78 are postcontact (historic-era) sites, 31 are multicomponent sites with both precontact and postcontact (historic-era) resources, one is a multicomponent site with both precontact and ethnohistoric resources, and 11 sites are unknown.

Site or site component functions within the study area are shown in **Table TA 11-6**. The most common function is lithic reduction followed by transportation (trail). Other common functions include habitation, waste management, ceremonial/religious/special use, and camps. Some sites or site components are of indeterminate function and are listed in **Table TA 11-6** according to their site type (i.e., potter scatter or rock feature).

**Table TA 11-6**
**Summary of Site or Site Component Functions within the Study Area in California**

| Function | Numbers of Sites or Site Components |
|---|---|
| Limited Activity | 4 |
| Habitation | 71 |
| Camp | 26 |
| Resource Procurement/Processing | 9 |
| Road | 3 |
| Lithic Reduction | 264 |
| Storage/Cache | 1 |
| Ceremonial/Religious/Special Use | 43 |
| Rock Art | 0 |
| Waste Management | 48 |
| Water Management | 5 |
| Transportation | 0 |
| Utility | 2 |
| Livestock/Ranching | 0 |
| Industrial-Mining | 3 |
| Industrial-Other | 0 |
| Government | 1 |
| Rock Feature | 16 |
| Pottery Scatter | 38 |
| Trail | 98 |
| Quarry | 5 |
| Other | 9 |

Source: Eddy et al. 2024
Notes: The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

### Nevada

In the Nevada study area, 514 archaeological sites were identified in the non-NPS and NPS data sets (273 NPS and 241 NVCRIS only) based on the Class I records search (Winslow et al. 2024). Six sites are listed in the NRHP, including the B-29 Heavy Bomber Superfortress and the Pueblo Grande de Nevada: Main Ridge Locality. Additionally, 26 sites are eligible for the NRHP (including the St. Thomas historic townsite (ca. 1865). 23 are ineligible or recommended non-significant; and the remaining 459 resources are either unevaluated or unknown.

Precontact sites include habitation sites, rock shelters, campsites, artifact scatters, tool stone procurement localities, and rock features. Euro-American sites include roads, utility lines, house foundations, mines, recreation facilities, and sites associated with the construction and operation of Hoover and Davis Dams (**Table TA 11-7**).

**Table TA 11-7**
**Summary of Site or Site Component Functions within the Study Area in Nevada**

| Function | Numbers of Sites or Site Components (NPS Data) | Numbers of Sites or Site Components (non-NPS Data) | Total |
|---|---|---|---|
| Habitation | 40 | 47 | 87 |
| Lithic Reduction | 12 | 50 | 62 |
| Lithic Procurement and Testing | 1 | 20 | 21 |
| Military | 1 | 0 | 1 |
| Mining | 8 | 3 | 11 |
| Ranching | 0 | 1 | 1 |
| Recreation | 2 | 2 | 4 |
| Resource Processing | 0 | 4 | 4 |
| Temporary Habitation | 0 | 15 | 15 |
| Town | 1 | 0 | 1 |
| Transportation | 2 | 7 | 9 |
| Unknown/Other | 199 | 51 | 250 |
| Utility | 2 | 3 | 5 |
| Waste Management | 0 | 5 | 5 |
| Water Management | 6 | 31 | 37 |

Data source: Winslow et al. 2024
Notes: The information presented in this table incorporates NPS and non-NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

### Utah

The Class I records search identified 950 sites (721 non-NPS and 229 NPS) within the Utah study area (Eskenazi 2024). Of the 950 sites, one is listed in the NRHP, 182 are eligible for the NRHP, 156 are not eligible, 611 are unevaluated, undetermined, or have an unknown NRHP eligibility status. Precontact sites in the study area total 802, and postcontact (historic-era) sites total 63. Fifteen are multicomponent and contain components that date to both periods, 13 date to the ethnographic period, and 57 date to an unknown temporal period. Precontact sites and site components functioned as task-specific sites, domestic sites, unknown or other sites, transportation and communication sites, and special-use sites (**Table TA 11-8**). The postcontact (historic-era) sites and site components are associated with agriculture and subsistence, domestic use, industry, special-use sites, task-specific sites, transportation and communication, and unknown or other.

**Table TA 11-8**
**Summary of Site or Site Component Functions within the Utah Study Area in Utah**

| Function | Numbers of Sites or Site Components (NPS Data) | Numbers of Sites or Site Components (non-NPS Data) | Total |
|---|---|---|---|
| Agriculture | 0 | 8 | 8 |
| Ceremonial/Religious/Special Use | 5 | 4 | 9 |
| Communication | 0 | 1 | 1 |
| Defensive | 1 | 0 | 1 |
| Habitation | 148 | 3 | 227 |
| Limited Activity | 38 | 96 | 134 |
| Lithic Reduction | 31 | 101 | 132 |
| Mining | 2 | 3 | 5 |
| Ranching | 8 | 2 | 10 |
| Recreation | 0 | 2 | 2 |
| Resource Procurement/Processing | 20 | 34 | 54 |
| Rock Art | 41 | 49 | 60 |
| Storage | 13 | 22 | 35 |
| Temporary Habitation | 62 | 127 | 189 |
| Transportation | 10 | 9 | 19 |
| Unknown | 8 | 47 | 55 |

Source: Eskenazi 2024
Notes: The information presented in this table incorporates NPS and non-NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

***Built Environment Resources***

Built environment resources are those human-made and/or intentionally modified components of our world that are shaped by the way we live, work, and play. For the purposes of this analysis, this includes buildings, structures, sites, objects, and districts that are historic in age (at least 50 years old since first constructed) and retain their basic structural elements, configurations, alignments, or patterns of organization (i.e., that are not in ruins and thus categorized as archaeological resources).

It is important to note that the state-specific lists of built environment resources discussed in this section do not include every individual resource or property type of historic age and, collectively, are not intended to represent a comprehensive inventory within the overall study area. Each state has different requirements when it comes to documenting built environment resources, as some state agencies manage such records in continuously maintained databases, while others do not. Arizona does not have a process to track built environment surveys conducted within the state, and at present, such resources are not assigned to any type of unique identifier like archaeological sites. California allocates project numbers to cultural resource investigations and assigns primary numbers to all cultural resources documented during those inventories, but the state's database system (California Historical Resources Information System) does not distinguish between archaeological and built environment (architectural) surveys and/or resources. Nevada maintains its own statewide inventory database where both archaeological and built environment inventories are registered by NVCRIS number and resources documented under the latter are currently assigned state-specific built environment numbers. Lastly, Utah manages information pertaining to previously recorded built environment resources (The HUB) where individual property record numbers are assigned.

Because Arizona, California, Nevada, and Utah each approach the management of built environment resource data in various ways, the types of information presented in this section are specific to each of the four states in the study area. For Arizona, built environment resources have not been documented consistently in the past, and currently, there is no systematic tracking or database managed for these resources. For this reason, the only sources of data that were readily available for historic-era built environment resources in Arizona were the NRHP/Arizona Register of Historic Places, lists encompassing designated NHLs, NHAs, and NHTs, as well as NPS Heritage Documentation Programs (Historic American Building Survey, Historic American Engineering Record, Historic American Landscapes Survey) databases and historical aerial imagery. Because of this, only the most important built environment resources (as demonstrated by research) associated with the historic setting of the study area are included for analysis. The datasets acquired from federal and state agencies were also examined to identify any additional properties that qualified as built environment resources, which were then culled from the archaeological site data; none of the datasets provided included information pertaining to NRHP-ineligible and/or unevaluated built environment resources. For California, all documented cultural resources are assigned a state-specific primary number, and built environment resources documented in the study area were identified by their primary numbers from the comprehensive datasets obtained from the California Historical Resources Information System and other registers and lists. Conversely, because Nevada and Utah have (at least to some degree) state-maintained databases for built environment resources, those that are eligible, ineligible, and unevaluated for the NRHP are considered for analysis, however, this is limited to only those resources that have officially been assigned state resource numbers. Additional details pertaining to identification efforts performed for resources in Arizona, California, Nevada, and Utah are presented in the data gathering methods summaries in each state-specific volume (Tremblay, Lemoine, et al. 2024; Eddy et al. 2024; Winslow et al. 2024; Eskenazi 2024).

Lastly, there is a substantial degree of overlap between designations, particularly involving NHLs and NRHP-listed historic properties, because NHLs are also listed in the NRHP when designated if they have not been already. For this reason, where historic properties were listed in the NRHP before they were later designated as NHLs (in some cases, many years later), they are included for analysis as NRHP-listed built environment resources and NHLs. NHLs in the study area are discussed in a separate section below (see NHLs, NHAs, and NHTs).

**Arizona**

In all, a total of 46 previously evaluated built environment resources were identified as part of the Class I records search in the Arizona portion of the study area (Tremblay, Lemoine, et al. 2024). Of these, 40 are NRHP-listed (non-NHL) historic properties (8 districts, 24 buildings, 6 structures, one object, one site) and six are NRHP-eligible historic properties (all districts). **Table TA 11-9** provides a summary of NRHP-listed/-eligible built environment resources identified in the Arizona study area.

## Table TA 11-9
## NRHP-Listed/-Eligible Historic Properties in the Study Area in Arizona

**DISTRICTS**

| Name | NRHP Status | Year | Eligibility Criteria | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Lee's Ferry and Lonely Dell Ranch | Listed | 1976, 1978 1997 (combined) | A, C | NPS | Glen Canyon NRA |
| North Rim Entrance Road Corridor | Eligible | 2011 | A, C | NPS | GCNP |
| *Grand Canyon Inn and Campground | Listed | 1982 | A, C | NPS | GCNP |
| *Grand Canyon North Rim Headquarters | Listed | 1982 | A, C | NPS | GCNP |
| El Tovar Stables | Listed | 1974 | A | NPS | GCNP |
| Grand Canyon National Park Trail System | Eligible | N/A | A | NPS | GCNP |
| Transcanyon Water Distribution Pipeline (including Silver Bridge) | Eligible | 2016 | A, C | NPS | GCNP |
| Cross Canyon Corridor | Eligible | 2015 | A, C | NPS | GCNP |
| Grand Canyon Railway | Listed | 2000 | A | NPS, U.S. Forest Service, Private | GCNP, Kaibab National Forest (federal lands only) |
| Horace M. Albright Training Center | Listed | 2013 | A, C | NPS | GCNP |
| Temple Bar Developed Area | Eligible | 2020 | A | NPS | Lake Mead NRA |
| Katherine's Landing Developed Area | Eligible | 2021 | A | NPS | Lake Mead NRA |
| Parker Dam | Eligible | N/A | A, C | Reclamation | Lower Colorado River Office (LCRO) |

**DISTRICTS**

| Name | NRHP Status | Year | Eligibility Criteria | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Brinley Avenue | Listed | 1982 | A, C | Municipal, Private | City of Yuma (city lands only) |
| Yuma Main Street | Listed | 1994 | A | Municipal, Private | City of Yuma (city lands only) |

**BUILDINGS**

| Name | NRHP Status | Year | Eligibility Criteria | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Buckey O'Neill Cabin | Listed | 1975 | A | NPS | GCNP |
| San Carlos Hotel | Listed | 1984 | C | Private | N/A |
| Yuma County Courthouse | Listed | 1982 | A, C | County | Yuma County |
| Yuma Main Post Office | Listed | 1985 | A, C | Private | N/A |
| Cactus Press-Plaza Paint Building | Listed | 1987 | C | Private | N/A |
| Pauley Apartments | Listed | 1982 | C | Private | N/A |
| Methodist Parsonage | Listed | 1982 | A | Private | N/A |
| Methodist Episcopal Church | Listed | 1982 | A, C | Private | N/A |
| Masonic Temple | Listed | 1984 | C | Private | N/A |
| Hotel del Ming | Listed | 1982 | A, C | Private | N/A |
| Lee Hotel | Listed | 1984 | C | Private | N/A |
| Old Yuma City Hall | Listed | 1982 | A, C | Municipal | City of Yuma |
| Dressing Apartments | Listed | 1982 | C | Private | N/A |
| Power Apartments | Listed | 1982 | C | Private | N/A |
| Named private residences (n=10) | Listed | 1982 | B and/or C | Private | N/A |

**STRUCTURES**

| Name | NRHP Status | Year | Eligibility Criteria | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Navajo Steel Arch Highway Bridge (Navajo Bridge) | Listed | 1981 | A, C | ADOT | ADOT |
| Trans-Canyon Telephone Line | Listed | 1986 | A, C | NPS | GCNP |
| Old Trails Bridge (Topock Bridge) | Listed | 1988 | A, C | FWS, Private | FWS Southwest Region, EPNG |

**STRUCTURES**

| Name | NRHP Status | Year | Eligibility Criteria | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Historic U.S. Route 66 in Arizona | Listed | 1989 | A, C | FWS, State, County | FWS Southwest Region, ADOT, Mohave County |
| Ocean-to-Ocean Highway Bridge | Listed | 1979 | A, C | County | Yuma County |
| Southern Pacific Passenger Coach Car | Listed | 2000 | A, C | State | ASPT |

**SITES**

| Name | NRHP Status | Year | Eligibility Criteria | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Hardyville Pioneer Cemetery | Listed | 2001 | A | Municipal | City of Bullhead City |

**OBJECTS**

| Name | NRHP Status | Year | Eligibility Criteria | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Blaisdell Slow Sand Filter Washing Machine | Listed | 1979 | A | Municipal | City of Yuma |

Source: Tremblay, Lemoine, et al. 2024
Notes: Resources are listed in order from north to south by type (district, building, structure, site, object). Jurisdiction and ownership are given only for the study area (ADOT [Arizona Department of Transportation]; EPNG [El Paso Natural Gas Company]; ASPT [Arizona State Parks and Trails]; and FWS. Properties marked with an asterisk (*) include the Grand Canyon Inn and Campground as well as the Grand Canyon North Rim Headquarters historic districts on the North Rim within GCNP, which recently suffered extensive damage from the 2025 Dragon Bravo Fire; therefore, the NRHP status for district components may have changed as a result of wildfire impacts. The Buckey O'Neill Cabin also contributes to the Grand Canyon Village NHL. Parker Dam has not been evaluated as a district in Arizona but was subject to a preliminary assessment in California in 1997, concluding the dam and its components likely qualified as an NRHP-eligible historic district; a formal NRHP nomination is currently in progress for listing. The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

Additionally, 16 unevaluated but notable built environment resources (five districts, one building, nine structures, one site) were also identified as important resources that may be eligible for the NRHP based on extensive research. **Table TA 11-10** summarizes these resources identified in the Arizona portion of the study area.

**Table TA 11-10**
**Unevaluated But Notable Built Environment Resources in the Study Area in Arizona Listed from North to South**

| Name | Property Type | Location/Vicinity |
|---|---|---|
| Glen Canyon Dam | District | Glen Canyon NRA |
| Glen Canyon Dam Bridge | Structure | Glen Canyon NRA |
| Greenland Lake Salt Cabin | Building | GCNP |
| Black Suspension Bridge (Kaibab Suspension Bridge) | Structure | GCNP |
| Davis Dam | District | Laguna |
| London Bridge | Structure | Lake Havasu City |
| Ehrenberg Pioneer Cemetery | Site | Ehrenberg |
| Palo Verde Diversion Dam | Structure | Yuma |
| Yuma Levee System (Yuma Project) | District | Yuma |
| Fisher’s Landing | District | Yuma |
| Imperial Dam | Structure | Yuma |
| Gila Project | District | Yuma |
| Laguna Dam | Structure | Yuma |
| Southern Pacific Railroad | Structure | Yuma |
| Southern Pacific Railroad Bridge (Colorado River) | Structure | Yuma |
| Morelos Dam | Structure | NIB* |

Source: Tremblay, Lemoine, et al. 2024
Notes: Location and/or vicinity does not imply jurisdiction, ownership, or administrative responsibilities. *NIB = Northerly International Boundary. The Southern Pacific Railroad has been recorded in other locations in Arizona, but the route as aligned through Yuma has not yet been documented and/or evaluated for the NRHP, nor has the Southern Pacific Railroad Bridge across the river. Notes: The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

### California

A total of nine built environment investigations have been conducted within the California portion of the study area based on the Class I records search, which involved inventory and evaluation for components of the All-American Canal, the Imperial Dam, the Imperial Irrigation District, land ports of entry, and masonry arch bridges. In all, 63 historic-era built environment properties were identified from archival records searches, including three districts (Picacho Squatters Settlement District, Topock Compressor Station District, and Parker Dam), a regional park (Moabi Regional Park), and various buildings, structures, roads, and transmission lines (Eddy et al. 2024). **Table TA 11-11** summarizes the general categories of built environment resources (based on function and/or use) established for the literature review.

**Table TA 11-11**
**Built Environment Resource Categories in the Study Area in California**

| Category | Number of Resources |
|---|---|
| Bridge | 3 |
| Building | 12 |
| District | 3 |
| Historic/Survey Marker | 3 |
| Other Structure | 8 |
| Park | 1 |
| Railroad | 2 |
| Road | 21 |
| Single Family Dwelling | 2 |
| Transmission | 3 |
| Water Conveyance/Management | 5 |
| **Totals** | **63** |

Source: Eddy et al. 2024
Notes: Sixteen individual resources are within the Topock Compressor Station District, which is counted as one of three districts in this table. The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

For the 63 built environment resources identified in the study area, two are listed in the NRHP (the Old Trails Bridge near Topock and the Ocean-to-Ocean Highway Bridge in Yuma), six were recommended as eligible for the NRHP, 17 were recommended/determined ineligible (including the Topock Compressor Station District and Moapi Regional Park), while 38 have either not yet been evaluated (including the Picacho Squatters Settlement District), or NRHP status was not reported (Eddy et al. 2024). Parker Dam and its associated facilities were subject to a 1997 preliminary evaluation that concluded the dam complex is likely eligible as a district, therefore it is considered an NRHP-eligible historic district for the purposes of this Draft Environmental Impact Statement (see Arizona above). The eight NRHP-listed/-eligible historic properties are summarized in **Table TA 11-12**.

## Table TA 11-12
## NRHP-Listed/-Eligible Historic Properties in the Study Area in California Listed from North to South

| Resource Name/Type | Category | Property Type | NRHP Status | Criteria |
|---|---|---|---|---|
| National Trails Highway (Bat Cave Wash) | Transportation | Structure | Eligible | A |
| Historic U.S. Route 66 | Transportation | Structure | Eligible | A |
| Old Trails Bridge (Topock Bridge) | Transportation | Structure | Listed | A, C |
| Parker Dam | Water conveyance/ management | District | Eligible | A, C |
| All-American Canal | Water conveyance/ management | Structure | Eligible | A, C |
| Transmission Line (near Fort Yuma Riviera) | Electric Power | Structure | Eligible | D |
| Southern Pacific Railroad | Transportation | Structure | Eligible | D |
| Ocean-to-Ocean Highway Bridge | Transportation | Structure | Listed | A, C |

Source: Eddy et al. 2024

Notes: As previously mentioned, Parker Dam was subject to a preliminary assessment in California in 1997; a formal NRHP nomination is currently in progress for listing and therefore, the dam complex is included here as an NRHP-eligible district. The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

### Nevada

In all, the Class I records search identified 22 built environment inventories that have been completed within the Nevada portion of the study area, which were undertaken for several Lake Mead NRA improvements, transmission line construction, roadway improvements, resource evaluations, and NRHP eligibility determinations. Research identified 159 previously documented built environment resources, consisting mostly of properties (districts [i.e., groupings of resources], along with individual buildings, structures, sites, and objects) associated with the construction and ongoing operation of Hoover Dam on the Nevada side of the Colorado River (Winslow et al. 2024). As previously mentioned, Hoover Dam Historic District was listed in the NRHP in 1981 and later designated an NHL in 1985. Because of the substantial number of district resources present on the Nevada side of the Colorado River, nearly all of which were given individual state-specific numbers, Hoover Dam is discussed in detail in this section as an NRHP-listed historic district. In all, 98 individual built environment resources were documented as part of Hoover Dam, of which 66 are contributing (eligible), and 29 are noncontributing (ineligible) components of the NRHP-listed historic district, with the remaining three having no information pertaining to NRHP status. These include dam operational components (diverter towers, spillways, intakes, tunnels, penstocks, diversion channels, concrete support structures, and anchor foundations), cableway components (hoist house, crane towers, tower bases and cable lines), electric power-related components (powerplants, switchyards, transformers, and transmission lines); visitor services components (modern visitor facilities [not housed in operational buildings], parking lots and structures, food/beverage/gift shop facilities, historical monuments and interpretive installations, walking trail systems, and scenic overlooks), transportation components (access roads, gates, railroads and associated features, and bridges); and other components (unique/unclassifiable resources like spoils piles, survey markers, and memorials).

In addition to the Hoover Dam Historic District, there is one additional NRHP-listed historic property within the boundaries of Lake Mead NRA in the study area: Willow Beach Gauging Station (listed in the NRHP in 1986). Elsewhere in the Nevada study area, a total of 26 built environment resources associated with the development of recreation around Lake Mead and Lake Mohave within Lake Mead NRA have been given state-specific built environment resource numbers, consisting of 10 NRHP-eligible properties (including Echo Bay Developed Area, Cottonwood Cove Developed Area, and the Las Vegas Wash Developed Area) and 16 ineligible properties (including Boulder Beach Developed Area District, Callville Bay Developed Area, and Overton Beach Developed Area District). At the south end of Lake Mohave is Davis Dam, and because most of the dam complex is on the Arizona side of the river, only three components of the dam have been documented and given inventory numbers, and all are eligible for the NRHP (Winslow et al. 2024).

Furthermore, 23 built environment resources identified in the Nevada study area were documented on an individual basis (apart from Hoover and Davis Dams and established recreation areas in Lake Mead NRA), including 11 NRHP-eligible properties and five NRHP-ineligible properties, leaving eight properties where NRHP status information was absent in the archival record (Winslow et al. 2024). Half of these resources represent individual overhead powerlines that are owned and maintained by various utility entities (federal, state, municipal, private), bringing electricity generated at both Hoover and Davis dams to their respective service areas primarily in southern California. The other half consists of transportation (road segments), non-electric power utility (the Boulder City water supply line, a telephone line), science and research (U.S. Geological Survey [USGS] monitoring facilities), resources that have been given state-specific built environment numbers. Lastly, there are six built environment resources for which no information (e.g., resource category, property type, NRHP status, and jurisdiction/ownership) was available from corresponding archives. **Table TA 11-13** summarizes the built environment resources by category (i.e., function and/or use) along with corresponding property types and NRHP status as identified in the Nevada portion of the study area.

**Table TA 11-13**
**Built Environment Resources Documented in the Study Area in Nevada**

**HOOVER DAM**

| Category | Property Type | NRHP Status (Criteria) | Resource Count | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Dam Operations | Building | Eligible (A and/or C) | 4 | Reclamation | LCRO |
| | | Ineligible | 3 | Reclamation | LCRO |
| | Structure | Eligible (A and/or C) | 19 | Reclamation | LCRO |
| | | Ineligible | 1 | Reclamation | LCRO |
| | | ***Total*** | ***27*** | — | — |

| Hoover Dam | | | | | |
|---|---|---|---|---|---|
| **Category** | **Property Type** | **NRHP Status (Criteria)** | **Resource Count** | **Jurisdiction/ Ownership** | **Administering Agency** |
| Cableway | Building | Eligible (A and/or C) | 1 | Reclamation | LCRO |
| | Structure | Eligible (A and/or C) | 4 | Reclamation | LCRO |
| | | ***Total*** | ***5*** | — | — |
| Electric Power | Building | Eligible (A and/or C) | 2 | Reclamation | LCRO |
| | Structure | Eligible (A and/or C) | 15 | DOE, Reclamation, Municipal | WAPA, LCRO, LADWP |
| | | Ineligible | 19 | Unknown | Unknown |
| | | ***Total*** | ***36*** | — | — |
| Visitor Services | Building | Eligible (A and/or C) | 1 | Reclamation | LCRO |
| | | Ineligible | 2 | Reclamation | LCRO |
| | Structure | Eligible (A and/or C) | 4 | Reclamation | LCRO |
| | | Ineligible | 2 | Reclamation | LCRO |
| | Object | Eligible (A and/or C) | 1 | Reclamation | LCRO |
| | | Ineligible | 1 | Reclamation | LCRO |
| | | Unknown | 1 | Reclamation | LCRO |
| | | ***Total*** | ***12*** | — | — |
| Transportation | Structure | Eligible (A and/or C) | 12 | Reclamation | LCRO |
| | | Ineligible | 1 | Reclamation | LCRO |
| | | ***Total*** | ***13*** | — | — |
| Other | Structure | Ineligible | 1 | Reclamation | LCRO |
| | Site | Eligible (A and/or C) | 2 | Reclamation | LCRO |
| | | Unknown | 1 | Reclamation | LCRO |
| | Object | Eligible (A and/or C) | 1 | Reclamation | LCRO |
| | | ***Total*** | ***5*** | — | — |
| | | **Hoover Dam Resource Total** | **98** | | |

**LAKE MEAD / LAKE MOHAVE**

| Category | Property Type | NRHP Status (Criteria) | Resource Count | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Recreation | District | Eligible | 3 | NPS | Lake Mead NRA |
| | | Ineligible | 3 | NPS | Lake Mead NRA |
| | Building | Eligible (A and/or C) | 5 | NPS | Lake Mead NRA |
| | | Ineligible | 11 | NPS | Lake Mead NRA |
| | Structure | Eligible (A and/or C) | 2 | NPS | Lake Mead NRA |
| | Site | Ineligible | 2 | NPS | Lake Mead NRA |
| | | **LAKE MEAD / LAKE MOHAVE RESOURCE TOTAL** | **26** | | |

**DAVIS DAM**

| Category | Property Type | NRHP Status (Criteria) | Resource Count | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Transportation | Structure | Eligible (A and/or C) | 1 | Reclamation | LCRO |
| | | ***Total*** | ***1*** | | |
| Other | Site | Eligible (A and/or C) | 2 | Reclamation | LCRO |
| | | ***Total*** | ***2*** | | |
| | | **DAVIS DAM RESOURCE TOTAL** | **3** | | |

**INDIVIDUAL**

| Category | Property Type | NRHP Status (Criteria) | Resource Count | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Electric Power | Structure | Eligible (A and/or C) | 7 | DOE, State, Municipal, Private | WAPA, MWD, LADWP, SCE |
| | | Ineligible | 3 | DOE, Private | WAPA, NV Energy, SWGC |
| | | Unknown | 2 | Private | SCE |
| | | ***Total*** | ***12*** | | |
| Recreation | Building | Unknown | 5 | NPS | Lake Mead NRA |
| | | ***Total*** | ***5*** | | |
| Transportation | Structure | Eligible (A and/or C) | 1 | NPS | Lake Mead NRA |
| | | Ineligible | 1 | Reclamation | LCRO |
| | | ***Total*** | ***2*** | | |

**INDIVIDUAL**

| Category | Property Type | NRHP Status (Criteria) | Resource Count | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Utility (Non-Electric) | Structure | Eligible (A and/or C) | 1 | Reclamation | LCRO |
| | | Unknown | 1 | Unknown | Unknown |
| | | ***Total*** | ***2*** | | |
| Science/Research | Building | Eligible (A and/or C) | 1 | Unknown | Unknown |
| | Structure | Eligible (A and/or C) | 1 | Unknown | Unknown |
| | | ***Total*** | ***2*** | | |
| | | **INDIVIDUAL RESOURCE TOTAL** | **23** | | |

**UNKNOWN**

| Category | Property Type | NRHP Status (Criteria) | Resource Count | Jurisdiction/ Ownership | Administering Agency |
|---|---|---|---|---|---|
| Unknown | Unknown | N/A | 6 | Unknown | Unknown |
| | | **UNKNOWN RESOURCE TOTAL** | **6** | | |

Source: Winslow et al. 2024

Notes: Jurisdiction is given only for the study area and is based ownership information in NVCRIS; WAPA (Western Area Power Administration) is under the DOE (Department of Energy); the Southern Nevada Fish and Wildlife Office is part of the FWS; other administering entities include: MWD (Metropolitan Water District of Southern California), LADWP (Los Angeles Department of Water and Power), SWGC (Southwest Gas Corporation), SCE (Southern California Edison), Nevada Department of Wildlife; for transmission lines, shared jurisdictional responsibility is not uncommon however this is not reflected in this table. For components of the Hoover Dam Historic District, resources noted as eligible are contributing components of the district while ineligible resources are noncontributing components. For Lake Mead and Lake Mohave—two districts (Boulder Beach [ineligible] and Las Vegas Wash Campground [eligible]) each encompass a share of the buildings, structures, and sites listed separately. The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

#### Utah

The Class I records search identified one built environment resource within the Utah portion of the study area—Hite Crossing Bridge—which was previously documented and recommended as eligible for the NRHP under Criterion C (Eskenazi 2024). Also known as the Colorado River Arch Bridge, it spans the river connecting Utah State Route 95 near Hite Marina within the boundaries of Glen Canyon NRA. Part of the Trail of the Ancients National Scenic Byway and the Utah Bicentennial Highway Scenic Byway, the Hite Crossing Bridge is under the management of the Utah Division of Transportation.

### *Specially Designated Cultural Resources*

As previously mentioned, there are three different types of special designations identified in the study area—that of the NHL, as well as the congressionally designated NHA and the NHT. NHLs are historic properties that illustrate U.S. heritage, while NHAs are nationally important landscapes encompassing unique natural, cultural, and scenic values. NHAs are not managed by the federal government, rather, they are managed by state governments, non-profit organizations, or private entities. Lastly, NHTs follow past routes of exploration, migration, trade, struggle, and/or military action representing historic corridors of national significance, which may or may not have a present physical manifestation. With some exceptions, administration of an NHT is generally assigned to a single federal agency (NPS, BLM, or U.S. Forest Service), with on-site jurisdiction belonging to various governmental agencies or private entities that own or manage the lands along each NHT.

The specially designated areas intersecting the study area are briefly summarized below by state, with more detailed discussions presented in the respective state volumes prepared to support this Draft Environmental Impact Statement (Eddy et al. 2024; Eskenazi 2024; Tremblay, Lemoine, et al. 2024; Winslow et al. 2024). It should be noted that there are five specially designated areas crossing the study area in more than one state including two NHLs and three NHTs—Hoover Dam NHL (Arizona and Nevada within Lake Mead NRA), Yuma Crossing NHL (Arizona and California), the Armijo Route (Arizona and Utah within Glen Canyon NRA) and the Mojave Road route (Nevada within Lake Mead NRA) of the Old Spanish NHT, as well as the Juan Bautista de Anza NHT and the recently designated Butterfield Overland NHT (Arizona and California).

**Arizona**

The Class I records search identified eight NHLs that intersect the Arizona portion of the study area—four districts and four individual buildings (Tremblay, Lemoine, et al. 2024). Most of the NHLs in the study area are within GCNP, including two districts and four buildings on the South Rim, all of which are administered by the NPS. The remaining two NHLs outside of GCNP are Hoover Dam and Yuma Crossing. Hoover Dam is under the jurisdiction of Reclamation and is situated within the boundaries of Lake Mead NRA but is not part of the NPS-administered park. The NHL designation encompasses infrastructure in both Arizona and Nevada, with the majority of components on the latter side of the river. Yuma Crossing NHL is unique in that it is composed of five distinct individual areas (including two state parks) that are collectively also designated as an NHA. The NHL designation encompasses portions of the study area in both Arizona and California while the NHA boundary only includes Arizona. The NHA is managed by a non-profit organization.

For the Arizona study area, the Armijo Route of the Old Spanish NHT crosses portions of Lake Powell within Glen Canyon NRA, while both the Juan Bautista de Anza NHT and the recently designated Butterfield Overland NHT traverse the river corridor in the Yuma area. There are no known physical remnants of the Old Spanish NHT in Arizona and if present, such evidence would be under the waters of Lake Powell. The routes of the Juan Bautista de Anza NHT and the Butterfield Overland NHT are approximate through the study area and, likewise, there is no known physical evidence of any original trail sections for either NHT. Therefore, there are no known NRHP-eligible segments of any of the three NHTs (Tremblay, Lemoine, et al. 2024).
**Table TA 11-14** summarizes the specially designated areas (NHLs, NHAs, and NHTs) in the Arizona study area.

## Table TA 11-14
## National Historic Landmarks, National Heritage Areas, and National Historic Trails in the Study Area in Arizona

**NATIONAL HISTORIC LANDMARKS**

| Name | Year Designated | Property Type | Jurisdiction/Ownership | Administering Agency |
|---|---|---|---|---|
| *M.E.J. Colter Buildings | 1987 | District | GCNP | NPS |
| *El Tovar Hotel | 1987 | Building | GCNP | NPS |
| *Grand Canyon Depot | 1987 | Building | GCNP | NPS |
| *Grand Canyon Park Operations Building | 1987 | Building | GCNP | NPS |
| *Grand Canyon Power House | 1987 | Building | GCNP | NPS |
| Grand Canyon Village (including Grand Canyon Pioneer Cemetery) | 1997 | District | GCNP | NPS |
| Hoover Dam | 1985 | District | Federal | Reclamation |
| Yuma Crossing and Associated Sites | 1966 | District | Multiple (tribal, state, city) | N/A |

**NATIONAL HERITAGE AREAS**

| Name | Year Designated | Property Type | Jurisdiction/Ownership | Administering Agency |
|---|---|---|---|---|
| Yuma Crossing | 2000 | N/A | Multiple (state, city) | Non-profit |

**NATIONAL HISTORIC TRAILS**

| Name | Year Designated | Property Type | Jurisdiction/Ownership | Administering Agency |
|---|---|---|---|---|
| Old Spanish Trail (Armijo Route) | 2002 | N/A | Glen Canyon NRA | NPS |
| Juan Bautista de Anza Trail | 1990 | N/A | Multiple (tribal, state, city, private) | NPS |
| Butterfield Overland Trail | 2023 | N/A | Multiple (tribal, state, city, private) | NPS |

Source: Tremblay, Lemoine, et al. 2024
Notes: Jurisdiction and ownership are given only for the study area. NHLs, when designated, are automatically listed in the NRHP if not already. NHLs in this table that also contribute to other NRHP-listed historic districts are indicated with an asterisk (*) and may also be repeated in subsequent applicable table(s). The M.E.J. Colter Buildings NHL consists of four isolated buildings on the South Rim (Lookout Studio, Hopi House, Desert View Watchtower, and Hermit's Rest) of which two (Lookout Studio and Hopi House) contribute to the significance of the Grand Canyon Village NHL. Yuma Crossing NHA encompasses Yuma Territorial Prison State Park, Colorado River State Park, Yuma East Wetlands, Yuma West Wetlands, and Pivot Point Plaza. The Grand Canyon (North Rim) Lodge was designated as an NHL in 1987 along with its associated cabins; however, the main lodge was recently lost during the 2025 Dragon Bravo Fire along with several cabins. While it is still designated as an NHL, it has been mostly destroyed by wildfire and its status is likely to change, therefore, this NHL has been removed from consideration. The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

**California**

The Class I records search identified one NHL—Yuma Crossing—which extends across the Colorado River into California to encompass the site of Fort Yuma, a former nineteenth century U.S. military post now on the Fort Yuma-Quechan Reservation (Eddy et al. 2024). There are no NHAs in the California portion of the study area because the Yuma Crossing NHA designation only includes the portion of the NHL on the Arizona side of the river. For the portions of the Juan Bautista de Anza NHT and Butterfield Overland NHT that cross the study area in California, there is no physical evidence of original trail segments known to exist.

**Nevada**

The Class I records search identified two specially designated cultural resources intersecting the study area—Hoover Dam NHL and the Mojave Road route of the Old Spanish NHT (Winslow et al. 2024). Hoover Dam NHL was designated in 1985, spanning two states, encompassing half the dam along with extensive electrical infrastructure on the Nevada side of the river, including primary visitor services. The Old Spanish NHT corridor enters the Nevada study area along the Virgin River and is submerged under the Overton Arm of Lake Mead. It exits the study area near Boulder Wash Cove and reenters at Callville Bay before exiting again at Las Vegas Bay. There are no known original segments of the Old Spanish NHT within the Nevada portion of the study area, and if remnants do exist, they were submerged when Lake Mead was impounded and would be underwater.

**Utah**

Based on the Class I records search, there is only one congressionally designated area in the Utah portion of the study area—the Armijo Route of the Old Spanish NHT—which crosses into the study area within Glen Canyon NRA (Eskenazi 2024). There are no known segments of the original trail documented within the Utah portion of the study area. Like Lake Mead, if such do exist, they are inundated under the waters of Lake Powell.

### *Cultural Landscapes*

There are different definitions for what constitutes a cultural landscape, however, at its basic level, a cultural landscape is a geographic area, encompassing both cultural and natural resources, that illustrates evidence of human interaction with the physical environment. The only defined cultural landscapes in the study area are within GCNP, where NPS has identified 16 cultural landscape areas in the park, representing historically or culturally significant designed, vernacular, and ethnographic landscapes, which allows land managers to assess how these landscapes should be managed and interpreted (NPS 2024). The Colorado River and its associated uplands represent a cultural landscape with both tangible and intangible attributes for many Indigenous peoples. Natural resources, such as animals, plants, springs, rivers, land formations, and human-made elements, such as ancestral homes and trails, fields, prayer objects enshrined in travertine and salt, are all important aspects of a cultural landscape. Tribal perspectives on cultural landscapes are summarized in **TA 13**, Tribal Resources.

The historic landscape at Lees Ferry, a recreation site at the confluence of the Colorado and Paria rivers in Glen Canyon NRA, is an example of a managed cultural landscape encompassing the NRHP-listed Lee's Ferry and Lonely Dell Ranch Historic District, which represents over 60 years of non-Indigenous cultural use of the Colorado River beginning with the establishment of the first ferry crossing by John D. Lee in 1871 up to 1909 when the Church of Jesus Christ of Latter-day Saints divested itself from both the ferry and farmstead. Lee's Ferry was the only ferry crossing of the Colorado River within 700 miles because, here, the river was not bound by steep canyon walls, allowing wagons to be driven to the river's edge. Historically, Lee's Ferry operated as a ferry crossing and farmstead with an extensive irrigation system, which today are represented by several historic-era buildings, a cemetery, an orchard, trails, and fields. The Lee's Ferry and Lonely Dell landscape is an interpretative site that is still used today by day visitors, river runners, campers, and the USGS for their river gauging stations.

#### *Traditional Cultural Places*

A TCP, which is a type of historic property, is "a building, structure, object, site, or district that may be eligible for inclusion in the National Register for its significance to a living community because of its association with cultural beliefs, customs, or practices that are rooted in the community's history and that are important in maintaining the community's cultural identity" (NPS 2024). Because the TCPs of concern are those of indigenous peoples, the analysis of impacts on TCPs is found in **TA 13**, Tribal Resources.

## TA 11.2 Environmental Consequences

### TA 11.2.1 Methodology

Direct and indirect impacts on cultural resources could result from changes in lake levels or river flows from the annual releases. Of greatest concern are effects on historic properties (i.e., resources eligible for or listed in the NRHP) that alter the characteristics of the properties in a way that would diminish the integrity of its location, design, setting, materials, workmanship, feeling, or association (36 CFR 800.5). Direct impacts may be from processes such as wave action and wet/dry cycling, but include any impact that is immediate in place and time, including visual, auditory, and atmospheric impacts; indirect impacts, such as from increased ease of access to previously inundated sites, are those that occur farther away in distance and/or later in time.

Impacts on cultural resources analyzed in this section only include those impacts resulting from Reclamation's management of annual releases from Glen Canyon and Hoover dams.

#### *Archaeological Sites*

Three types of analyses are used to discuss potential impacts on archaeological resources: site counts by elevation and modeled lake elevations, preservation risk modelling developed by the USGS and NPS, and aeolian transport modelling also developed by the USGS. Elevations for all sites identified in the Class I records search compiled for Arizona, California, Nevada, and Utah were calculated and used to identify those sites that are at elevations subject to changes in water levels or flows. Archaeological data over broad areas will be, by virtue of how and when it was collected, variable in coverage and documentation. For example, areas around Lake Powell have a higher cultural resource survey coverage and therefore, more archaeological data are available, while areas around Lake Mead do not. Also, there is very limited data on archaeological sites below the water line due to a lack of studies prior to inundation in Lake Mead NRA.

**Inundated Resources and Water Levels**

Fluctuating water levels at Lake Powell and Lake Mead can impact the preservation of archaeological sites, especially for those that are currently or previously inundated. The NPS prepared an initial study of how inundation and fluctuating water levels at Lake Powell affect resources (Morgan and Conlin 2023), which generally parallel the findings of earlier archaeological inundation studies (e.g., Ware 1989). Archaeological resources are more vulnerable to disturbance and degradation when water levels fluctuate. Fluctuating water levels can result in increased wave impacts, wet-dry cycling, and erosion. Changes in temperature, water chemistry, pH, salinity, and sedimentation as water levels rise and fall can also be detrimental to the preservation of resources. While inundation is also not ideal, as it can displace artifacts and disturb/damage site components sensitive to water and/or moisture (like mud mortar), inundation can protect resources through sedimentation if it is consistent over time. Resources which have previously been inundated and are exposed through fluctuating water levels are particularly vulnerable to wave action, etc., as well as to impacts from visitation. Like fluctuating lake levels, changes in river flows may impact archaeological sites through erosion, wet-dry cycling, exposure to the elements, and increased visitation of exposed resources. Discussion of lake elevations is based on end-of-water-year (EOWY) elevations and water year (WY) minimum elevations for Lake Powell and end-of-calendar-year (EOCY) and calendar year minimum elevations for Lake Mead (see **TA 3**, Hydrologic Resources).

**Preservation Risk Modelling**

The USGS, in cooperation with NPS, developed a preservation risk model for archaeological resources at or below full pool elevation at Lake Powell and Lake Mead (Caster et al. 2026). The Preservation Risk model is a spatial model which considers several landscape characteristics, locations of previously recorded cultural resources, and potential for water-related impacts such as wave action and erosion. The lake landscape was gridded off into 10m-resolution cells, and each 10m-resolution grid cell within the model was categorically ranked 1 to 5 based on low (1) to high (5) potential for site preservation to be negatively affected by water at a given reservoir elevation. The Preservation Risk model incorporates two other models: 1) the Site Distribution model, which identifies where archaeological resources are more likely or less likely to be found; and 2) the Preservation Hazard model, which identifies where site impacts related to lake fluctuations will likely occur.

Specific for archaeological sites, the Site Distribution model is based on landscape characteristics (geologic/geomorphic context-geologic maps and digital elevation models [DEMs], topographic position-DEMs/bathymetry, proximity to major runoff flow concentrations seen in National Hydrology Dataset flowlines and DEMs, and known locations of archaeological sites (precontact and postcontact). As mentioned above, not all of Lake Powell was surveyed prior to the completion of Glen Canyon Dam construction, and very little of Lake Mead prior to when filling began in 1934, so this model allows for the prediction of site distribution based on the correlation of landscape characteristics to known site location. However, the known site distribution was used within Lake Powell (a larger percent surveyed) to help define the distribution ranks (Rank 1 – no known archaeological sites, Rank 2 – known site density less than 1.5 per square mile (2.6 square kilometer), Rank 3 – known site density greater than and equal to 1.5 per square mile and less than 3 per square mile, Rank 4 – known site density greater than and equal to 3 per square mile and less than 4.5 per square mile, and Rank 5 – known site density greater than and equal to 4.5 per square mile).

The Preservation Hazard model is based on the simplified physical factors influencing lake shore geomorphic change. Like with coastal environments, wave action is a major player in erosion, but reservoirs have the added risk of large, rapid, and sustained changes in water level that affect runoff base level conditions, soil deformation, and chemical weathering with submersion and exposure. These aspects were incorporated into the model using available USGS topography and bathymetric data and the known relationships between slope-wave interactions/baselevel adjustments, lake fetch lengths (distance wind travels over water surfaces to help build waves), and lake shoreline area change, as well as a given change in elevation. In this model, the highest rank (5) correlates to a higher potential for impacts, and the lowest rank (1) correlates to a lower risk from these factors.

When combining the Site Distribution and Preservation Hazard models, a simple rule set was used based on the assumptions that: 1) regardless of hazard rank, areas likely to contain resources have potential to be affected by dam management operations; 2) even where archaeological resource likelihood is low, hazards from water levels can impact a potentially significant site; 3) areas with very high likelihood of containing archaeological sites and very high potential for impacts are at the highest risk of resource condition changes; and 4) areas with very low likelihood of containing archaeological sites and very low potential for impacts are at the lowest risk of resource condition changes.

The above concepts allow for each grid cell in the reservoir footprint to be ranked. For the analysis, the Preservation Risk model was summarized for greater than 60 units of 10-foot elevation bins at and below full pool. The summaries represent statistics of the Preservation Risk rank at the lake shoreline between the upper and lower reservoir elevations, defining each 10-foot bin (i.e., each bin represents a different summary area). Monthly modeled reservoir values are used in this model. In this way, each monthly modeled reservoir level will fall into one of the 10-foot summary bins and can be assigned a preservation risk rank summary statistic, such as the mean risk rank, that represents generalized potential impacts along the lake shoreline for that reservoir level. Monthly risk values, based on reservoir elevations, can then be used to evaluate differences between scenarios and traces within the modeling period.

**Wind-deposited Sediment**

Research conducted by the USGS and NPS has demonstrated that wind-deposited (aeolian) sediment can help stabilize and preserve archaeological sites along the Colorado River over long periods of time (East et al. 2016; Sankey et al. 2023). Sediment is generally deposited via wind on nearby terraces with archaeological sites at an average rate of a few millimeters a year; however, operations of the Glen Canyon Dam can inhibit the formation of sand bars from which the sediment is blown. Management of the Colorado River influences the supply of windblown river sand in two ways: 1) the reduction of river flows below current average baseflow levels causes sand in the river channel to be exposed subaerially and, given sufficient time, can dry out and become available for wind transport (Sankey et al. 2022); and 2) when High-Flow Experiment (HFEs) are successfully implemented to rebuild river sandbars, the sand in the subaerial portion of the sandbars becomes available for wind transport (Caster et al. 2022; Kelley et al. 2026). However, riparian vegetation can block the windblown transport of sand; when vegetation cover decreases, the potential for wind transport increases.

The analysis integrated three independent models: the aeolian sand availability model (hereafter referred to as the "Sand Area model," (Kasprak et al. 2024), the Vegetation Habitat Suitability model (Butterfield et al. 2018; Butterfield and Palmquist 2026), and the Sandbar Volume model (initially modified from Mueller and Grams 2021; Salter and Grams 2026). The Sand Area model was specifically developed to predict the supply of river-sourced, windblown sand as a function of river discharge and subaerial exposure time; however, the Sand Area model used here does not incorporate changes in vegetation cover that occur as a function of river hydrology or geomorphic changes (deposition and erosion of sand) that would also affect sand area. Therefore, the Sand Area model was then coupled with the outputs with those from the Marble Canyon Vegetation Habitat Suitability model. Scenarios were assessed in which modeled sand availability exceeded a defined threshold while vegetation suitability remained below a specified benchmark—conditions presumed to favor increased aeolian transport.

To further capture the dynamic influence of high flow events, which can increase sandbar volume and enhance future sand supply, the Sandbar Volume model output was then included in the evaluation framework. In this analysis, a future is defined as a "preferred minimum performance" if one of the following logical criteria was met: (1) the Sand Area model exceeded and the Vegetation Habitat Suitability model simultaneously fell below their respective thresholds (suggesting favorable conditions for aeolian transport), or (2) the Sandbar Volume model exceeded the threshold, indicating enhanced sand supply via fluvial-related deposition. Previous work suggests that dam releases that allow for these conditions to be met at least once every 1–3 years may slow the rate of degradation to enable time for proactive mitigation and planning (Sankey et al. 2018). Considering temporal variability of future preferred minimum performance, it is a preferred minimum performance if these conditions are met at least once every 3 years. Model thresholds were derived from recent historical baselines: the sand area and vegetation (Marble Canyon only) thresholds reflect the 50th percentile of model outputs from 2000 to 2023, while the sandbar volume threshold is set at 1.5 times the modeled initial condition beginning in 2027. For sandbars to grow in volume, and provide a continuous supply of river sand for aeolian transport to protect cultural resources, HFEs must be conducted on a frequent basis (e.g., every 1–3 years). However, the frequency of HFE occurrence, and thus sandbar volume growth, is likely overpredicted in the modeling, as the decision for an HFE to occur or not in a given year is a policy decision based on environmental conditions and other factors.

### *Built Environment Resources*

No modelling was conducted specifically for built environment resources. Recalling that built environment resources are those human-made and/or intentionally modified components of our environment, these types of resources are much less vulnerable to impacts compared to archaeological resources. The most prominent of the built environment resources identified in the study area also constitute critical infrastructure, constructed as part of major Reclamation projects like Glen Canyon Dam, Hoover Dam, as well as Davis and Parker dams. This also includes the smaller dams like the Palo Verde Diversion Dam, Imperial Dam, Laguna Dam, and Morelos Dam, along with the various canals and levee systems in the lowest reaches. Collectively, these facilities are key to Colorado River operations, and none of the alternatives would result in the decommissioning or substantial alteration of such critical infrastructure, so the historic importance of these resources would not be jeopardized. Therefore, it is assumed there would be no direct or indirect impacts on this critical infrastructure, and they are not carried forward for analysis.

In terms of built environment resources around the reservoirs and immediately along the river corridor that are not considered critical infrastructure for river operations, these properties were developed in response to either the creation of both Lake Powell and Lake Mead or to provide access to and/or across the river itself. Historic-era transportation roadway and railway networks spanned the river via bridges, while trails were established to provide river access. Recreation areas like those identified in Lake Mead NRA were intentionally placed in locations that took advantage of proximity to water. Other tourist facilities, like those in GCNP, were designed to accommodate visitors near the river and provide safe crossing between the North and South Rims. As such, for most built environment resources in the study area, these types of properties were built in consideration of fluctuating water levels both around the reservoirs and the river corridor. They are not considered vulnerable to inundation or varying water levels, increased wave impacts, wet-dry cycling, or erosion like archaeological sites because they were designed to withstand or avoid those impacts historically. Therefore, impacts on NRHP-listed/eligible built environment resources would occur where uncharacteristic water levels and river flows exceed historical ranges.

#### *Specially Designated Cultural Resources*

No modelling was undertaken for NHLs, NHAs, or NHTs. The one NHA identified in the study area (Yuma Crossing) coincides with the Arizona portion of the Yuma Crossing and Associated Sites NHL, therefore, it is analyzed as an NHL. There are no confirmed segments of the original trail in the study area for the three NHTs. Impacts on specially designated cultural resources (NHLs) would occur where uncharacteristic river flows exceed historical ranges.

#### *Impact Analysis Area*

The impacts analysis area consists of the Colorado River corridor from the upper limits of Lake Powell in Utah, through the Grand Canyon in Arizona, and Lake Mead in Arizona, and from Hoover Dam to the SIB.

#### *Assumptions*

- Once a resource has been inundated by a reservoir, being continuously inundated thereafter is more conducive to preservation than repeated cycles of inundation and exposure (i.e., wet/dry cycling and wave action).
- Repeating cycles of inundation and exposure of resources by the reservoirs and/or the river are not conducive to preservation.
- The covering of resources by windblown river-sourced sediment is conducive to preservation.
- Impacts on cultural resources can be characterized based on projected minimum and end-of-year lake elevations for very wet through very dry conditions and river flow volumes.
- Cultural resources that have not been previously inundated would not be inundated under the Continued Current Strategies (CCS) Comparative Baseline, the No Action Alternative, or any action alternatives (i.e., no additional cultural resources above reservoir spillway elevations or current river flows would be inundated).

- The limit of physical impacts on cultural resources by the river is constrained to resources within the river corridor (bank to bank) or within 20 meters (66 feet) of the river.
- Where previous survey coverage is absent within the study area, there may be sites that have not yet been identified (i.e., undiscovered) that could be affected under the CCS Comparative Baseline, the No Action Alternative, or any action alternatives.
- The Class I records search conducted for the study area in Arizona, California, Nevada, and Utah serves as a representative dataset for the purposes of analysis.
- Lake Mohave and Lake Havasu would be operated under the current rule curve (see **TA 3**, Hydrologic Resources) for target end-of-month elevations. Both lakes would not be affected by the alternatives; therefore, there would be no impacts on cultural resources at these two reservoirs.

#### *Impact Indicators*

- Projected monthly and end-of-year lake elevations that may expose cultural resources to damage from wave action, wet/dry cycling, or increased ease of access
- Forecasted changes in river flows that may contribute to erosion and exposure of cultural resources that may expose sites to damage from erosion, wet/dry cycling, or increased ease of access
- Projected availability of sediments along the river, which may be transported by wind and deposited on archaeological sites

### TA 11.2.2 Issue 1: How will any changes in dam operations affect 1) lake elevations at Lake Powell and Lake Mead and 2) river flows downstream which may affect cultural resources?

**Lakes**

As water levels in Lake Powell and Lake Mead fluctuate, archaeological sites that were previously inundated become vulnerable to several hazards. Direct impacts from wave action, wet/dry cycling, and erosion are more likely to occur as water levels drop to expose previously inundated resources; indirect impacts may occur from increased visitor traffic as access to exposed resources becomes easier. This section discusses the potential for archaeological resources to be exposed, and therefore potential impacts from exposure, using the distribution by elevation of cultural resources and the hydrologic modelling results for Lake Powell and Lake Mead elevations. However, please note that more data was available for Lake Powell than for Lake Mead because of variable archaeological survey coverage. The following discussion incorporates the discussion of hydrological modelling as presented in **TA 3**, Hydrologic Resources.

Because of the variable survey coverage throughout the study area and the issue of much of the locational data for the sites being recorded prior to modern technology, precise site counts for analysis are not feasible; rather, site counts can be considered a representative sample to understand the overall level of sensitivity in the study area. Representative site counts by elevation were compiled from Class I data using associated elevations based on critical conditions for each lake, which are discussed in **TA 3**, Hydrologic Resources. For Lake Powell, the associated elevations for critical conditions pertinent to this analysis are 3,700 feet (top of the Glen Canyon Dam spillway) down to 3,490 feet (minimum power pool; see **Table TA 3-2** in **TA 3.2.1** of **TA 3**, Hydrologic Resources). For Lake Mead, these associated elevations for critical conditions pertinent to this analysis are 1,221 feet (top of the Hoover Dam Spillway) down to 950 feet (minimum power pool; see **Table TA 3-5** in **TA 3.2.1** of **TA 3**, Hydrologic Resources). Archaeological sites identified in the Lake Powell dataset are presented by elevation range in **Table TA 11-15** while those identified in the Lake Mead dataset are presented (also by elevation range) in **Table TA 11-16**.

**Table TA 11-15**
**Archaeological sites in the Lake Powell dataset by elevation range (Arizona and Utah)**

| Elevation Range (feet) | Elevation Range (meters) | No. of Sites (NPS) | No. of Sites (non-NPS) | Total |
|---|---|---|---|---|
| 3,700–3,680 | 1,128–1,122 | 65 | N/A | 65 |
| 3,680–3,660 | 1,122–1,116 | 39 | N/A | 39 |
| 3,660–3,640 | 1,116–1,109 | 31 | N/A | 31 |
| 3,640–3,620 | 1,109–1,103 | 58 | N/A | 58 |
| 3,620–3,600 | 1,103–1,097 | 50 | N/A | 50 |
| 3,600–3,580 | 1,097–1,091 | 31 | N/A | 31 |
| <3,580 | <1,091 | 477 | N/A | 477 |
| | | | **Total Sites in the Lake Powell Dataset** | **751** |

Sources: Tremblay, Lemoine, et al. 2024; Eskenazi 2024
Notes: Glen Canyon NRA provided updated NPS site counts by elevation in November 2025, stating that all lands within the study area under 3,700 feet are NPS lands and should be accounted for in the updated data, so the non-NPS data acquired during the Class I records search (which relies on agency data acquired in August 2023) has been omitted. Therefore, this table does not correlate with the NPS and non-NPS site counts (or the total number of sites) identified by the Class I records search.

**Table TA 11-16**
**Archaeological sites in the Lake Mead dataset by elevation range (Arizona and Nevada)**

| Elevation Range (feet) | Elevation Range (meters) | No. of Sites (NPS) | No. of Sites (non-NPS) | Total |
|---|---|---|---|---|
| 1,221–1,201 | 372–366 | 59 | 10 | 69 |
| 1,201–1,181 | 366–360 | 42 | 8 | 50 |
| 1,181–1,161 | 360–354 | 54 | 2 | 54 |
| 1,161–1,141 | 354–348 | 25 | 4 | 29 |
| 1,141–1,121 | 348–342 | 10 | 5 | 15 |
| 1,121–1,101 | 342–336 | 8 | 3 | 11 |
| 1,101–1,081 | 336–329 | 7 | 2 | 9 |
| <1,081 | <329 | 3 | 0 | 3 |
| | | | **Total Sites in the Lake Mead Dataset** | **240** |

Sources: Tremblay, Lemoine, et al. 2024; Winslow, et al. 2024

Notes: Lake Mead NRA provided updated NPS site counts by elevation in November 2025, acknowledging that the park's database may contain errors. For this reason, non-NPS data acquired in August 2023 for the Class I records search has been retained for analysis. Therefore, this table does not correlate with the NPS and non-NPS site counts (or the total number of sites) identified by the Class I records search.

There are no NRHP-listed/eligible built environment resources within the critical elevations for Lake Powell (3,700–3,490 feet), but there is one NRHP-eligible district within the critical elevations for Lake Mead (1,221–950 feet): Echo Bay Developed Area in Lake Mead NRA. The historic-era boat ramp within the district boundary falls between 1,221 and 1,100 feet.

*Lake Powell*

This section references **Tables TA 3-3** and **TA 3-4** and **Figure TA 3-3** in **TA 3.2.1**, *Issue 1: Reservoir Elevations,* of **TA 3**, Hydrologic Resources. **Table TA 3-3** shows the statistical breakdown of EOWY elevations (in feet) at Lake Powell for each of the different hydrologic conditions under the different modeled scenarios. These values include the maximum, 90th percentile, 75th percentile, median (50th percentile), 25th percentile, 10th percentile, and minimum EOWY elevations. Similarly, **Table TA 3-4** shows the statistical breakdown of WY minimum elevations (in feet) with the same values. **Figure TA 3-3** visualizes the same data that is included in the tables using side-by-side conditional box plots. The bold line through each box represents the median elevation (50th percentile), the top and bottom of each box captures the 25th and 75th percentile of the modeled results (the interquartile range), the lines extend to the 10th and 90th percentiles, and the outliers are represented as dots beyond these lines (maximum and minimum elevation ranges for the modeled results).

In general, where water-level elevations are at reach the top of the Glen Canyon Dam spillway (3,700 feet), all 751 archaeological sites in the Lake Powell dataset would be inundated while water levels dropping to minimum power pool could expose up to all 751 archaeological sites (depending on how many of those in the Lake Powell dataset remain above 3,490 feet), leaving them vulnerable to impacts. A total of 477 sites (equating to around 64 percent of the sites in the Lake Powell dataset) are below 3,580 feet, thus, where any of the modeled scenarios result in reservoir levels below this elevation, a greater proportion of archaeological sites would be left vulnerable to impacts. Additionally, it is important to note that because some areas at Lake Powell have not been surveyed, any of the modeled scenarios have the potential to impact undiscovered archaeological resources. Based on these parameters, this section will focus on median and interquartile elevations for analysis and frequently refers to **TA 3**, Hydrologic Resources, where appropriate.

As discussed in Hydrologic Resources, the CCS Comparative Baseline and the No Action, Basic Coordination, Enhanced Coordination, and Maximum Operational Flexibility Alternatives all perform similarly under the Wet Flow Category (16–31.11 million acre-feet [maf]) with WY minimum and EOWY median elevations at around or above 3,680 feet. Therefore, based on this median elevation, any of these scenarios could inundate up to 686 sites while exposing up to 65 archaeological sites, as well as any undiscovered sites that may be present within the 3,700–3,680-foot zone. The Supply Driven Alternative (both Lower Basin [LB] Priority and LB Pro Rata approaches) has median elevations of around 3,660 feet, which could potentially leave an additional 39 archaeological sites (thereby inundating fewer sites) and any undiscovered sites that may be present within the 3,680–3,660-foot zone exposed. Sites exposed at higher elevations may be less vulnerable to impacts from wet/dry cycling and wave action, but may have increased ease of access depending on their location.

As conditions move toward average, the sites affected by wet/dry cycling are found at lower elevations in the lake, while sites exposed at higher elevations would see less of those impacts but may have increased ease of access. In the Average Flow Category (12–14 maf), the modeled scenarios begin to perform differently compared to wetter hydrological conditions. WY minimum and EOWY medians for the CCS Comparative Baseline and the No Action and Basic Coordination Alternatives all fall below 3,600 feet but just above 3,580 feet, which could expose up to 274 archaeological sites (thereby inundating the 477 sites below 3,580 feet) and any undiscovered sites that may be present with the No Action Alternative having the greatest interquartile range. The Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) have median elevations just below 3,580 feet, which would again leave at least 274 archaeological sites above 3,850 feet (and any undiscovered sites present) vulnerable to impacts while inundating the 477 sites identified in the dataset as being below that elevation. The Enhanced Coordination and Maximum Operational Flexibility Alternatives perform the best with median elevations at around 3,630 feet and 3,620 feet, respectively, which would inundate the 558 archaeological sites found below 6,620 feet in the Lake Powell dataset and leave a total of 193 sites (and, again, any undiscovered sites present) above this elevation exposed. Both the Enhanced Coordination and the Maximum Operational Flexibility Alternatives also have the narrowest interquartile ranges.

As discussed in **TA 3**, Hydrologic Resources, as hydrological conditions become drier, the CCS Comparative Baseline, No Action Alternative, and all action alternatives struggle to reach key elevations for Lake Powell. For the Critically Dry Flow Category (4.46–10 maf), the CCS Comparative Baseline, and the No Action, Basic Coordination, and Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives with median flows for WY minimum and EOWY median elevations as well as interquartile ranges at or below 3,500 feet, dropping below 3,490 feet (minimum power pool) in some cases. Therefore, there is the potential for the most archaeological sites in the Lake Powell dataset, along with any undiscovered sites that may be present, to be left exposed and vulnerable under the driest hydrologic conditions, depending on the elevations of the 477 sites located below 3,580 feet. The elevation where sites are vulnerable to wet/dry cycling and wave action would be the lowest for all scenarios because more of the sites would be above the inundation line as water levels drop, but this scenario would also have the potential for increased ease of access. While the Enhanced Coordination and Maximum Operational Flexibility Alternatives perform better, the WY minimum and EOWY median elevations are still relatively low at around 3,570 feet and around 3,550, respectively, resulting in the exposure of at least 274 archaeological sites at and above 3,580 feet as well as any undiscovered sites present above this elevation. These two action alternatives also have the potential to expose some of the 477 archaeological sites below 3,580 feet, depending on their elevation. The interquartile ranges for these two alternatives indicate that only the Enhanced Coordination Alternative has the potential to inundate up to 508 archaeological sites, the most of all modeled scenarios in terms of critically dry conditions, as the uppermost limit of this action alternative reaches at least 3,600 feet.

*Lake Mead*

This section references **Tables TA 3-6** and **TA 3-7** along with **Figure TA 3-11** in **TA 3.2.1**, *Issue 1: Reservoir Elevations,* of **TA 3**, Hydrologic Resources. Here, **Table TA 3-6** shows the statistical breakdown of EOCY elevations (in feet) at Lake Mead for each of the different hydrologic conditions under the different modeled scenarios. Similarly, **Table TA 3-7** shows the statistical breakdown of calendar-year minimum elevations (in feet). Both tables include values for the maximum, 90th percentile, 75th percentile, median (50th percentile), 25th percentile, 10th percentile, and minimum elevations. **Figure TA 3-11** visualizes the same data that is included in the tables side-by-side conditional box plots.

For Lake Mead generally, when water-level elevations are at or above 1,221 feet, all 240 archaeological sites in the dataset (and any undiscovered sites present) would be inundated. Conversely, if water levels drop to or below 1,081 feet, all 240 sites in the Lake Mead dataset (and any undiscovered sites above this elevation) would be exposed (see **Table TA 11-16**). The archaeological sites identified from the Class I records search at Lake Mead are relatively distributed evenly across the uppermost elevation ranges of the reservoir, with 173 sites (around 72 percent of sites in the Lake Mead dataset) recorded above 1,161 feet. Therefore, if any of the modeled scenarios result in reservoir levels below 1,161 feet, a greater proportion of archaeological sites would be exposed. However, sites exposed at higher elevations may be less vulnerable to impacts from wet/dry cycling and wave action, but may have increased ease of access depending on their location. To reiterate, very little of Lake Mead was surveyed prior to the construction of the Hoover Dam in the early 1930s, and, as a result, undiscovered archaeological resources are likely to be present in unsurveyed areas which could be affected under any of the modeled scenarios. Like Lake Powell, this section focuses on median and interquartile elevations for analysis, referring to **TA 3**, Hydrologic Resources, where necessary.

Although conditions as modeled in the Wet Flow Category for Lake Mead are unlikely, in the Wet Flow Category (16–31.11 maf), the CCS Comparative Baseline and No Action Alternative perform similarly for calendar-year minimum and EOCY median elevations and interquartile ranges. Even under the wettest hydrological conditions for the modeled scenarios, median elevations for the CCS Comparative Baseline and No Action Alternative for both the calendar-year minimum and EOCY scenarios are around 1,150 feet, exposing a minimum of 173 archaeological sites and any undiscovered sites.

For the Basic Coordination Alternative, the median calendar-year minimum elevation is around 1,180 feet (inundating 121 sites and exposing the 119 sites above this elevation) and EOCY median elevation is around 1,190 feet (inundating at least 121 sites, those below this elevation in the 1,181–1,201-foot zone, and any undiscovered sites present within these elevation ranges). The Enhanced Coordination and Maximum Operational Flexibility Alternatives perform similarly, with median elevations around 1,210 feet for both calendar-year minimum and EOCY. This would inundate 171archaeological sites below 1,201 feet, and those below 1,210 feet in the 1,221–1,201-foot zone (along with any undiscovered sites that are present in these elevation ranges), which is like other modeled scenarios described above. The Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) perform the best out of the modeled scenarios in this flow category, with median elevations of around 1,210 feet (calendar-year minimum) and around 1,220 feet (EOCY) inundating at least 171 sites (and any undiscovered sites present). As discussed above, sites exposed at higher elevations may be less vulnerable to impacts from wet/dry cycling and wave action, but may have increased ease of access depending on their location.

Similarly to Lake Powell, as conditions for Lake Mead become drier, the sites affected by wet/dry cycling are found at lower elevations in the lake, while sites exposed at higher elevations would see less of those impacts but may have increased ease of access. In the Average Flow Category (12–14 maf), the modeled scenarios result in a variable range of performance respective to minimum calendar-year elevations (refer to **TA 3**, Hydrologic Resources). The No Action Alternative performs the poorest with median elevations for both calendar-year minimum and EOCY at about 990 feet, which would expose all 240 archaeological sites in the Lake Mead dataset and any undiscovered sites that may be present. The CCS Comparative Baseline has higher median elevations than the No Action Alternative at around 1,040 feet, but will still leave up to 240 archaeological sites and any additional undiscovered archaeological sites present above this elevation vulnerable. The Basic Coordination Alternative has calendar-year minimum and EOCY median elevations of around 1,080 feet, leaving all but 3 archaeological sites, along with any undiscovered sites present exposed, while the corresponding interquartile range from 1,130 feet at the upper limit down to around 1,030 feet could leave up to 240 sites (and any undiscovered sites) left vulnerable to impacts. The Enhanced Coordination, Maximum Operational Flexibility, and Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives all perform similarly under average hydrological conditions, with slight variations in median elevations but greater variability in interquartile ranges. The Enhanced Coordination Alternative has calendar-year minimum and EOCY median elevations of around 1,110 feet, protecting at least 12 archaeological sites and those below that elevation in the 1,121–1,101-foot zone, but potentially leaving up to 228 sites (and any undiscovered sites present) vulnerable to exposure. The interquartile range for this alternative is similar for both calendar-year minimum and EOCY, from about 1,140 feet to about 1,080 feet, which may expose all but 3 recorded archaeological sites and any undiscovered sites present in the study area at Lake Mead. The Maximum Operational Flexibility Alternative has a median calendar-year minimum elevation of about 1,130 feet (protecting at least 23 of the 240 sites and those below this elevation in the 1,141–1,121-foot zone, along with any undiscovered sites present) and a median EOCY elevation around 1,140 feet, which would protect 38 sites and leave 202 sites (and any undiscovered sites present) vulnerable to impacts. The interquartile range for the Maximum Operational Flexibility Alternative is the largest of all modeled scenarios for both minimum calendar-year and EOCY elevations, from about 1,180 feet down to just above 1,070 feet, which would leave all but 3 archaeological sites (and any undiscovered sites present) vulnerable to impacts.

The Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) perform the best in the Average Flow Category, with the Supply Driven Alternative (LB Priority approach) calendar-year minimum and EOCY median elevations of around 1,150 feet (inundating at least 38 sites, those below this elevation in the 1,141–1,161-foot zone, and any undiscovered sites present in those elevation ranges) and the Supply Driven Alternative (LB Pro Rata approach) median elevations of around 1,160 feet (which would inundate at least 54 more sites, and leave 173 sites (along with any undiscovered sites above that elevation) exposed. The interquartile ranges for the Supply Driven Alternative (LB Priority approach) and the Supply Driven Alternative (LB Pro Rata approach) are similar and drop to no more than 1,100 feet, leaving 229 sites vulnerable through exposure. Overall,

all modeled scenarios have values that would result in the exposure of up to 240 archaeological sites (and any undiscovered sites present) in the study area during average hydrological conditions.

As conditions grow drier, the modeled scenarios remain the same in relation to one another relative to median calendar-year minimum but shift downward collectively in elevation about 100 feet in the Critically Dry Flow Category (4.46–10 maf). Similarly, the interquartile ranges become wider under the driest hydrological conditions for the modeled scenarios, indicating a greater range of variability and increased risk for impacts on archaeological sites than under wetter conditions (see **TA 3**, Hydrologic Resources).

Under critically dry hydrological conditions, the elevation where sites are vulnerable to wet/dry cycling and wave action would be the lowest for all scenarios. Both the No Action Alternative and the CCS Comparative Baseline have median calendar-year minimum elevations below minimum power pool of 950 feet. The CCS Comparative Baseline median EOCY elevation is around 950 feet; however, the No Action Alternative has median EOCY elevation far below 950. Both would potentially leave all 240 archaeological sites in the Lake Mead dataset (and any undiscovered sites present) vulnerable from exposure, depending on the elevations of the three sites below 1,081 feet. The Basic Coordination Alternative fares slightly better with calendar-year minimum and EOCY median elevations of around 980–990 feet and a 75th percentile value of around 1,060 feet, but would still have the potential to leave up to 240archaeological sites (and any undiscovered sites present) exposed. This is also true of the Enhanced Coordination Alternative, which has a median calendar-year minimum of just above 1,000 feet and a median EOCY elevation of around 1,020 feet and an interquartile range from 1,060 feet down to around 960 feet. The Maximum Operational Flexibility Alternative is similar to median elevations of around 1,030 feet, which would still leave at least 237 vulnerable to impacts. This alternative does, however, have interquartile ranges of up to around 1,100 feet, which would inundate at least 12 sites, but leave 228 sites exposed above the water, along with any undiscovered sites above this elevation. The Supply Driven Alternative (LB Priority approach) has similar calendar-year minimum and EOCY median elevations of around 1,030 feet, while the Supply Driven Alternative (LB Pro Rata approach) has median elevations around 1,050 feet, which is the highest median elevation in the Critically Dry Flow Category. Regardless of this, at least 237 archaeological sites (and any undiscovered sites) would still be exposed based on median elevations under the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches). The Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) do have the potential to protect some sites through inundation when examining the upper limits of their interquartile ranges, around 1,110 feet (inundating at least 12 sites and those sites below this elevation in the 1,121–1,101-foot zone along with any undiscovered sites in these elevation ranges) for the Supply Driven Alternative (LB Priority approach) at around 1,120 feet, which would inundate another 11 sites (for a total of 23) along with any undiscovered sites present; however, both scenarios would still leave over 215 sites (and any undiscovered sites above 1,120 feet) exposed of the water and vulnerable to impacts.

For the Echo Bay Developed Area, any of the modeled scenarios as described above that result in calendar-year minimum and EOCY median elevations below 1,100 feet would result in additional exposure of the boat ramp, but this would be outside the NRHP-eligible district boundary toward the receding lakeshore. Conversely, any of the modeled scenarios resulting in elevations above 1,100 would result in partial and/or full submersion of the ramp up to 1,221 feet, which would be more likely with the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) as the interquartile range for calendar-year minimum and EOCY elevations for the Supply Driven Alternative (LB Priority approach) extends just above 1,100 feet and up to around 1,120 feet for the Supply Driven Alternative (LB Pro Rata approach). At elevations above 1,221 feet, there would be impacts on recreation area infrastructure within the district boundary.

*Preservation Risk Modelling*

Preservation Risk modelling results were compared to the 90th percentile values of modelled values for the 2008–2024 time period; the 90th percentile risk value for Lake Powell is 2.72, and for Lake Mead is 2.24 (Caster et al. 2026). **Figure TA 11-1** shows the WY maximum archaeological preservation risk for Lake Powell and Lake Mead.

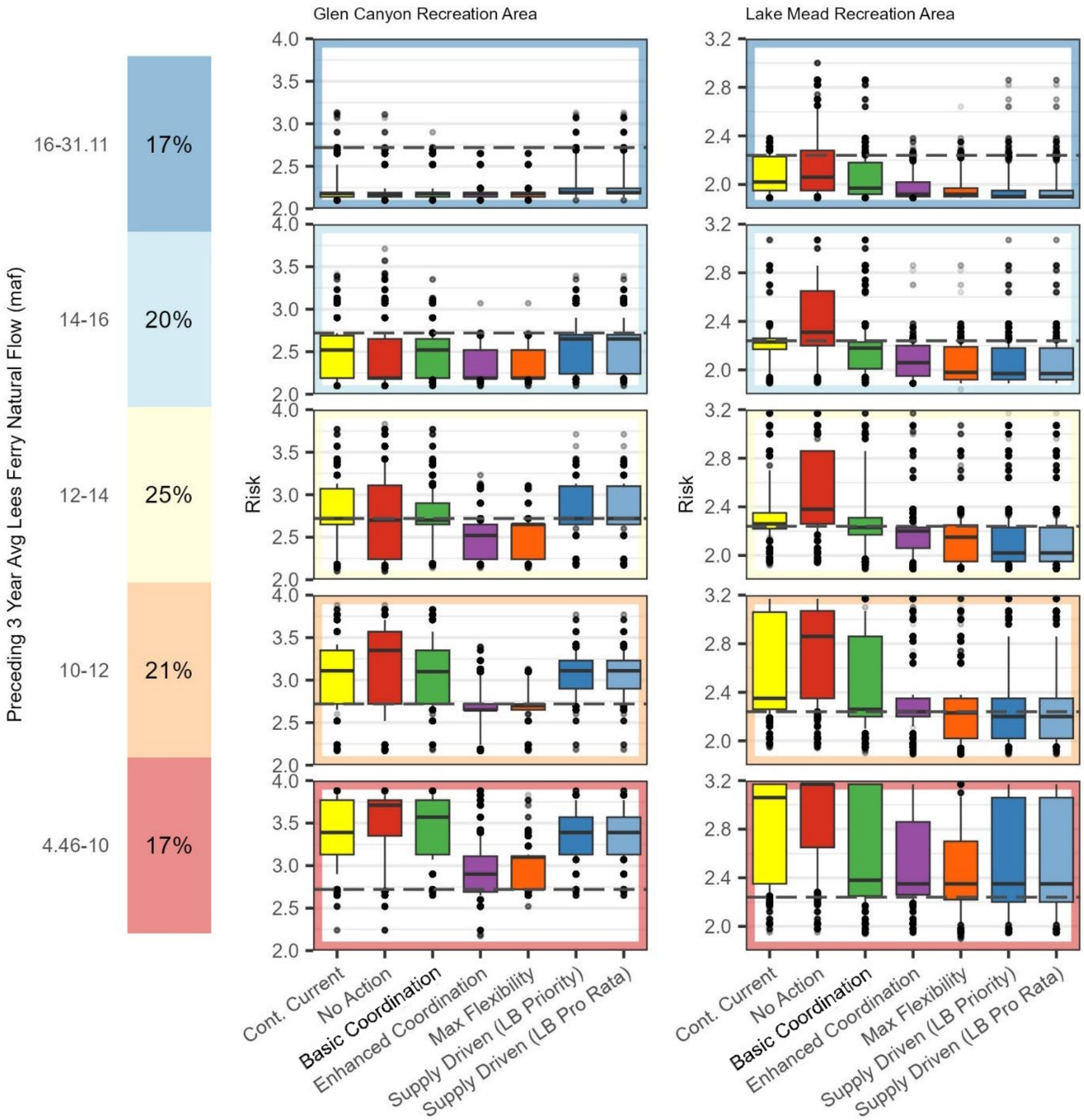
For both Lake Powell and Lake Mead, the median maximum preservation risk is lowest in the Wet Flow Category (16–31.1 maf) for the CCS Comparative Baseline, No Action Alternative, and all action alternatives. At Lake Powell, the median preservation risk value is just above 2.0 for the CCS Comparative Baseline, No Action Alternative, and all action alternatives. At Lake Mead, the median risk value is at or below 2.0 for all alternatives and the CSS Comparative Baseline, except for the No Action Alternative, which has a median above 2.0 but still under 2.42. However, the interquartile range for the No Action Alternative and the CSS Comparative Baseline reaches to or slightly above 2.42.

In the Average Flow Category (12–14 maf), the No Action, Basic Coordination, and Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives, as well as the CCS Comparative Baseline, all have a median risk level at the 2.72 threshold for Lake Powell. However, the No Action Alternative has the greatest variation in risk in the interquartile range. The median preservation risk for the Enhanced Coordination Alternative is at about 2.5 and for the Maximum Operational Flexibility Alternative at just under 2.72; both have similar interquartile ranges.

For Lake Mead in the Average Flow Category, the median risk value is highest for the No Action Alternative at about 2.4. The Basic Coordination and Enhanced Coordination Alternatives and the CSS Comparative Baseline have median risk values at or above 2.24, with the interquartile range for the Enhanced Coordination Alternative dropping the most below the 2.24 value. The median for the Maximum Operational Flexibility Alternative is just below the 2.24 value. The median risk value for the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) is the lowest at 2.0.

In the Critically Dry Flow Category (4.46–10 maf), the No Action Alternative has the median highest preservation risk for Lake Powell at well over 3.5, followed by the CCS Comparative Baseline, the Basic Coordination Alternative, and the Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives at or just below 3.5. Both the Maximum Operational Flexibility and Enhanced Coordination Alternatives have an interquartile range that extends down to 2.72; however, the Maximum Operational Flexibility Alternative has a higher mean risk value at above 3.0, while the Enhanced Coordination Alternative has a lower mean risk value at below 3.0.

**Figure TA 11-1**
**Water Year Maximum Archaeological Preservation Risk at Glen Canyon NRA and Lake Mead NRA**



The median Preservation Risk model values for Lake Mead at the Critically Dry Flow Category for all scenarios except the No Action Alternative and the CCS Comparative Baseline at just above the 2.24 value; however, the interquartile ranges for the Basic Coordination and the Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives are much greater than those of the Enhanced Coordination and Maximum Operational Flexibility Alternatives.

**Figure TA 11-2** and **Figure TA 11-3** show the percent of futures in which the preservation risk is below 2.72 for Lake Powell and 2.24 for Lake Mead in at least 90 percent of months. The 2.72 and 2.24 preservation risk values represent the 90th percentile of modeled historical values from 2008–2024 which aligns with the current operational guidelines and includes the period of significant reservoir storage loss. The highlighted row shows the results at these values.

For Lake Powell, over the full modelling period, the Enhanced Coordination Alternative is the most robust, meeting the 2.72 risk threshold in 58 percent of futures. The Maximum Operational Flexibility Alternative is less robust, meeting the 2.72 threshold in 36 percent of futures, followed by the No Action Alternative at 23 percent. This pattern is consistent if the modeling period is broken out with the Enhanced Coordination Alternative performing best at the 2040–2049 time frame at 74 percent.

**Figure TA 11-2**
**Cultural Resources in Glen Canyon NRA: Robustness**
**Percent of futures in which monthly preservation risk stays below the value specified in each row in at least 90% of months**

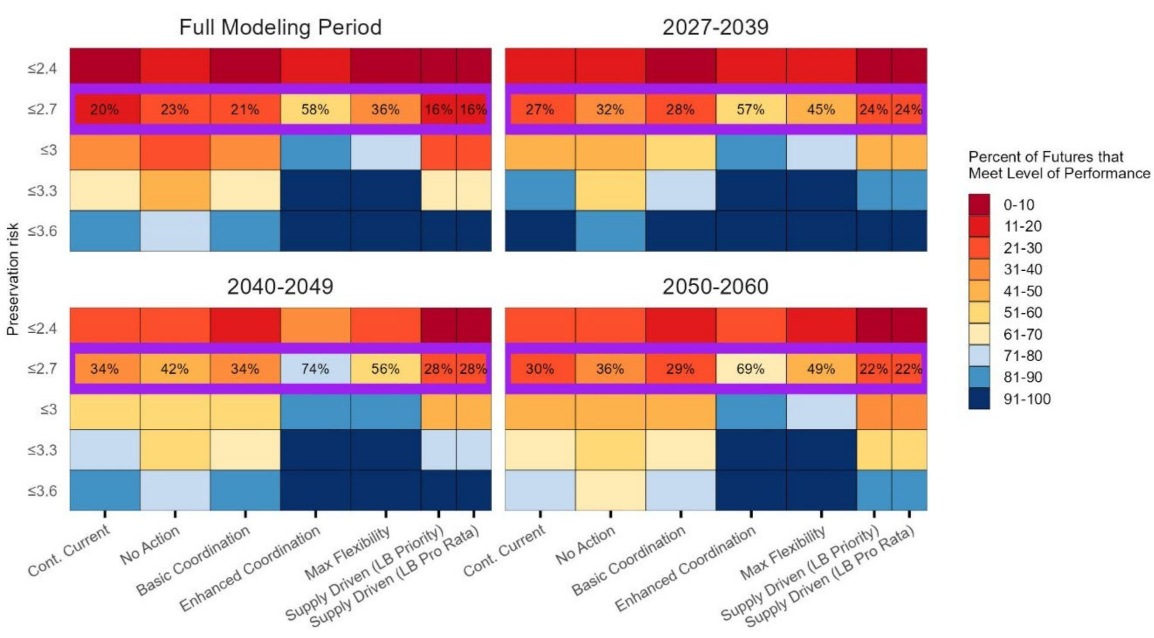
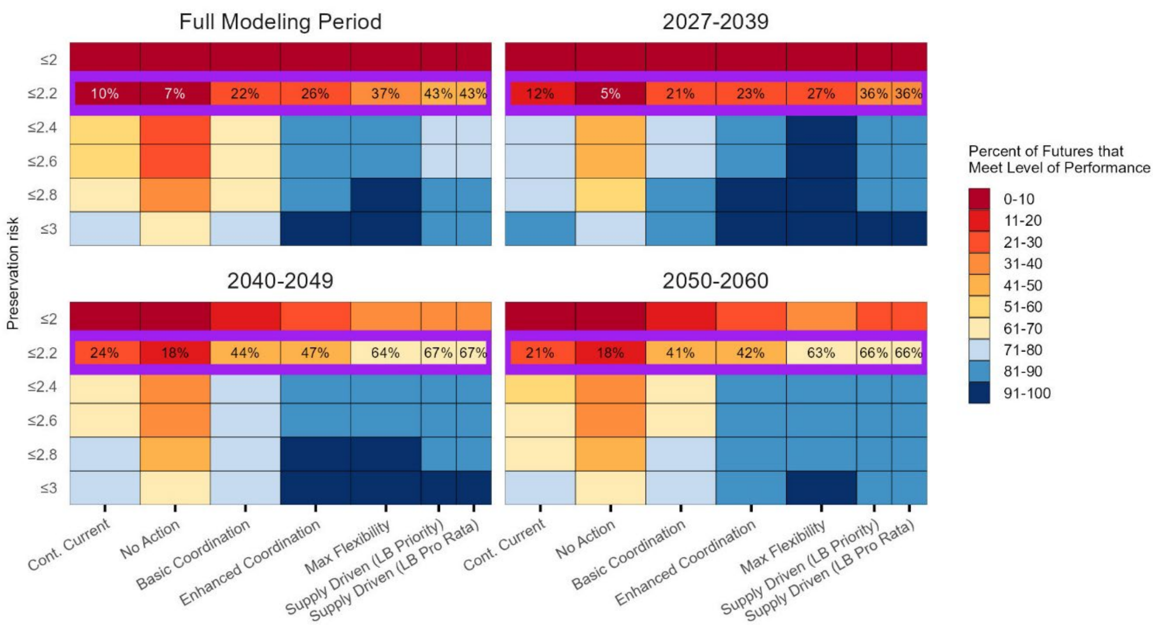


**Figure TA 11-3**
**Cultural Resources in Lake Mead NRA: Robustness**
**Percent of futures in which monthly preservation risk stays below the value specified in each row in at least 90% of months**




For Lake Mead, the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) are the most robust by meeting the 2.24 risk threshold in 43 percent of futures. The Maximum Operational Flexibility Alternative meets the threshold in 37 percent of futures, followed by the Enhanced Coordination Alternative at 26 percent and the Basic Coordination Alternative at 22 percent. If the modelling period is broken out, the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) can be seen to meet the threshold for 67 percent of futures in the 2040–2049 period and 65 percent of futures for the 2050–2026 time period. The Maximum Operational Flexibility Alternative meets the threshold 64 percent and 63 percent for these periods.

Overall, the Enhanced Coordination Alternative is the most robust for Lake Powell, followed by the Maximum Operational Flexibility Alternative, while the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) are the most robust for Lake Mead, followed by the Maximum Operational Flexibility Alternative.

**River Flows**

Archaeological sites that may be physically affected by changes in river flow are those along the river, with the primary impact being from erosion caused by moving water. As with the lake site data discussed above, variable survey coverage and older locational data must be taken into account. To identify a representative number of sites that may be affected by changes in flow, sites with all or portions of their boundaries in the river corridor or within 20 meters (66 feet) of the river corridor (bank to bank) were sorted out of the overall dataset using a geographic information system. **Table TA 11-17** lists the number of sites along the river.

### Table TA 11-17
### Representative Number of Sites within 20 Meters (66 Feet) of the River by Reach

| Reach | No. of NPS Sites | No. of Sites (non-NPS) | Total |
|---|---|---|---|
| Glen Canyon Dam to Lake Mead | 128 | 43 | 171 |
| Hoover Dam to Davis Dam | 180 | 78 | 258 |
| Davis Dam to Parker Dam | N/A | 64 | 64 |
| Parker Dam to Imperial Dam | N/A | 16 | 16 |
| Imperial Dam to the SIB | N/A | 2 | 2 |

Source: Eddy et al. 2024; Eskenazi 2024; Tremblay, Lemoine, et al. 2024; Winslow et al. 2024
Notes: The information presented in this table incorporates NPS and non-NPS data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

Like archaeological sites, built environment resources, and specially designated cultural resources that may be most affected by river flow changes are those immediately along the river corridor. As previously mentioned, built environment resources along the river tend to be more resilient to changes in river flow because they were designed to avoid impacts from shifts in conditions. Using elevations from DEM and other data sources, NRHP-listed/eligible built environment resources and specially designated cultural resources that are all or in part within 20 meters (66 feet) of the riverbank and/or above the river itself (such as in the case of bridges) were identified. Unevaluated built environment resources are treated as eligible for the purposes of analysis. **Table TA 11-18** summarizes these properties.

### Table TA 11-18
### Built Environment and Specially Designated Cultural Resources within 20 Meters of the River by Reach

| Reach | Resource Name | Status | Property Type |
|---|---|---|---|
| Glen Canyon Dam to Lake Mead | Lee’s Ferry and Lonely Dell Historic District | NRHP (Listed) | District |
| | Grand Canyon National Park Trail System | NRHP (Eligible) | District |
| | Transcanyon Water Distribution Pipeline (including Silver Bridge) | NRHP (Eligible) | District |
| Hoover Dam to Davis Dam | Willow Beach Gauging Station | NRHP (Listed) | Structure |
| Davis Dam to Parker Dam | Historic U.S. Route 66 | NRHP (Listed) | Structure |
| | National Old Trails Arch Bridge (Topock Bridge) | NRHP (Listed) | Structure |
| Parker Dam to Imperial Dam | Fisher’s Landing | Unevaluated | District |

| Reach | Resource Name | Status | Property Type |
|---|---|---|---|
| Imperial Dam to the SIB | Southern Pacific Railroad Bridge | Unevaluated | Structure |
| | Ocean-to-Ocean Highway Bridge | NRHP (Listed) | Structure |
| | Yuma Crossing and Associated Sites | NHL, NRHP (Listed) | District |

Source: Eddy et al. 2024; Eskenazi 2024; Tremblay, Lemoine, et al. 2024; Winslow et al. 2024
Notes: The Hoover Dam to Davis Dam and Davis Dam to Parker Dam reaches exclude Lake Mohave and Lake Havasu, respectively, because these two reservoirs would continue to be operated under their same rule curves for target end-of-month elevations, regardless of modeled scenario. The information presented in this table incorporates data acquired in August 2023 for the Class I records search, therefore, the number of sites and/or their corresponding NRHP status may or may not reflect current agency databases.

*Glen Canyon Dam to Lake Mead*

This section references **Table TA 3-14** and **Figure TA 3-21** in **TA 3.2.3**, *Issue 3: Reservoir Releases,* of **TA 3**, Hydrologic Resources. **Table TA 3-14** shows the statistical breakdown of WY releases (in maf) from Glen Canyon Dam for each of the different hydrologic conditions under the different modeled scenarios. These values include the maximum, 90th percentile, 75th percentile, median (50th percentile), 25th percentile, 10th percentile, and minimum EOWY releases (in maf). **Figure TA 3-21** visualizes the same data that is included in the table using a conditional box plot. The bold line through each box represents the median elevation (50th percentile), the top and bottom of each box captures the 25th and 75th percentile of the modeled results (the interquartile range), the lines extend to the 10th and 90th percentiles, and the outliers are represented as dots beyond these lines (maximum and minimum elevation ranges for the modeled results). In all categories except the Critically Dry Flow Category, the high end of the results range has been cut off to improve comparisons in the average and drier flow conditions.

Since 2008, after the implementation of the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (2007 Interim Guidelines), releases from Glen Canyon Dam have been from around 7 maf to around 13.9 maf, averaging around 8.8 maf. The annual average release of around 8.8 maf is lower than the average annual releases from 1996 to 2007 of nearly 10 maf, which is the result of both hydrological conditions in the Colorado River Basin and implementation of the 2007 Interim Guidelines (see **TA 3.1.3**, *Lake Powell and Glen Canyon Dam,* in **TA 3**, Hydrologic Resources). In general, where annual releases from Glen Canyon Dam deviate from this past range of 7–13.9 maf, there is greater potential for impacts on known cultural resources within 20 meters of the river as well as to undiscovered resources that may be present along the river corridor. The primary impacts would include water erosion from river currents during higher releases, but may also include exposure from lower water levels where dam release volumes are reduced; however, these impacts are only be considered in terms of this analysis when these volumes are outside past releases or flows. Based on these parameters, this section will focus on median and interquartile release volumes (in maf) for analysis and frequently refers to **TA 3**, Hydrologic Resources, where appropriate.

River flows from Lake Powell to Lake Mead primarily consist of controlled releases from Glen Canyon Dam. WY releases from Glen Canyon Dam under the Wet Flow and Average Flow

Categories would generally fall within the range of past annual release volumes for all modeled scenarios, including the CCS Comparative Baseline, with median WY volumes around or just above 8 maf. Neither the CCS Comparative Baseline, No Action Alternative, nor the action alternatives have median volumes that dip below 9 maf in the Wet Flow Category and none drop below 7.8 maf in the Average Flow Category. In terms of interquartile ranges under wet hydrological conditions, none of the modeled scenarios exceed past release volumes (7–13.9 maf). For sites within 20 meters (66 feet) of the river in this reach, it is anticipated that, under wet flow conditions, there would be no additional impacts because none of the modeled scenarios deviate outside the established range. This is also true for the three built environment resources found along this reach, including the boundary of the Lee's Ferry and Lonely Dell Historic District which extends into the river channel.

For the Average Flow Category, the interquartile range for the Enhanced Coordination Alternative is the only modeled scenario that deviates from the range of past release volumes (7 maf up to 13.9 maf), as it is forecasted as potentially dropping to around 6.8 maf (25th percentile). Reductions in the volume of WY releases would affect river flows, thereby potentially exposing the Spencer Steamboat. The same drops in river flows, resulting from reduced WY releases from Glen Canyon Dam, would not be detrimental to the three known historic properties within 20 meters (66 feet) of the river, as lower water levels would protect the Lee's Ferry and Lonely Dell Historic District as well as the Grand Canyon National Park Trails System and the Transcanyon Water Distribution Pipeline (including Silver Bridge) from river currents.

For the Critically Dry Flow Category, median WY release volumes for the CCS Comparative Baseline, No Action Alternative, and all action alternatives fall below 7 maf, down as low as around 5.1 maf for the Enhanced Coordination Alternative. Under the driest hydrological conditions, the CCS Comparative Baseline and the No Action Alternative perform better than the others relative to the upper limits of their interquartile ranges (75th percentile), which are around 7.5 maf for the CCS Comparative Baseline and 8.2 maf for the No Action Alternative. All of the modeled scenarios could expose the Spenser Steamboat if the reduced volumes of these WY releases cause the river to drop below previous water levels. On the other hand, these same potential drops in river water level would protect the three NRHP-listed/eligible properties within 20 meters (66 feet) of the river, as previously discussed.

*Hoover Dam to Davis Dam*

This section references **Table TA 3-20** and **Figure TA 3-27** in **TA 3.2.4**, *Issue 4: River Flows,* of **TA 3**, Hydrologic Resources. **Table TA 3-20** shows the statistical breakdown of annual flow volumes (in maf) of the Colorado River below Hoover Dam for each of the different hydrologic conditions under the different modeled scenarios. These values include the maximum, 90th percentile, 75th percentile, median (50th percentile), 25th percentile, 10th percentile, and minimum annual flow volumes (in maf). **Figure TA 3-27** visualizes the same data that is included in the table using a conditional box plot. In all categories, the high end of the results range has been cut off to improve comparisons in the average and drier flow conditions.

Since 2008, releases from Hoover Dam have been from around 8.5 maf to around 9.6 maf, averaging around 9.2 maf. The 2007 Interim Guidelines have reduced average annual releases from Hoover Dam from a previous average of around 10.2 maf (from 1996 through 2007) because of adjusted monthly elevation targets resulting in reduced releases and decreased river flows. In general, where annual releases from Hoover Dam deviate from this past range of 8.5–9.6 maf, there is greater potential for impacts on known cultural resources within 20 meters (66 feet) of the river as well to undiscovered resources that may be present along the river corridor. The primary impacts would include water erosion from river currents during higher releases, but may also include exposure from lower water levels where dam release volumes are reduced; however, these impacts are only considered in terms of this analysis when these volumes are outside past releases or flows. . Based on these parameters, this section will focus on median and interquartile release volumes (in maf) for analysis and frequently refers to **TA 3**, Hydrologic Resources, where appropriate.

River flows below Lake Mead primarily consist of controlled releases from Hoover Dam. Median annual flow volume under the Wet Flow Category (would remain within the range of past annual flow volumes except for the Supply Driven Alternative, with the Supply Driven Alternative (LB Priority approach) at 10.4 maf and the Supply Driven Alternative (LB Pro Rata approach) at 10.6 maf. Under this alternative, the median annual flows would exceed 9.6 maf by up to 1 maf, potentially causing erosion to sites along the river. Interquartile ranges for the CCS Comparative Baseline and the No Action Alternative are narrow, but the upper range (75th percentile) for both does exceed past annual flow ranges at 10.2 maf and 10.4 maf, respectively, while the lower range (25th percentile) stays within established conditions. Similarly for the action alternatives, while the interquartile ranges vary, the upper limits (75th percentile) of all exceed 9.6 maf with 10.8 maf for the Basic Coordination Alternative, 11.1 maf for the Enhanced Coordination Alternative, 11.3 maf for the Maximum Operational Flexibility Alternative, and 11.4 maf for the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches). Exceeding the range of past annual flow volumes (i.e., above 9.6 maf) risks impacting at least 258 archaeological sites within 20 meters (66 feet) of the river that have not been previously affected by river flows if annual river flows above 9.6 maf cause river water levels to also rise in this reach. Depending on these river levels, the substructure of the one NRHP-listed built environment resource (Willow Beach Gaging Station) identified within this reach could be affected, but this structure was designed to accommodate historical river flows and was built directly above the river's surface; therefore, impacts are unlikely even under the wet hydrological conditions presented under the different modeled scenarios.

Annual flow volumes in the Average Flow Category, median annual flow volumes for the CCS Comparative Baseline, and the No Action Alternative are the only two modeled scenarios that remain within the 8.5–9.6 maf range for previous annual flow volumes below Hoover Dam in this reach, with around 8.5 maf for CCS Comparative Baseline and 8.7 maf for the No Action Alternative. The action alternatives do not perform as well, with the median annual volume for Basic Coordination Alternative in the Average Flow Category around 8.1 maf, followed by the Maximum Operational Flexibility Alternative at 7.8 maf, the Supply Driven Alternative (LB Priority approach) also at 7.8 maf, the Supply Driven Alternative (LB Pro Rata approach) at 7.7 maf, and the Enhanced Coordination Alternative at 7.7 maf. The interquartile ranges for the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) at 7.3 maf (25th percentile) to 8.5 maf (75th percentile) and the Enhanced Coordination Alternative at 7.2 maf (25th percentile) to 8.5 maf (75th percentile) are at or below the previous annual flow volume range of 8.5–9.6 maf. Reductions in annual flow volumes could impact archaeological sites, where the result is lower water levels along the river that could result in exposure and/or erosion. The same drops in river water levels, resulting from reduced annual flow volumes below Hoover Dam, would not be detrimental to NRHP-listed Willow Beach Gaging Station.

For the Critically Dry Flow Category, median annual flow volumes would be well below previous volume ranges for the CCS Comparative Baseline, No Action Alternative, and all action alternatives, which fall below 8 maf, down as low as around 6.6 maf for the Enhanced Coordination and Maximum Operational Flexibility Alternatives. Under the driest hydrological conditions, the No Action Alternative, followed by the CCS Comparative Baseline, performs better than the others relative to the upper limits of their interquartile ranges (75th percentile), which is around 8.6 for the No Action Alternative and 8.3 maf for the CCS Comparative Baseline. With these ranges, all of the modeled scenarios could expose archaeological sites if the reduced annual flow volumes cause the river to drop below previous water levels. However, these same potential drops in river water level would not impact the NRHP-listed Willow Beach Gaging Station previously discussed.

Within this reach is Lake Mohave, which is operated under a rule curve that maintains end-of-month target elevations between 630 feet up to around 646 feet, has been kept relatively constant at around 641 feet since 2008 (see **TA 3.1.7**, *Hoover Dam to Lake Mohave,* in **TA 3**, Hydrologic Resources). Because Lake Mohave would continue to be operated under this rule curve, regardless of scenario, there are no anticipated impacts on any known cultural resources around the reservoir in this portion of the reach.

*Davis Dam to Parker Dam*

The 84-mile-long reach from Davis Dam to Parker Dam forms Lake Havasu. Davis and Parker dams are operated under the same rule curve that determines end-of-month target elevations, which are between 445 and 450 feet for Lake Havasu (see **TA 3.1.8**, *Davis Dam to Lake Havasu,* in **TA 3**, Hydrologic Resources). Therefore, no impacts from the CCS Comparative Baseline, the No Action Alternative, nor any of the action alternatives to 64 known archaeological sites within 20 meters (66 feet) of the river between Davis Dam and Parker Dam are anticipated. This is also true for the portions of NRHP-listed Historic U.S. Route 66 or the NRHP-listed National Old Trails Bridge (Topock Bridge) as the only two built environment resources within 20 meters (66 feet) of the river.

*Parker Dam to Imperial Dam*

Parker Dam releases are scheduled on both a daily and hourly basis, and while the 2007 Interim Guidelines did not specifically target operations of this dam, implementation of these guidelines has resulted in reduced annual release rates (see **TA 3.1.9**, *Parker Dam to Cibola Gage,* in **TA 3**, Hydrologic Resources). Parker Dam annual releases since 2008 have ranged from 6.2 maf to 6.7 maf, averaging 6.4 maf, which represents an average annual decrease of 1 maf in volume from the previous pre-2008 average of 7.4 maf. At the end of this reach is Imperial Dam and the Imperial Reservoir, which is operated to maintain a nearly constant elevation to meet water delivery requirements for major diversions to California (All-American Canal) and Arizona (Gila Main Canal) (see **TA 3.1.10**, *Cibola Gage to Imperial Dam,* in **TA 3**, Hydrologic Resources). Additionally, this reach is characterized by several stretches of mechanically channelized river corridor (particularly through wildlife refuges) and no impacts on the 16 known archaeological sites or the one built environment resource (Fisher's

Landing) within 20 meters (66 feet) of the river are expected regardless of flow volume through these areas.

*Imperial Dam to SIB*
The Colorado River channel is reinforced by a system of leaves from Imperial Dam south to the Northerly International Boundary (NIB), and flows through this first portion of this reach are influenced primarily by Imperial Dam releases made for water deliveries. Other factors, like the Laguna Dam and the confluence with the Gila River, also influence river flows in this reach. Implementation of the 2007 Interim Guidelines did not affect the operations or flows in the upper portion of the reach between Imperial Dam and the NIB (see **TA 3.1.11**, *Imperial Dam to Northerly International Boundary,* in **TA 3**, Hydrologic Resources). Because of the levee system from Imperial Dam south to the NIB, there are no anticipated impacts on the two archaeological sites, two built environment resources (Southern Pacific Railroad Bridge and the NRHP-listed Ocean-to-Ocean Highway Bridge) or the Yuma Crossing NHL (also NRHP-listed) located within 20 meters (66 feet) of the river.

Just downstream of the NIB is Morelos Dam, which impounds most of the water supply to be diverted to the United Mexican States (Mexico), and is owned, operated, and maintained by Mexico per the 1944 United States-Mexico Treaty on Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande. Most of the remaining Colorado River water supply that makes it to the Morelos Dam is diverted to Mexico via the Reforma Canal. Thus, the remaining river flows below Morelos Dam to the SIB consist of excess water volumes above Mexico's scheduled delivery due to Flood Control operations at Hoover Dam, seepage from Morelos Dam and other return/inflows. Morelos Dam operations did not change with the implementation of the 2007 Interim Guidelines because of the required 1.5 maf annual water delivery (see **TA 3.1.12**, *Northerly International Boundary to Southerly International Boundary,* in **TA 3**, Hydrologic Resources). There are no other known cultural resources (aside from Morelos Dam, which is excluded from analysis) between the lower portion of this reach from the NIB to the SIB.

### TA 11.2.3 Issue 2: How will changes in dam operations affect sediment availability for aeolian transport to protect archaeological sites in the Grand Canyon?

As discussed above in **TA 11.2.1**, the aeolian transport model looks at favorable conditions for wind-born sand to be present to protect archaeological sites over long periods of time using projected vegetation cover and exposed sand area or sandbar volume (Butterfield and Palmquist, 2026; Kelley et al., 2026; Salter and Grams, 2026). The vegetation and sandbar volume modelling used is from the Marble Canyon sub-reach from Lees Ferry Gaging Station to the Little Colorado River. The exposed sand modelling was conducted for the portion of the river from Lee's Ferry to Bright Angel Creek. But the general conclusions are pertinent to the entire river.

The results of the annual vegetation cover modelling are presented in **TA 9**, Vegetation, including Special Status Species. Overall, less vegetation is better for aeolian sand transport as it leaves sand exposed to be picked up by the wind. As discussed in **TA 9.2.2**, *Issue 1,* and seen in **Figure TA 9-13** (see **TA 9**, Vegetation, including Special Status Species), for all modeled scenarios under the wet and moderately wet conditions there would be less vegetation cover (below observed conditions) from higher water levels and longer HFEs. As conditions grow drier, water flows diminish, and HFEs are shorter, vegetation cover increases (see **Figure TA 9-13** in **TA 9.2.2** of **TA 9**, Vegetation, including Special Status Species). For the Average Flow Category, vegetation cover under all scenarios would be around observed conditions with the Enhanced Coordination being the only alternative with vegetation cover under historic conditions. Under the dry and critically dry conditions, vegetation cover increases and differentiation between alternatives can be seen. For the Critically Dry Category, the No Action alternative has the highest level of vegetation cover (median acreage just under 30 acres), followed by the Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives (median acreage just under 25 acres). The Basic Coordination, Enhanced Coordination, and Maximum Operational Flexibility alternatives would have the less median acreage of vegetation cover under the critically dry category at about 20 acres.

The results of the sandbar volume modelling are presented in **TA 5,** Geomorphology and Sediment. For the aeolian transport model, increased sandbar volume means more sand available to protect archaeological sites. In general, as conditions get drier and the amount of water flowing through the river decrease, sandbar volume increases (see **TA 5.2.4**, *Issue 4: Sandbar Volume*, in **TA 5**, Geomorphology and Sediment). Beginning in the Average Flow Category (see **Figure TA 5-11** in **TA 5.2.4**), the Enhanced Coordination and Maximum Operational Flexibility alternatives outperform the other scenarios in sandbar volume increase with a value at or above median of 1,700 cubic meters for the average through critically dry flow categories. The Basic Coordination and the Supply Driven (both LB Priority and LB Pro Rata approaches) alternatives perform similarly in the Average Flow Category but then drop in sandbar volume as conditions become drier.

**Figure TA 11-4** shows the results of the WY average of exposed sand area modelling. As with sandbar volume, increased sand area is beneficial for the aeolian transport of sand to protect archaeological sites. Under Average Flow Category, exposed sand area is at or just below the historic median acreage. As conditions become drier, all the modelled scenarios perform similarly with forecasted median exposed sand area above the observed median with the Enhanced Coordination having a slighter higher median than the action alternatives.

**Figure TA 11-4**
**Water Year Average of Exposed Sand Area**

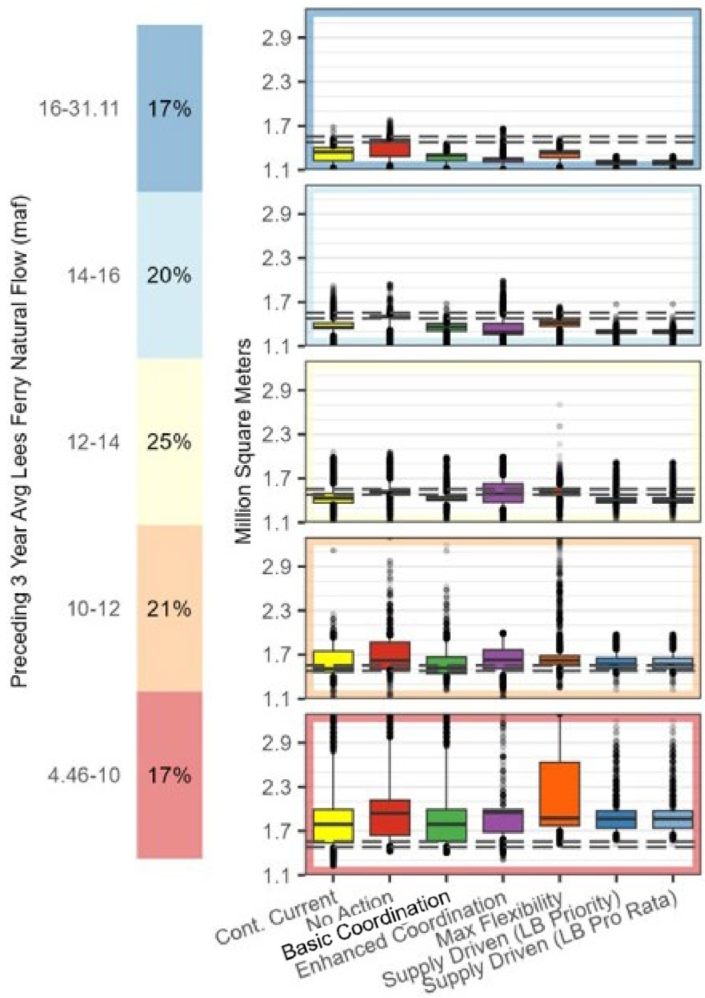
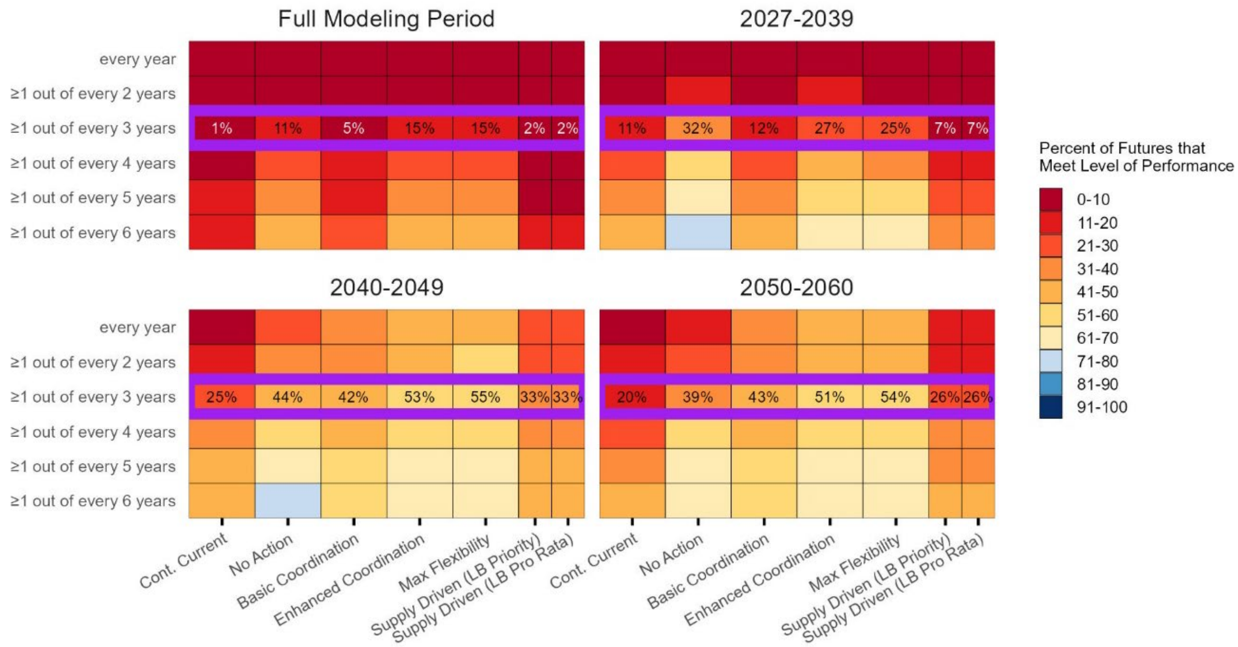



**Figure TA 11-5** shows the results of the aeolian sand modelling in which the percent of futures meet one of two criteria: either the annual sand volume is greater than the median observed sand volume over the last 20 years and the vegetation cover area is less than then median observed area over the last 20 years or sandbar volume greater than 1.5 times initial condition. The highlighted row shows when those conditions are met at least one out of every three years which is the optimal time frame for enough sand to be available for aeolian transport based on previous studies.

Over the full modelling period, the Enhanced Coordination and Maximum Operational Flexibility alternatives are the most robust meeting the desired conditions of at least one out of every three years in 15percent of futures followed by the No Action Alternative only in 11 percent of futures. The Supply Driven Alternatives (both LB Priority and LB Pro Rata approaches) are the least robust, meeting the desired conditions in only 2 percent of futures. If the year interval is lengthened (i.e., to one out of four, five, or six years) the models perform in a similar overall pattern with the Enhanced Coordination and Maximum Operational Flexibility alternatives performing the best.

**Figure TA 11-5**
**Multi-model Aeolian Transport Condition: Robustness**
**Percent of futures in which annual sand area is >50th and vegetation cover is <50th percentile or sandbar volume is >1.5 times initial condition in the frequency specified in each row**




When results are split out over intervals from 2027–2039, 2040–2049, and 2050–2060, the percent of futures meeting the desired conditions increases for both the Enhanced Coordination and the Maximum Operational Flexibility alternatives from 27 percent to 53 percent and 51 percent and from 25 percent to 55 percent and 54 percent respectively. These results seem to indicate an increase in percentage of futures over time which may correlate to increased available sand over time; however, the perceived increase is driven by an increase in sandbar volume overtime in the modelling with the understanding that HFEs would continue as planned. In reality, the decision to conduct HFEs is dependent on annual review.

## TA 11.2.4 Summary Comparison of Alternatives

### *Issue 1: How will any changes in dam operations affect 1) lake elevations at Lake Powell and Lake Mead and 2) river flows downstream which may affect cultural resources?*

#### Lake Powell and Lake Mead

Because the continual inundation of archaeological sites is more conducive to preservation than repeating cycles of inundation and exposure and risks of wave action, changes in lake elevations that may expose previously inundated resources in the biggest concern. As water elevations drop, the elevation at which sites become vulnerable to wet/dry cycling and wave action becomes lower; however, sites exposed at higher elevations may be less vulnerable to impacts from wet/dry cycling and wave action but may have increased ease of access depending on their location. Based on the hydrological models, during the wet hydrological conditions, water levels at Lake Powell are project to stay above 3,660 feet for all scenarios. As conditions become drier, the Enhanced Coordination and Maximum Operational Flexibility Alternatives perform the best during the Average Flow Category with median water elevations at or above 3,620 feet. They also perform best during the Critically Dry Flow Category, however, the projected medians are still below 3,580 leaving at least 274 archaeological sites and any undiscovered sites at these elevations exposed.

For Lake Mead, the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) perform best over the Average and Critically Dry Flow Categories, followed by the Enhanced Coordination and Maximum Operational Flexibility Alternatives. The Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) have projected median elevations up to 1,150 in the Average Flow Category, while the Enhanced Coordination and Maximum Operational Flexibility Alternatives have median elevations around 1,100 feet. For the Critically Dry Flow Category, all scenarios would result in the exposure of at least 237 archaeological sites (all but three in the Lake Mead dataset) and any undiscovered sites that may be present; however, the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) have the potential to protect more sites with upper interquartile ranges at about 1,120 feet.

A similar pattern can be seen in the Preservation Risk Model analysis, where the Enhanced Coordination Alternative is the most robust for Lake Powell, with 58 percent of the modelled futures over the full modelling period meeting the 2.72 threshold, followed by the Maximum Operational Flexibility Alternative with 36 percent of futures. The Supply Driven Alternative (both LB Priority and LB Pro Rata approaches) are the most robust for Lake Mead, with 43 percent of the modelled futures over the full modelling period meeting the 2.42 threshold, followed by the Maximum Operational Flexibility Alternative with 37 percent of futures.

**River Flows**

For the reaches between Glen Canyon Dam and Lake Mead and Hoover Dam to Lake Mohave, in the Wet and Average Flow Categories, all scenarios generally fall within the ranges of past annual release volumes. However, in the Critically Dry Flow Category, the median WY release volumes all fall below 7 maf for the reach below Glen Canyon Dam, with the Enhanced Coordination Alternative falling to 5.1 maf. Below Hoover Dam, median annual flow volumes all fall below 8 maf, with the Enhanced Coordination and Maximum Operation Flexibility Alternatives falling as low as 6.6 maf. Therefore, under the Critically Dry Flow Category, there is greater potential for sites to be exposed by dropping water levels; however, any impacts would only occur to sites closest to the riverbanks.

Below Davis Dam, little to no impacts regardless of flow category are expected as the dams below Lake Mohave are operated under guidelines that maintain lake elevations or target water deliveries, as well has having several stretches of channelized banks.

### *Issue 2: How will changes in dam operations affect sediment availability for aeolian transport in the Grand Canyon?*

Based on the aeolian transport model for the full model period, the Enhanced Coordination and Maximum Operational Flexibility alternatives would have the best outcome for increasing the availability of sand for wind-transport to protect archaeological sites. Both alternatives have the same percentage of futures within the at least one out of every three years desired outcome at 15 percent. Although this is a small percentage, the two alternatives perform better than the Basic Coordination and Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives which all have values at 5 percent or lower.

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