National Park Service

Glen Canyon National Recreation Area – Identification of Potential Locations for Launch Ramps in Lake Powell

Project Program Report
Final

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Acronyms and Abbreviations

Acronym	Definition
APE	area of potential effect
EA	Environmental Assessment
GLCA	Glen Canyon National Recreation Area
IRB	Investment Review Board
Lake	Lake Powell
LiDAR	light detection and ranging
MNA	Museum of Northern Arizona
NEPA	National Environmental Policy Act
NPS	National Park Service
NRHP	National Register of Historic Places
Park	Glen Canyon National Recreation Area
UDOT	Utah Department of Transportation

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Chapter 1 – Site Program Description

1.01 Project Overview

The National Park Service (NPS) will evaluate constructing, modifying, or relocating boat ramps at four visitor use areas within Glen Canyon National Recreation Area (GLCA or the Park). Due to unprecedented low water conditions at Lake Powell (Lake), there is a need to develop a rapid response plan to maintain boater access with resilient, long-term, engineered solutions. This project will focus on four visitor use areas: Bullfrog, Halls Crossing, Antelope Point, and Hite.

GLCA's enabling legislation states that it was established "…to provide for public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto in the States of Arizona and Utah and to preserve scenic, scientific, and historic features contributing to public enjoyment of the area." To meet this objective, visitors should continue to have reasonable access to Lake Powell for recreational activities. The launch ramps serve a public health and safety need to provide safe access to the water as well as minimize impacts to natural resources by providing designated access points to the water.

As a result of the low water and access issues, the Park is experiencing significant political and public pressure to act. GLCA is losing a significant portion of revenue due to concession loss and drops in visitation, which is in part due to the perception that the Lake is inaccessible.

1.02 Project Background

Lake Powell was formed when the Glen Canyon Dam was built in 1963 to block off the Colorado River. It is the nation's second-largest reservoir after Lake Mead. Droughts in the western United States in recent years have left the reservoir at 30% full and dropping. The Lake levels have left boat ramps high and dry, leaving the approximately 4 million annual users of GLCA unable to use several of the boat ramps to launch their personal vessels.

Encompassing more than 1.25 million acres, GLCA stretches between both northern Arizona and southeastern Utah. The recreation area includes portions of Garfield, Kane, San Juan, and Wayne Counties in Utah and Coconino County in Arizona. The Park's southern boundary runs contiguous to lands of the Navajo Nation for almost 500 miles. GLCA shares boundaries with other NPS units, including Grand Canyon National Park, Capitol Reef National Park, Canyonlands National Park, and Rainbow Bridge National Monument. GLCA adjoins approximately 9.3 million acres of other federal lands administered by the Bureau of Land Management, including the Grand Staircase-Escalante National Monument, Vermilion Cliffs National Monument, Bears Ears National Monument, and the Paria Canyon-Vermilion Cliffs Wilderness. The Park staff consults regularly with the Hopi Tribe, Kaibab Paiute Tribe, Navajo Nation, Paiute Indian Tribe of

Utah, Pueblo of Zuni, San Juan Southern Paiute, and Ute Mountain Ute in areas of mutual interest.

GLCA is located in a geographic area commonly referred to as the Colorado Plateau. This desert region is characterized by expansive areas of exposed and uplifted rocks that have been carved by the Colorado River and several tributaries. Lake Powell is formed by the impounded waters of the Colorado River above the Glen Canyon Dam and is the second-largest reservoir in the United States. Lake Powell is considered a world-class water-sports destination and is an economic engine for the region. The Bureau of Reclamation manages the Glen Canyon Dam. When Lake Powell is at full pool, it comprises 13% of the Park's geographic area and draws a large percentage of the Park's annual visitation of approximately 4 million visitors. Approximately 87% of the Park is Colorado Plateau red rock landscape, offering a wide range of recreational opportunities and habitat for a diverse assemblage of terrestrial and aquatic species and significant historic sites include Lees Ferry and the Hole-in-the-Rock Trail. GLCA is one of the Southwest's premier archeological parks.

The town of Page, Arizona, is the nearest town to GLCA. It is located in Coconino County, Arizona, near the Glen Canyon Dam and South Lake Powell. The population is 7,500, and the Park Headquarters is located in Page.

1.03 Project Scope

For the initial studies and concept design, the four areas were evaluated under a single design effort and task order. However, the sites will be progressed to construction as separate projects and design packages and the scope descriptions are divided as such.

As noted, drought conditions in the Colorado River Basin are contributing to unprecedented low water conditions for Lake Powell. The "full pool" water elevation for Lake Powell is 3,700 feet. At the time of this report in July 2022, the water level is approximately 3,537 feet, after reaching a seasonal low of 3,522 feet in April 2022. Water levels are expected to continue to drop. The level of 3,450 feet represents the Park's lowest conceivable low water elevation for future Lake levels; there is a 1 in 3 chance the Lake will fall below 3,490 feet within the next 3 years. These low water conditions are the key driver for this project's scope as the Park seeks to maintain recreational access to the Lake for all future water conditions.

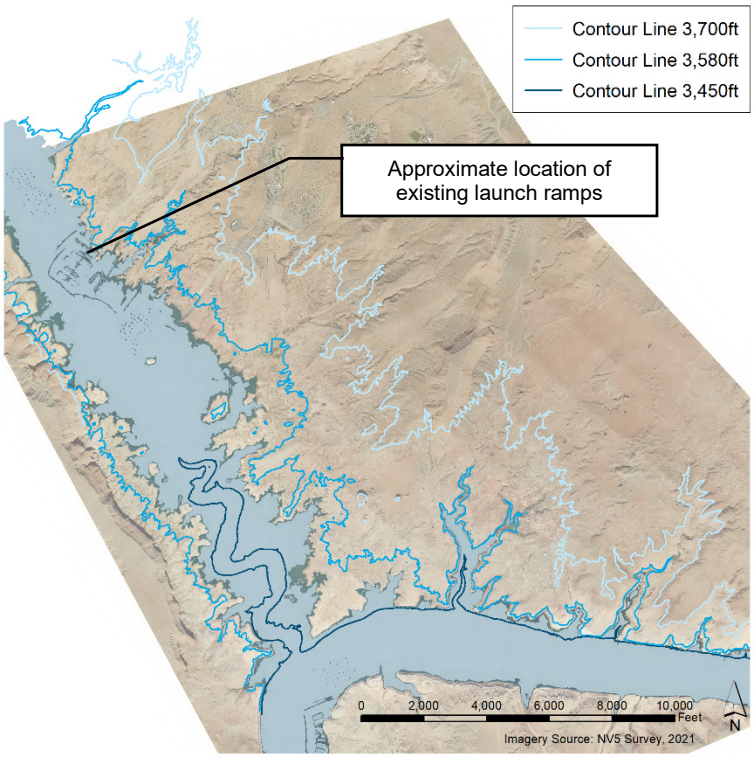
1.03.1 Bullfrog

At the time of the development of this project plan in early 2022, there are no available Boat Ramps at North Lake Powell. Water levels have fallen below the reach of both Bullfrog Main Launch Ramp and Bullfrog North Launch Ramp at 3,580 feet. An emergency extension project in spring 2022 provides modified access to 3,520 feet elevation; however, water levels will continue to drop, ultimately beyond the reach of this extension. The area has a full-service marina, including lodging facilities, food and

beverage, campgrounds, boat rentals, boat storage, and retail stores. The marina is operated by concessionaire; however, NPS is responsible for utility service to the marina, and the Launch Ramp that serves the marina is under the ownership and operation of the Park.

Due to surrounding bathymetry, and the shallow "shelf" in the proximity of the existing ramp in Bullfrog Bay, the existing ramp will be more than a mile from the water line in a future low water condition. The location of the Bullfrog Launch Ramp and associated parking and utility service needs to be located to a new location to provide a ramp that can serve both high and low water conditions. Figure 1 provides key design contours at Bullfrog that illustrate the distance between the existing launch ramp and the low water elevation of 3,450 feet.

Figure 1. Design Contours at Bullfrog



The marina location and configuration are being evaluated for the following two options:

1. A proposed layout that allows the marina to maintain its general location and connect to existing utilities to a certain water elevation.

2. Moving the marina and associated utility infrastructure to accompany the relocated launch ramp.

1.03.2 Halls Crossing

As stated in the previous subsections, there are currently no functioning boat launches in North Lake Powell. All available boat ramps at Halls Crossing are currently closed due to low water levels, though the marina is still open. Halls Crossing and Bullfrog are approximately 3.5 miles across the Lake from each other; however, without Lake access, a 4-hour drive is required between sites. Typically, a Utah Department of Transportation ferry provides access between the sites, serving as an important link for the two communities. This ferry cannot currently operate due to lack of operating launch ramps at both Bullfrog and Halls Crossing.

This project proposes a regrade and extension of the existing Halls Crossing Launch Ramp to provide low water access. The launch ramp will provide a combined use ramp for both public access and ferry service.

1.03.3 Antelope Point

The Antelope Point Public Launch Ramp is operated by the Park and is located near the Antelope Point Marina, an NPS-approved concession managed by Antelope Point Holdings. Antelope Point is a joint-development project between the NPS and the Navajo Nation. Due to low water, the Antelope Point Public Launch Ramp is currently closed, though the marina is open. The marina business and valet ramp are also currently closed due to low water. Antelope Point provides an important access point for kayakers visiting Antelope Canyon, as well as large houseboats and other motorized vessels in South Lake Powell. Vessels are able to access this area by boating from the Wahweap Stateline Auxiliary launch ramp, which has been extended with declining water level. However, there are periodic closures or delays for construction and boilerplate installations. The distance between Antelope Point and Wahweap is too far to serve kayakers. Additionally, capacity at Wahweap Stateline Auxiliary launch ramp is increasingly overwhelmed as it is the only functioning boat launch in South Lake Powell and, therefore, additional capacity and access is needed at Antelope.

This project evaluates three options to include a regrade and extension of the existing Antelope Point Public Launch Ramp. This ramp is proposed to be a combined business and public use launch ramp. Specifically this means that the ramp will provide both high and low water access for recreational boaters, CUA access for kayaking and other small vessel tourism, and professional valet services for large houseboats. No utilities will be provided at the new Antelope Launch Ramp.

1.03.4 Hite

The Hite District (Hite) is a small outpost at the junction of the Colorado River and the northernmost reach of Lake Powell. Hite is a popular location for land- and water-based recreation, as well as a take-out for rafters exiting Cataract Canyon and other water-based activities. Due to low water and sediment deposits from the Dirty Devil

Confluence, the existing Hite ramp does not provide access to the river. Cataract Canyon rafters and other boaters currently use a site called North Wash as a take-out and primitive launch area. However, this area is problematic due to its location on an exterior bend of the river channel. Natural hydrological forces continually wash away and destabilize the shoreline at this location, rendering it unsafe for boaters and rafters.

This project will identify an alternate primitive take-out location within the Hite Region for boaters and rafters to potentially launch and retrieve vessels. This includes a desktop evaluation of the hydrogeological features along the Colorado River and an evaluation of different alternatives for long-term viability.

1.04 Functional Requirements

A primary goal of this project concept phase was to understand the functional requirements of launch ramps. This information informs the design criteria and identifies project needs for the detailed design phase.

1.04.1 Existing Launch Ramp Infrastructure

A key desire for this project is to maintain similar level of access and services that were provided historically at each of the ramp locations. Therefore, many functional requirements for the project are driven through a comparison to the existing launch ramp infrastructure, summarized in Table 1. It is noted that Hite is not included as the historic ramp serving the marina was abandoned several years ago, and the current take-out area in use at North Wash is not permanent infrastructure.

Table 1. Existing Launch Ramp Infrastructure

Site	Existing Launch Ramp Criteria				Area Services	Existing Utilities	Parking* (approximate square footage)
	Width (feet)	Length (feet)	Grade (%)	Water Elevations			
Bullfrog Public Ramp	124	1,250	9.00	3,700 to 3,580	Marina, restaurant, lodging, fuel, ferry	Water, power, sewer, telecom	700,000
Bullfrog Low Water Ramp Extension	150	1,165	9.60	3,580 to 3,525			
Halls Crossing Public Ramp	60	1,500	10.67	3,700 to 3,550	Marina, fuel, ferry	None	86,000

Antelope Point Public Ramp	120	900		3,700 to 3,580	Marina	None	295,000

* Only parking area associated with the named launch ramp included in table.

1.04.2 Early Listening Sessions

Jacobs held eight early listening sessions with key stakeholders between November 2021 and February 2022. The purpose of these listening sessions was to provide a forum for input that would inform design considerations for the launch ramps. Early listening sessions included the following:

- November 16, 2021, Antelope Point Marina Concessionaire at Antelope Point Marina
- November 17, 2021, Utah Department of Transportation (UDOT) and Park at Bullfrog Ferry Ramp and Fire Station
- November 18, 2021, Hite Concessionaire at Hite
- November 22, 2021, Aramark Virtual Session
- December 16, 2021, CUAs (Antelope/ Bullfrog Focused) Virtual Session
- December 16, 2021, CUAs (Hite Focused) Virtual Session
- December 2021, CUAs (Antelope Focused) Virtual Session
- February 1, 2021, Navajo Nation (Antelope Focused) Virtual Session

Through all early listening sessions, one resounding theme was echoed: stakeholders are looking for consistent, safe access to the Lake and clear communication of a plan from the Park on how this will be achieved. There are significant economic impacts to businesses without access and concern for what the future might bring. The new Wahweap ramp is a welcome solution for access at South Lake, and the design details (grade and width) are well received, however demand is high, and so additional access points are needed, both in South Lake and North Lake Powell.

Appendix A provides a summary of these conversations.

1.04.3 Design Criteria

In partnership with the Park, and with input from other stakeholders during early listening sessions, Jacobs developed site-specific design criteria to address project needs for the Launch Ramp designs. Key design criteria for the ramps is summarized here, and the full document is provided in Appendix B.

Bullfrog/ Halls Crossing:

Design Water Elevation: 3,700 feet to 3,450 feet

Ramp Width: 150 feet (5- to 30-foot-wide lanes)

Ramp Grade: 10.5%

Minimum water Depth at end of ramp: 5 feet

Vessel Criteria: Houseboats: 125 feet LOA, 22-foot-wide, 6 feet draft, UDOT Ferry: 155 feet LOA, 50 feet wide, 8 feet draft

Vehicle Criteria: Customized WB-67

Gangways: CSA 46 Boarding Floats and Gangways

Geotechnical: cut and fill slopes of 1:2 (V:H)

Antelope:

Design Water Elevation: 3,700 feet to 3,450 feet

Ramp Width: 150 feet (5- to 30-foot-wide lanes)

Ramp Grade: 10.5%

Minimum water Depth at end of ramp: 5 feet

Vessel Criteria: Houseboats: 125 feet LOA, 22-foot-wide, 6 feet draft, UDOT Ferry: 155 feet LOA, 50-foot-wide, 8 feet draft

Vehicle Criteria: Customized WB-67

Gangways: CSA 46 Boarding Floats and Gangways

Geotechnical: cut slope is 1:1 (V:H) and assumed fill slope is 1:2 (V:H)

Hite:

Design Water Elevation: 3,630 feet to 3,596 feet

Ramp Width: 35 feet

Ramp Grade: 16%

Minimum water Depth at end of ramp: 3.5 feet

Vessel Criteria: small craft

Vehicle Criteria: AASHTO P-B (passenger vehicle towing boat). Overall vehicle length 42 feet

Gangways: None

Geotechnical: cut and fill slopes of 1:2 (V:H)

Several design criteria have significant influence on the overall cost of the project. These are identified in Section 2.02 and may be revisited as the project moves to detailed design.

1.04.4 Observed Site Conditions

In November 2021, Jacobs met at GLCA Headquarters in Page, Arizona, with Park staff. This meeting and accompanying site visits provided an understanding of this unique project site and challenges. Appendix C provides photos from these site visits.

General notes and reactions include the following:

Antelope

- Public Ramp is significantly above low water with dramatic rock outcroppings surrounding, Marina ramp is a long pedestrian walk to the water with no boat access, valet ramp is still operating but likely not for long, this ramp has very steep rock cut on either side and is much narrower than other ramps.
- Design for ramp to accommodate concessionaire/valet services for houseboats and public use (small craft and a few houseboats). A consolidated ramp for all uses will need to be wider and may require operational controls to run smoothly.
- Consider keeping public ramp as is and running a spur to side (toward beach) to address low water conditions. Spur connection would have to accommodate houseboat on 18-wheeler being back down from apron at top.
- Team onsite discussed a second ramp for kayakers and pedestrians to come off the parking lot at top of ramp and run in switchback style down along existing grade.

Bullfrog

- A small gravel/asphalt spur off bottom of ramp, constructed and abandoned in 1960s before Lake came up to “full pool,” is now back in use. Asphalt in surprisingly good shape, but does get spongy when wet. Park anticipates the spur will be inaccessible in January 2022.
- Public Ramp goes from approximately 3,700 to 3,580 feet and is high/dry.
- Width is suitable for public use, but would need to be increased to accommodate ferry operations.

- At Stanton Creek there is a large drainage/inlet area that creates a challenging connection between some of the identified sites. Will require a long utility and roadway run to connect to marina and offer access to ramps. Route that runs closer to water is on higher ground, less wash-outs.

Hall's Crossing

- Services are far more limited at Hall's Crossing. Gravel parking lot, mobile/portable Automatic Identification System and decontamination station.
- Hall's marina utilities currently strung through segmented floating corridor, running down the rock face from the parking lot to the water. Very steep and long switchback ramp only access from land to marina. Consider this condition closely when evaluating how Bullfrog Marina will be located. How will utilities run in high, intermediate, low water conditions? How will staff access from parking lots? How will materials and fuel be brought in?
- Team is concerned that extension of current public ramp will prove difficult due to shelf at bottom and interaction with road at top. Revisit bathy data.
- Team discussed using old fuel depot location to create a new low water ramp.
- Team discussed ferry ramp may be able to be extended to reach low water point? If so, there would be no need to accommodate ferry at new public ramp.

Hite

- Original concept (portable or prefabricated gangway) in project scope is not suitable, given conditions.
- North Wash was just a graded gravel ramp, which NPS maintained and attempted to keep accessible for kayakers to put-in/take-out. Roughly 18 months ago, during a grading project, the entire ramp fell away (no one was on it at the time) and it's been unmaintained since then.
- NPS prefers access on the Hite side of the river.
- Appears that ideal location for simple/primitive take-out/put-in may be roughly at same location as previous marina. Ramp can be fairly limited in width, 25 to 50 feet? Will require small apron for turnaround for trucks with small craft. Consider geogrid? Consider jetty wall?
- How to address concern about potential 'silt waterfalls' forming? This is the issue that stopped NPS from proceeding with a project to put-in a primitive access ramp on the Hite side near the old ramp location.

Chapter 2 – Site Analysis

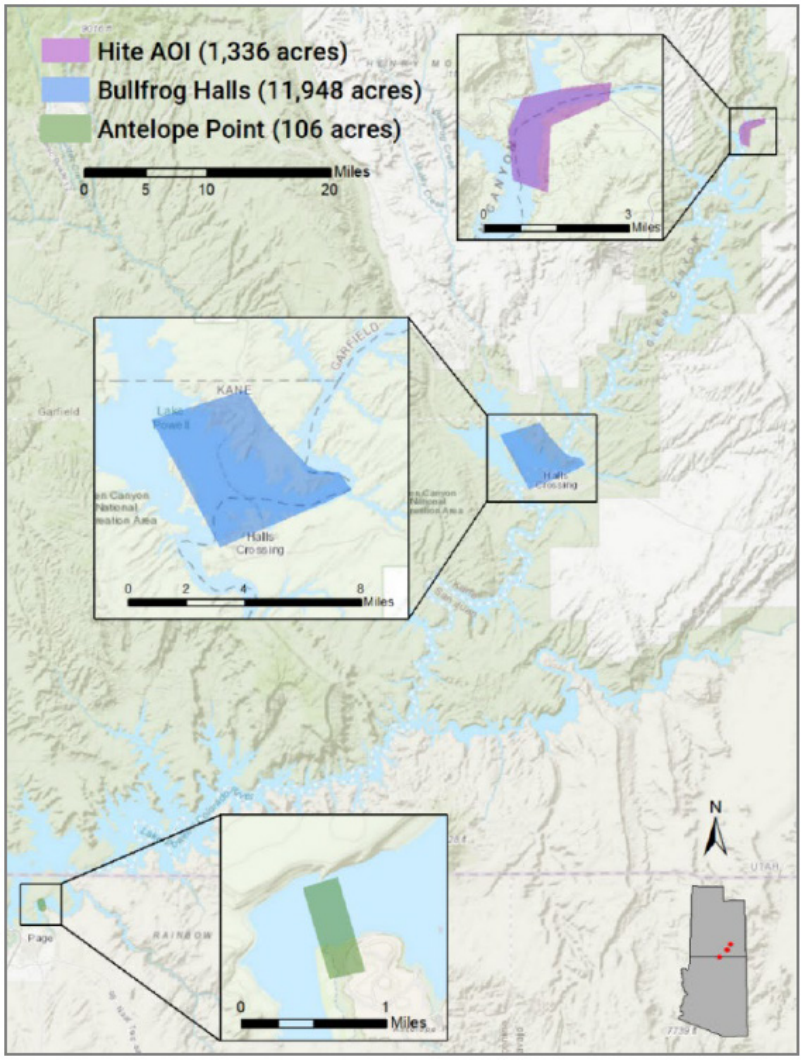
2.01 Field Work/Site Surveys

As part of this initial concept phase, Jacobs has identified the following required field work and site surveys.

2.01.1 Topo/Bathymetric Surveying

Accurate topographic and bathymetric surveying is essential to the layout and detailing of the launch ramps. Figure 2 identifies the aerial light detection and ranging (LiDAR) survey areas for the Bullfrog, Halls Crossing, Antelope Point, and Hite Survey Areas.

Figure 2. Bullfrog, Halls Crossing, Antelope Point, and Hite Survey Areas



The following deliverables list are survey products developed specifically for this project. The focus of the survey data collection is to define detailed and current elevation data above and below the surface of the Lake. The data were collected between November 1, 2021, and January 28, 2022, and included the following collection methodologies:

- Establish permanent ground control markers for use on all surveys going forward.
- Collect high-density overland aerial LiDAR data from fixed-wing aircraft.
- Collect bathymetric LiDAR data from fixed-wing aircraft.
- Collect high-resolution updated aerial photography from fixed-wing aircraft.
- Collect detailed bathymetric multibeam sonar data from a 24-foot-long boat.
- Fully integrate all sources into single surfaces and imagery mosaics for each of the three ramp locations.
- Tie all data to permanent survey control.

The *Lake Powell Topobathymetric LiDAR Report* in Appendix D provides greater detail on the fixed-wing aircraft results.

Data Deliverables

Lake Powell Survey Specs and Deliverables:

- All deliverables will be in:
  - Coordinate System: Universal Transverse Mercator 12N
  - Units: U.S. survey feet
  - Horizontal Datum: North American Datum of 1983 (2011)
  - Vertical Datum: North American Vertical Datum of 1988 (Geoid 18)

Survey and LiDAR:

- Combined topobathymetric Digital Elevation Model: 3-foot cell size, Esri grid
  - Includes Multibeam sonar for Antelope and Bullfrog/Halls Crossing
- Highest hit DSM: 3-foot cell size, Esri grid
- Intensity images: 1.5-foot cell size, Geotiff
- 2D water's edge breaklines (Esri Shapefile)
- Boundary polygons (Esri Shapefile)
- Tile index (if needed – Esri Shapefile)
- Ground survey and monuments as.csv format.

Imagery:

- 3-inch pixel resolution orthomosaic
- GeoTIFF and compressed ECW formats

Following site selection, a detailed, deeper multibeam bathymetric surveying was performed at the Antelope, Bullfrog, and Halls Crossing Launch Ramp sites. The Teledyne Reason T50P multibeam echosounder uses an array of 512 beams with a practical swath of up to 150 degrees, with each beam producing a 1-degree cone, which has a resolution of 6 millimeters. This method of data collection creates a highly densified point cloud with very little interpolation needed. The capture of topography and bathymetry were merged into one surface for ease of use in computer-aided design and geographic information system applications.

Due to dynamic river environment, with significant current and turbidity, bathymetric data collection at Hite is extremely challenging, and the riverbed is continually changing. Therefore, the data may not reflect current conditions at the time of construction, which is a risk and concern. Similar data collection may be needed at Hite for hydrodynamic modeling; however, this will be confirmed once the Hite site is selected.

All deliverables will be provided to GLCA via external hard drive.

2.01.2 Geotechnical Borings

To develop the design, it is necessary to obtain a detailed profile of the subsurface conditions along the launch ramps. In this regard, a geotechnical investigation has been proposed to investigate the subsurface geotechnical conditions and to supplement the available Glen Canyon soils report.

The drilling should be hollow stem auger in soil (if there is any) and HQ triple tube diamond bit rock coring to approximately 5 feet below the bottom of the boat ramps. Geological mapping is also recommended to determine the orientation of the rock fractures, joints, and bedding planes.

Geotechnical boring locations have been identified for the concept designs at Bullfrog Option 1, Halls Crossing, Antelope Option 1-3 and Hite Option 1-2; these locations are shown in Appendix E, and Table 2 provides a summary for the proposed boring locations.

Table 2. Geotechnical Boring Locations

Site	Boring ID	Northing	Easting	Depth (feet)
Bullfrog Option 1	BH01-22	37.486214	-110.692028	45

Site	Boring ID	Northing	Easting	Depth (feet)
Bullfrog Option 1	BH02-22	37.483572	-110.692336	45
Halls Crossing	BH01-22	37.465882	-110.719328	40
Antelope Option 1	BH01-22	36.965788	-111.441907	130
	BH02-22	36.964322	-111.441427	130
	BH03-22	36.962621	-111.441004	130
Antelope Option 2	BH01-22	36.966185	-111.442238	130
	BH02-22	36.964817	-111.442353	120
	BH03-22	36.963998	-111.442397	130
Antelope Option 3	BH01-22	36.963489	-111.445072	130
	BH02-22	36.964536	-111.444238	90
	BH03-22	36.965608	-111.442905	65
Hite Option 1	BH01-22	37.892315	-110.374377	50
Hite Option 2	BH02-22	37.887333	-110.379863	60

2.01.1 Utility Surveys

The Bullfrog Marina may be relocated with the launch ramp to its new location. This would require service from new potable water, sewer, electric, and communication lines. A utility survey was conducted by Jacobs from February 21 to 25, 2022, to provide necessary information for the utility design. Other launch ramps do not have utility needs identified at this time.

2.01.2 Archaeological/Cultural Surveys

A preliminary area of potential effects (APE) for Bullfrog improvements has been established. The preliminary APE limits are based on current project design and are buffered by 50 feet on either side of design cut and fill lines and road centerlines. In the next phase of work, construction staging areas will be identified. The final APE needs to incorporate the maximum extent of ground disturbance required for construction.

Museum of Northern Arizona (MNA) has recently completed a survey for the Bullfrog Marina access roads. GLCA staff is currently reviewing the survey and will provide the survey limit shapefiles for overlay against the preliminary APE. This will provide the level of information required to determine whether any new survey is needed for the preliminary APE. There are large gaps in survey coverage, which are expected to be largely rectified based on the extent of the MNA survey.

The MNA survey has identified new cultural resources sites. GLCA cultural resources staff is currently reviewing these sites for the National Register of Historic Places (NRHP) eligibility and will provide that information for overlay against the preliminary APE.

There may be cultural resources sites that conflict with the proposed Bullfrog Marina access road. Some sites may be recommended eligible for inclusion in the NRHP under Criterion D for its potential to contain significant data.

GLCA will need to receive concurrence from the State Historic Preservation Office on the determination of NRHP eligibility of the newly recorded cultural resources sites and the adequacy of the MNA survey.

It is currently understood by the Jacobs team that some adjustments may need to be made to the roadway alignment to avoid identified cultural resources sites. It is anticipated that these adjustments will be inconsequential to the overall design; however, this will be closely coordinated as the new survey data becomes available.

2.02 Design Variables

It is understood that the current cost estimates for the concept design are higher than anticipated by the Park; jeopardizing the ability for the projects to move forward as designed. The Jacobs team has identified the following design criteria that may be adjusted in the detailed design phase to reduce costs. These considerations have value tradeoffs and may need to be evaluated in a future Value Analysis workshop. It is noted that while adjustments to the design variables may provide a ‘scalability’ to achieve the project budget, these may compromise the stated functional requirements of meeting the existing level of service provided by the existing infrastructure (detailed in Section 1.03)

2.02.1 High vs. Low Water Ramps

At Bullfrog, two concept designs have been presented.

1. **A combined high- and low-water multiuse ramp** that provides access for water elevations ranging from elevation 3,700 to 3,450 feet (proposed Option 1). Some key advantages to this option are the combined use of all design vessels at all design elevations and providing a location for a permanent marina move.
2. **A low-water ramp** that provides access for water elevations from 3,580 to 3,450 feet (proposed Option 2P). This ramp design provides the advantage of approximately a 15% cost savings; however, requires moving assets, the marina, and operations as the water level changes from high to low water elevations. For water elevation 3,700 to 3,580 feet, the Park would be required to retreat to the existing public ramp. Hardened infrastructure (road, ramp, and parking) would have to be designed to be left submerged in high water scenarios, while other items such as marina gangways, utilities, and other operational assets would need to be physically relocated back to the historic location.

2.02.2 Design Low Water Elevation

The current design low water elevation for all ramps is 3,450 feet. This is a critical factor to the cost of this project. With current water levels at approximately 3,525 feet, it is anticipated at least 50 feet of water may be present at the time of the construction and significant cut and in-water work will be required to meet this design elevation.

The Bureau of Reclamation projections for future water levels have a wide level of variability, and it is unconfirmed when the chosen design water elevation of 3,450 feet may become a reality, if ever. Therefore, the design criteria for the low water elevation could be modified to a higher elevation. This would reduce construction costs; however, may reduce future accessibility.

2.02.3 Project Phasing

The current water level is approximately elevation 3,525 feet, and timing for projected future water levels is highly variable. There is not an immediate, emergency need to meet the design low water elevation of 3,450 feet. Therefore, the Park may choose to phase the construction of the project to reduce the initial construction cost by reducing the amount of in-water work and delaying expansion of the launch ramp to meet the design water low-water elevation to a future project. Appendix F provides approximated phasing diagrams for the concept design, which illustrate the impact of the water elevation. It is noted these diagrams are provided to illustrate a conceptual approach to construction, this will ultimately be modified based on the chosen design alternatives and design criteria.

2.02.4 End of Ramp Detailing

Standard design guidelines for launch ramps recommend at minimum the toe of the launch ramp be located 5 feet below the design water elevation and therefore would be located at elevation 3,445 feet. This provides approximately 45 feet of launch space below the design water elevation. This end condition should be further evaluated in detailed design for two governing criteria: safety and use. These both would include a discussion on the potential of including adding additional launch space at the bottom of the ramp for larger vessels, and discussion on the degree of barrier and curb at the toe of the ramp to provide sufficient deterrence from users getting to the edge of the ramp.

2.02.5 Width of Ramps

As it is currently designed, the ramps use five 30-foot-wide lanes for a total of 150 feet of width to meet the stated goals of the project. This width could be evaluated with the Park to introduce operation controls and limit user access to reduce the number of lanes. It is recommended that a 75-foot-wide ramp with one 30-foot-wide lane for large houseboats and ferries, and two 22-foot-wide lanes for general public use be the lower bound for this discussion. The construction cost reduction would be met with increased operational controls needed at the launch ramps.

2.02.6 Geotechnical Conditions

As noted in Section 2.01, a geotechnical boring program is planned in the near term. This information will inform the allowable side slopes for cut and fill at each site. The concept design currently assumes a 2:1 cut slope at Bullfrog and Halls Crossing, and 1:1 cut slope at Antelope. If these assumptions can be improved to a steeper cut slope, this will reduce costs as the volume of cut and fill material will be reduced. If the cut slope cannot be reduced, the team could also evaluate the introduction of retaining walls at a steeper slope. The construction cost of the retaining walls would be evaluated against the reduced earthwork

2.02.7 Parking

A preliminary parking layout was included in the concept design for Bullfrog for 700,000 square feet of asphalt parking. This layout matches the existing parking in both material and capacity (square footage). Both size and surface material (i.e., gravel) can be evaluated during detailed design.

2.03 Identification of Additional Infrastructure

Excluded from the scope of the concept development was the design of additional infrastructure associated with the proposed launch ramps. The following items have been identified as potential needs and inclusion in detailed design needs to be confirmed:

2.03.1 Parking

Concept design for Bullfrog detailed a parking lot matching the existing parking in both material and square footage. Other launch ramps do not currently include additional parking. As the launch ramps are much longer than the existing condition, the walk for pedestrians dropping a car and walking to the end of the launch ramp is significantly increased. Therefore, the Park may desire to introduce an “intermediate” parking area at an elevation midway along the launch ramp. The launch ramp would need to be designed to be able to be flooded during high water conditions. The introduction of new parking will increase cost but improve visitor experience.

2.03.2 Utilities

Bullfrog Launch Ramp design includes allowance for potable water, sewer, electric, and communications to serve the existing marina. A utility survey was recently conducted to understand the existing conditions and the results will be used to set design criteria and influence the design for the next phase of work. Jacobs and the Park must work together to identify and confirm the required capacities for the proposed new utilities. It is understood that sewer design will require pump-out capacity for more than 500 houseboats, which will be significant, and likely a higher cost than the allowance initially included in the estimates.

For other concept designs, an allowance for electric and communications were carried in the cost estimates; however, these new utilities may not be needed. This should be confirmed in the detailed design phase.

2.03.3 Visitor Facilities

Visitor facilities, including restrooms, kiosks, clean-out facilities, or wayfinding signs were not included in the concept design phase. If needed, they will need to be identified and detailed in the next phase of work.

2.03.4 Pedestrian Access Paths

Launch ramps were designed assuming pedestrians would access the water by way of the launch ramps. Separate pedestrian access paths were not included in the concept design. If desired, these will need to be identified and detailed in the next phase of work.

2.04 Permitting Requirements

It is anticipated that National Environmental Policy Act (NEPA) for Bullfrog may require an Environmental Assessment (EA) while the other sites would be anticipated as Categorical Exclusions (CE). This evaluation is pending further resource surveys and evaluation by the Park and is subject to change.

This NEPA timeline is anticipated to include the following checkpoints. The final checkpoint, a signed Finding of No Significant Impact is required for contractor mobilization and construction.

- Continued civic engagement and agency outreach
- Project website launch
- Public and agency scoping meeting (can be combined or separate meetings)
- Public meetings summary draft
- Public comment documentation
- Preparation and submission of permits for agency reviews
- Notice of availability and distribution of EA
- 30-day public comment period
- Public hearing (alongside virtual public room launch if needed)
- Additional public meetings (if needed)
- Final EA (if needed) and signed Finding of No Significant Impact

An NPS Permitting Assessment Form has been prepared and is provided in Appendix G. The Permitting Assessment Form identifies specific actions to be addressed early in the next phase of work.

- Perform field visit and prepare Biological Assessment to confirm listed species and protected and critical habitat.
- Coordinate with U.S. Army Corps of Engineers to confirm if project requires individual permit or nationwide permit for Section 404 of the Clean Water Act. A Water Quality Certification (Section 401) will be required as part of this.
- Determine if there are permits or easements associated with Utah Department of Transportation ferry service.

2.04.1 Communications Strategy

A Communications Strategy was developed for the project and provided to the Park on December 20, 2021. The strategy includes the follow stated objectives to guide project communications both inside and outside of the NEPA process:

- Establish early and continuous public participation opportunities that provide timely information about issues and decision-making processes to all interested parties.

- Provide opportunities for interactive and frequent participation with public access to educational, technical, and policy information to enhance the public's knowledge and ability to participate in the development of the study.
- Provide reasonable public access via a multitude of information-sharing platforms, including in-person and electronic methods, to educational, technical, and policy information to enhance the public's knowledge and ability to participate in the development of the study.
- Provide adequate public notice of participation opportunities during the development of the study, and time for public review and comment at key decision points in the planning and design process.
- Ensure that public participation opportunities are held at convenient and accessible locations and times (in compliance with the Americans with Disabilities Act of 1990).
- Make information accessible with visualization techniques, and available in appropriate electronically accessible formats and means, via the NPS website, technology-enabled media, and video teleconferencing.
- Include measures for seeking input from and considering the needs of those traditionally underserved as defined in Title VI of the Civil Rights Act of 1964, such as low-income, minority, and non-English-speaking households who may face challenges accessing employment and other services.
- Develop a unified message to ensure that stakeholders are receiving a clear and consistent message about the study from all partners.
- Provide a contact to listen, acknowledge, and respond promptly to public questions and issues.
- Manage expectations and promote long-term benefits.
- Build upon NPS's reputation as a transparent, credible agency and a good partner to the community.

2.04.2 Purpose and Need for the Proposed Action at Bullfrog

While formal a NEPA process has not been initiated, a preliminary purpose and need for the project has been drafted and provided. Further refinement will be necessary following additional civic engagement and project development.

GLCA, comprised of more than 1.25 million acres from Lees Ferry in Arizona to the Orange Cliffs in southern Utah, was designated by Congress in 1972 (Public Law 92-593). Per the enabling legislation, GLCA was established "…to provide for public outdoor recreation use and enjoyment of Lake Powell and lands adjacent thereto in the States of Arizona and Utah and to preserve scenic, scientific, and historic features contributing to public enjoyment of the area." There are currently four marinas on Lake Powell. These include two in Arizona, Wahweap Marina (approximately 5.5 miles from

Glen Canyon Dam) and Antelope Point Marina (approximately 5 miles upstream from Glen Canyon Dam), and two in Utah, Halls Crossing (approximately 95 miles upstream from Glen Canyon Dam) and Bullfrog (approximately 95 miles upstream from Glen Canyon Dam across the Lake from Halls Crossing). Dangling Rope marina was also recently closed due to natural conditions. Hite public launch ramp has not been usable for several years due to low water conditions.. The Charles Hall Ferry is out of service due to low water. The route crossed Lake Powell between Hall's Crossing and Bullfrog that used to provide a means for cars, trucks, and recreational vehicles to cross Lake Powell and served as a continuation of Utah Route 276.

Persistent drought in recent years has lowered the water level of Lake Powell significantly. Without surplus water deliveries, the water elevation at Lake Powell can drop as much as 30 feet a year. The Lake elevation in December 2021 was 3,533 feet,[1] and the Bureau of Reclamation projects it to drop as low as 3,519 feet by December 2022.[2] These vertical drops in-water elevation translate into hundreds of feet of horizontal movement in the water's edge below its current location. As of 7/25/2022, only the Wahweap Stateline Auxiliary boat ramp remains open to houseboats, and all other locations are inoperable or only available to small, motorized vessels. As water levels fluctuate, some ramps are open for short period of times and then closed as water falls again, leading to an unpredictable visitor experience and difficult operations and communications for the Park to manage. As ramps become inoperable, recreational users are accessing the Lake in undeveloped locations, which presents safety issues as well as impacts to natural and cultural resources.

The Bullfrog Marina is the closest of the five marinas to the Salt Lake City metropolitan area, and is in the unincorporated community of Bullfrog, Kane County, Utah. In addition, the ferry ramp is closed, and ferry services have been discontinued. The marina is open as of July 25, 2022; however, as water levels continue to drop, the water depth is becoming insufficient for some vessels to safely navigate at the marina.

The purpose of the project is to explore options to restore safe motorized boat access and use of recreational facilities at the Bullfrog boat launch and marina, potentially restore ferry service, and protect natural and cultural resources. This is needed to support access for a wide variety of users, including recreationalists, concessionaires, tour operations, and houseboat rentals; to maintain services, including NPS management activities, on-Lake emergency services, the movement of supplies and goods; and to restore the interconnection of the state road network. NPS is evaluating options to relocate the Bullfrog Marina and construct a multipurpose boat ramp in the

[1] Summit Technologies, Inc. 2022. Lake Powell Water Database. http://lakepowell.water-data.com/.
[2] Bureau of Reclamation. 2022. January 2022 24-Month Study Projections Lake Powell and Lake Mead: End of Month Elevation Charts. https://www.usbr.gov/uc/water/crsp/studies/images/PowellElevations.pdf.

general area to accommodate the lower water levels in Lake Powell and to restore ferry services (Proposed Action).

Chapter 3 – Schedule

3.01 Design-Build Procurement Schedule

Due to the emergency need for the Bullfrog Launch Ramp, NPS has decided to pursue a Design-Build contract for design and construction at this site. For this, Jacobs is proposing the following estimated key milestone deadlines.

1. Conduct Geotechnical Borings
2. Notice to Proceed for Engineering Services to Conduct Schematic Design and Design-Build Request for Proposal
3. Option Evaluation Memo – 2 weeks
4. 30% Design Plans Specifications & Estimate (PS&E) submittal (Schematic Design) – 90 days from NTP
5. Final Design-Build Request for Proposal – 100 days from NTP
6. Contractor Procurement – 4 months

It is noted this schedule is for the development of the Bullfrog Launch Ramp, access road, and parking. Adjustments may be needed for any additionally identified infrastructure.

Chapter 4 – Next Steps

4.01 Actions

The following are the actions and next steps for the Park to progress the project:

1. Finalize site selection for the Bullfrog Launch Ramp.
2. Conduct NEPA on the proposed geotechnical boring locations, so the borings can be completed
3. Confirm and update design criteria noted in Section 2.02 for detailed design.
4. Confirm additional infrastructure needs as identified in Section 2.03.
5. Conduct additional cultural, paleontological, and biological surveying as required. Coordinate with Park to identify sites and adjust design layout to avoid impacting contributing features.
6. Determine strategy for Investment Review Board (IRB).
7. Confirm public strategy and identify if a project website and virtual meeting room will be developed.

Appendix A – Early Listening Session Summary

Jacobs

GLCA Launch Ramps Early Listening Session Summary

Tuesday, November 16, 9 a.m. to 10:30 a.m. MT, Antelope Point
Attendees: see sign-in sheet, Appendix A
Listening Session with Marina Concessionaire

- Pre meeting notes from NPS: Antelope Point is a joint venture with Navajo Nation. Concession contract coming up for renewal, for first time in 50 years, in next 18 months.
- Background/Issues:
    - Concessionaire essentially a high-end valet service to store, launch, service, maintain high-end houseboats.
    - Marina - 300 slips private rental. 40 rental boat slips. 200 employees now, close to 400 in season. 80% employees are Navajo Nation. Facilities: store, RV park.
    - The biggest priority at this site is getting large houseboats in/out. The largest houseboat they have is 125′ long, 22′ wide, about 250T. This takes two trucks and a tractor to pull it out.
    - Typical houseboats are 75′ long.
    - Currently have some houseboats stuck at Antelope because they can't transport over land; they cannot get permit to transport boats wider than 18′ over bridge (post-meeting note: team is debating this point; Michele Holland heard the issue as noted, but others heard the limitation to be related to inability to transport via water due to height clearance at bridge).
- Concessionaire has explored solving this problem through their own project:
    - Have looked into lowering their own ramp 40′ to meet elevation 3525. Estimated $3 million to $5 million in construction, to be accomplished Jan-May 2022 in offseason.
    - They investigated a portable ramp extension, but it will not work at Antelope (they are constrained in plan dimension at base of ramp due to proximity of channel and first row of docks/houseboats).
    - Concessionaire has some interim space negotiated at Wahweap that is available until March (per Park, Heidi Grigg).
    - Ideally, they'd launch May – end of October.
- Design Discussion:
    - Estimate their ramp to be 6% slope (post-meeting note: actual slope is at least 8%, based on team's estimation from walking on it).
    - Need the ramp to extend into the water the length of the boat/houseboat.

- Concessionaire would accept operational solution to limit interaction with public (i.e., limit houseboat launches to very early/late in day) if combined use is moved to the public ramp.
- Concessionaire is observing lots of user conflicts between kayakers and boaters.
    - Kayakers tend to spread out all gear in large area, sometimes taking up multiple lanes.
    - Receptive to the idea of separating paddle sports to a separate area.
- Current administrative/concessionaire ramp has a pedestrian gangway that doubles as their utility corridor.
- Note that the apron area at top of ramp needs to be as flat as possible to accommodate 18-wheeler turning around/backing up the houseboats.
- Consider angling a ramp off to the right to accommodate low water.
- Kayakers tend to launch from bottom left of ramp and go into Canyon (No wake area, good paddling conditions).
- Recommends any ramp location go straight into main channel of CO River
- Accessibility/ safety could be improved. Some ideas discussed:
    - Signage and wayfinding
    - Paddle sport only locations
    - Marking out pedestrian lane
    - Callbox at the bottom of ramp
- Up to 60 feet of water fluctuation possible annually
- Parking on side of ramp would be helpful
- Lack of stormwater management is an issue

Wednesday, November 17th, 10:15 a.m. to 11:15 a.m. MT, Bullfrog:
Listening session at with UDOT and Park at Ferry Ramp and Fire Station:
Attendees: see sign-in sheet, Appendix A

- Background/ Issues:
    - Ferry serves as critical lifeline for Halls' Crossing – it brings the mail, serves as school bus service, and provides a lifeline to a remote community. There is no USPS, UPS/FedEx/Amazon delivery to Hall's Crossing…it all comes to Bullfrog and is ferried over. Any future ramp conditions must consider a means for the ferry connection.
    - Ferry holds ~ 15 vehicles (depends on how many RVs).
    - Ferry runs hourly (even hours, starting at 8 a.m., from Halls, odd hours from Bullfrog).
    - Ferry has no booth, permanent operations on either ferry ramp – all operations are done on the ferry. They currently struggle to run credit cards (they lose cell coverage quickly) but Park advises a new tower is about to go up in Bullfrog that will significantly increase coverage by multiple carriers, so this issue is not going to be a concern in the future.
    - Large RVs are an issue trying to board ferry. Vehicle length so long usually catch at grade break from ramp to loading ramp.
    - Halls and Bullfrog visitors are very distinct and increasing services on one side will not inherently draw visitors from the other…it's important to provide access and services for both.
    - Kayak group take-outs had to be shifted to after 7 p.m.. Kayakers prefer to take out at Hite but had no access.
    - Bullfrog and Halls different clientele than south lake. Bullfrog - more repeat customers. Fam oriented. Multi owners/timeshares.
    - Most visitors to Bullfrog coming from UT and CO. If moved to Halls would be 1 hour drive difference (adds an hour to drive).
    - If marina placed at Halls would need upgrades but wouldn't need to run utils to new ramp.
    - NPS responsible for water/wastewater on Bullfrog side. Aramark responsible for power.
    - Halls side NPS responsible for all utils.
    - Noted lake expected to drop another ~25 feet this winter.
- UDOT has explored solving this problem on their own:
    - Ramp was extended in 2017 to reach elevation 3585 by Brown Brothers Construction.
    - UDOT estimates at least $10 million to $15 million to extend ramps further to reach low elevation.
    - Ferry access had been shifted over to Bullfrog public ramp (once ferry ramp was high/dry on Bullfrog side), and while it was very tight at the water line (congestion, traffic management challenges) it was able to be managed. Overall, believe it can be accommodated as a permanent condition if ramp is wider and

courtesy docks staged appropriately. They did have to coordinate timing of ferry, and houseboat launches so they wouldn't happen simultaneously.
    - Right now, utilities run above ground along main road then underground through a series of bunkers (need further clarification on this, it wasn't clear if this was all utilities, and where specifically these utilities exist).
- Design:
    - Ferry is 50' wide. The wedge (metal plate) that is used to bridge ramp to ferry is 22.5' wide.
    - Only operational challenge currently is the RV's – they tend to bottom out due to angle where ramp meets ferry. Likely can only be addressed via design of wedge.
    - At least one staff member does not concur that mixing ferry and public use is a good idea.
    - Some concern expressed about channel congestion with two marinas across from one another if marina moved to Stanton Creek.
    - No fee booth needed for Ferry.
    - State Line Main Ramp offers some good examples of how to lay out 'lanes'.

Thursday, November 18th, 10 a.m. to 11 a.m. MT, Hite

Listening Session with concessionaire:

Attendees: see sign-in sheet, Appendix A

- Background/ Issues:
    - Kayakers/rafters do NOT like having to go to Halls, would much prefer to take out at Hite.
    - Hite is currently producing more power than they need (via diesel generators).
    - Access to CO river for recreation is limited. Why Lees Ferry is so popular.
    - Power currently runs to the top of the old boat ramp. Overgenerated for power now at Hite because was set up to power marina.
    - Noted they had been featured in an episode of "At Your Leisure - Hite" if wanted to look up video.
    - 2016 was a higher runoff year. Low point near existing marina ramp was inundated. New access road/ramp would need to be designed to be inundated at times. Normal fluctuations up to 6' in May.
- Hite is uniquely positioned to offer services that cannot be found elsewhere and offers new business opportunities
    - Would like to offer personal watercraft tours. Would like bass boat fishing to Good Hope Bay (far closer to Hite than Bullfrog, so this would be a very specific draw to Hite for fishermen) If could access would increase business.
    - Would like to do overnight kayak/camp trips up dirty devil to Poison Spring (if sited north of confluence).
    - Glamping area - would like to have potable water access, ideally wastewater as well. Would like to be able to have accommodations. Glamping area would be under water at full pool.
- Design:
    - Primitive style ramp takeout area needed.
    - Ideally, would like to be able to launch jet boats (22', nearly flat-bottomed), small 12' fishing craft, jet skis, and kayaks take out/put in.
    - Largest craft? Typically a small fishing boat. 22' bass boat. Main use is personal watercraft.
    - Will likely need a protected area/cove to allow for launching and landing. (Concessionaire brought a sketch to reflect their ideas- Figure 1). Eddy wall? Jetty? Have done this in Moab.
    - Need to consider what material to use, what forces to design for, how to account for changing river/lake elevation in the area.
    - Docks could be designed for kayakers and jet skis to pull up on the dock and access.
    - Largest vehicle to accommodate - RV towing PWC. Largest turning radius that would be needed.
    - Need apron/turnaround at top of ramp.

- Ideal location? Tie in off of road by visitor center.
- Parking is fine as is for now. Likely need some signage to keep people from parking in silt areas where they may get stuck. Eventually more parking may be needed but for now, it's fine as is.
- Bass fisherman would need power to charge trolling motor.

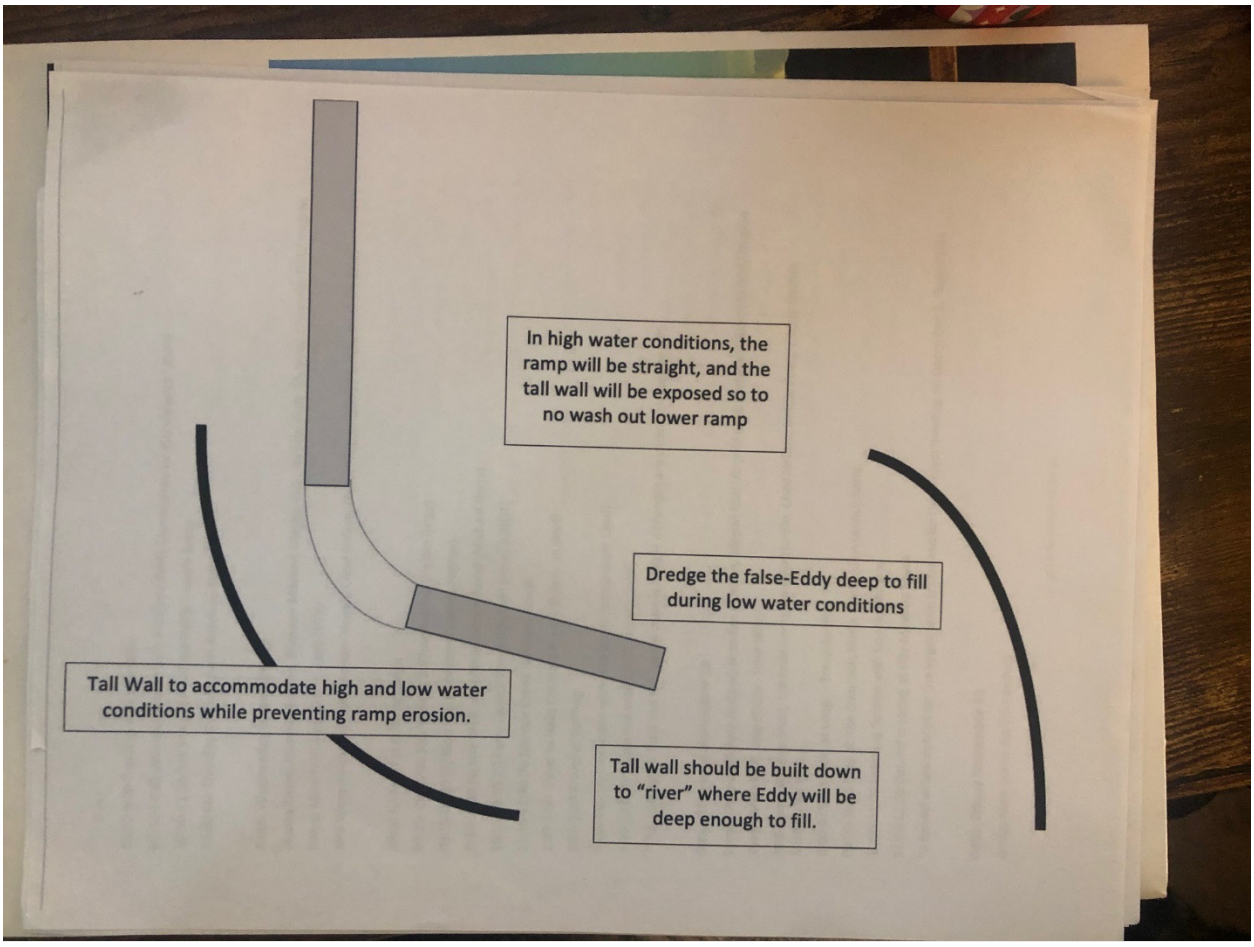


Figure 1 – Concessionaire Concept Sketch

Monday, November 22, 10 a.m. to 2 p.m. MT, Virtual
Listening Session with Concessionaire Aramark
Attendees:
Jacobs: Michele Holland, Erika Rosenstein, Megan Ruiz, Brendan Madsen, Melynne Chiariello, John Garcia, Angela Reid, Geoff Baekey (CHM),
NPS: Mike Will, Amy Hribar, Jenn Hardin, Billy Schott , NIchelle Rich, Heidie Grigg, Michelle Kerns, Chad Nelson, Timm Kennedy
Aramark: Scott McGinn, Joe Ligon, Josh Reid, Enes Zorkul, Kelly Zwierzchowski,

- Background/ Issues
    - Private marina
        - 40 feet of water, looking to move deeper.
        - Utilities include, power water and sewer.
        - 50-200 employees working at floating fuel dock and boat rental facilities.
        - Floating fuel dock.
- Discussion on splitting Bullfrog facilities to Halls Crossing
    - How would that change the BF users. Ferry has some impacts on this. Guests just want to keep boat in water and maintain access on BF side preferably but would consider the Halls side if needed.
    - Halls does not have the capacity, utilities or facilities required to do this, especially w/o a ferry.
    - Cannot block navigational access.
    - Relocated scenario requires changes to operations, refuse, maintenance. Still in the planning phase.
    - W/o the ferry running, Aramark would like barges and tour boats to become delivery service. Linens and laundry for boat rentals are done on land, would need to look into water based options.
    - If ferry can run, Aramark has substantial flexibility with goods and people/worker movement.
- Launch Ramp Design
    - Bullfrog – move launch ramp closer to main channel, Stanton creek area provides most flexibility to them. Allows for parking and keeps traffic over on main channel. And maintain what is left in Bullfrog Bay.
    - Marina for BF would have to broken up and restructures into smaller sections on the main channel.
    - One ramp makes the most sense rather than a separate high water and low water ramps.
    - Capacity needed for a ramp, 24’ truck length, 90-100’ trailer length, 105-120’ total, four axles, 12’ witch. 160000 to 180000. Would need the same things at Halls likely. Use ferry ramp in halls makes sense, extend that for Aramark.
    - Fuel delivery via 18-wheeler, need adequate access for this.
    - Larger boat and truck turnout up top.
- Marina design
    - 65 rental houseboats.
    - 1000 houseboats moored and slipped at peak capacity.

    - 20’ water depth to be safe. Truss structure is 6 feet to 7 feet under water, 10 feet makes us nervous, 20 feet is out stop point for movement.
    - Potable water and electricity.
    - Buoy fields grid measurements 600 by 1,200.
    - Shore power stations.
    - What land facilities need be relocated? Liquor store, otherwise, everything can stay where it is. Can expand or add services on water to accommodate. If moved to Halls, would need to move boat shop, outlet for food and beverage, and liquor store. Would need to accommodate much more visitor use.
    - Shuttle possibility, currently use one for peak season but are open to water based shuttling.
- Parking and accessibility
    - Parking is needed. Each house boat rental bring at least three to four cars with it in peak season.
    - ADA/mobility challenges – golfcarts. They typically get transported to docks and they have ADA cranes and houseboats. Use carts and ATVs to transport things as needed.
    - Stateline launch ramp at Wahweap is an example of what they would like to do with tiered parking.
    - Do not like switch backs.

***It is noted that names of attendees from the virtual listening sessions are as best recorded by Jacobs team as participants announced themselves on the phone.**

Thursday December 16, 10 a.m. to 11:30 a.m. MT, Virtual
Listening Session with CUAs
Attendees:
Jacobs: Erika Rosenstein, Megan Ruiz, Brendan Madsen, Michele Holland, Nancy Shelton
NPS: Heidie Grigg, Nichele Rich, Billy Schott. Greg Owen
Other: Bill West, Laketime Houseboats and Houseboat Management services
Cody Buckley
Dan – Ticaboo Lake Service
Guest (Big Water Utah)
James- Concession management Specialist South Lake
Josh Summers
Nathan Collins – President of Canyon Boat Rental Wahweap/ Page
Tom Pryor- Owner Outdoor Rentals
Trent Suther – Lake Powell Marine
Troy Sherman – Beach Bag Services
Guest (Aquanuts)
Mona B – CUA Coordinator with Canyonlands
Corey – Tour Company
Bill Wells– JMB Marine

- Design
    - Pitch of ramp makes large vessel launch and recovery tough, problem at top is tough but doable, a little too steep.
    - Concrete can be slick, need more teeth to the concrete.
    - Need a gradual transition from road to ramp. Abrupt change can cause the trailer to drag. (Specific Percent grade that is ideal? No measurements, but main ramp at BF up toward the top is just right, top 1/3 is ideal. Executive ramp is steep but workable. The flat part at the bottom of BF is tough.)
    - Gravel surface is ideal for turn around. Then hard surface for rest.
    - Separate commercial ramp is ideal.
    - Stateline ramp is ideal, has great bite to it on surface.
- There was noted concern about the capacity of the usable boat launches for the 2022 season (which is outside of the scope of what this project will solve- NPS will address in separate meetings)
    - Rumor that main Wahweap ramp is being expanded, the more we can get dot he south lake the better due to future demands.
    - Wahweap auxiliary ramp, can this be thrown into the mix? Could we get two more lanes at WW?
- Participants were eager to hear design updates, even though it is noted this was premature, the Jacobs team provided the following updates:
    - Looking at Stanton Creek area for a relocated Bullfrog ramp.
    - Design elevation 3450 to accommodate future low water.

    - Goal of project would provide a long-term solution beyond current “chasing of water”.
    - A new access road would be 3 to 4 miles and the value proposition is being evaluated. Team is looking at road and utilities that would be required.
    - Halls Crossing is being evaluated as a regrade in its current location, but also evaluating the Ferry ramp.
    - Antelope Ramp is being evaluated as a regrade in its current footprint, it is noted this would go further back in the land.
- Antelope is a significant access point for paddleboards and kayaks
    - Ask that Antelope become a non-motorized access only, with better trails to get down too. We could bring in many people that are nonpolluting.
    - Ramp is currently approaching dangerous.
    - The customers need a switchback trail system and better parking arrangement.
    - Also need bathrooms that are usable and available.
    - Designated lanes or separate trail for kayaks?
        - Need to have a wide enough trail for front and back two people and turns.
        - We use a barge to transport kayaks and customer simply walk.
        - Some people use winches and/or carry. Winching and sliding of gear up and down hill is very dangerous. Also lots of folks cannot traverse the incline.
    - Busiest time is 250-300 kayaks a day. Peak times? Few times where 70-110 inflatable paddleboards were at the bottom of the ramp at one time. Need to pump them up and carry up and down the hill, slide, etc. Pinch point times? 7 to 10 a.m. then 3 to 430/500 is the peak. Some sunrise and sunset folks. Would be “absolute mayhem” if boats were also able to use the ramp.
- Impacts to businesses
    - Foresee no change that would houseboat launching in a negative way, having a place to do launch and retrieval is the key. In the temporary, additional boiler plates are needed to extend access until a new project comes.
    - Closing the Antelope ramp during construction would shut off access for paddleboarding and kayaking in the area. Not possible to kayak from WW to ANT canyon due to the distance.
    - Customers and public want updates and projections on where this is going- lack of communication or action has led to negativity. Public confidence went way up with the construction of Wahweap in South Lake; North Lake needs a similar boost.

Thursday December 16, 1 p.m. to 2:30 p.m. MT, Virtual
Listening Session with CUAs
Attendees:
Jacobs: Erika Rosenstein, Megan Ruiz, Brendan Madsen, Michele Holland, Nancy Shelton
NPS: Heidie Grigg, Nichele Rich, Billy Schott, Jennifer Hardin, Amy Hribar, Timm Kennedy, Chad Nelson, Greg Owen
Other:
Anna Mild to Wild
Brendan/ Jose, Ops Manager for Expeditions Moab
Tim Gaylord – Holiday River, Canyonlands Contractor/ Outfitter
Brian – Expeditions GM
Essig – Outfitter
Merill – Western River Expeditions
Carter LLoyd – Western River Expeditions
Colin Evans – Colorado Plateau River Guides
Katherine Blits – Wild West Outfitters
Leslie Kobinski – Canyonlands Concessions Management
Kristy Johnson – Shellie Grifith Expeditions
Michah Evans – Utah Division of Wildlife
Mike DeHoff – Returning Rapids Project
Mike Hues
Carrie Nelson – Canyonlands Wilderness Coordinator
Ted Wild – Mild to Wild
Kaitlin Tohmas – PA specialist for Canyonlands
Tony – Utah D and R
Tyler – Oars – outfitter with Canyonlands
Steven Young – River District Ranger with Canyonlands
Paul Grahams USGS

- Background/ Issues
    - It was noted immediately this audience was most interested in Hite which has a challenging history as a site
        - 2003 saga began, that is when ramp started to not operate.
        - Remote and primitive and challenging situation.
        - Most people go to north wash area. That ramp is very steep and does not work.
        - There is a PowerPoint from 6 months ago that summarizes the challenges- this has been provided.
        - River is out of its original channel. No clear cut scenario as to what will happen with the changing river. What could work in the short term was presented previously.
        - Bureau of Reclamation control the elevation level. Need their plans for have an effective solution. Need 150 vertical feet of change to accommodate. There will be no usable north lake access points.

        - South of the dirty devil is a challenge- the sediment down there is unpredictable. Has anyone looked up stream of the dirty devil to the north. That is the first usable location that has rock and could be a good long-term location. (Jacobs confirmed this is being looked at by the geologists).
    - "Silt waterfalls"
        - Paul Grahams - the conditions right in front current ramp is in perched river section of concern. River is cutting 8' per year. It is underlaid by superficial sediments. Need coring because we don't know how the cutting action will continue. If it hits a hard surface, a rapid or waterfall could form and it is a real possibility which could happen in the next year or two
    - Canyonlands has data on users. 3-4 outfitters and 6-7 private on a given day. Morot rigs up to 37'. Downstream is not accessible. We are happy to provide pictures of it takes to get out of the water. 4×4, manpower, winches etc. need method to improve current north wash ramp. Think that the old, perched area ramp would get cut off. Need to address silt deposits.
- It is noted several attendees anticipated a meeting with more progressed updates and a short term solution for the 2022 season. There is significant concern about the 2022 season and the ability to operate
    - Jacobs communicated design updates for a long-term solution are coming in the New Year, the purpose of this meeting is to inform that design. Park can provide separate meeting on 2022 season.
    - Temporary matting on the Hite site may be something to look at for 2022 season.
- Design
    - Need a ramp large enough to accommodate three groups.
    - Need a usable slope. The one at north wash is way too steep and requires special equipment.
    - Need to actually get to the water. Movable/deployable could be a workable solution.
    - Durable surface needs to be incorporated. Loose footing can be a problem.
    - Need staging area.
    - Jacobs team was invited to site to discuss the design (it was noted Jacobs has recently visited the site).
    - Must accommodate kayak to 36-person (barge). Want to back a truck down with the rig and hoist.
    - Take out is most important but there is a desire for putting in boats as well.
        - Our method is to put a boat in the water at the north wash and push people off. Have had to hand lower a raft down, we have the need. Ability to put in is also important for search and rescue and getting up stream to help someone.

        - When someone is stuck or stranded, being able to deploy emergency rescue boat from Hite is important.
    - Saw flash floods last year from dirty devil. When it flash floods, can push a lot of sediment out and across channel. Would need to be far enough upstream to avoid if we were to site there.
    - A good grade is important. Fluctuation of river, will need to be in river so need to account for dramatic flows, high-high and low-lows.
    - Lake elevation is a big factor, but this section has a ton of fluctuation. 3,500 cfs to 109K cfs. 10-year period usually see 60k cfs.
    - What services are needed?
        - Commercial outfitters really only need some restroom facilities.
        - Parking and turnaround space needed.
        - Private users might need showers and campgrounds.
        - Restrooms, shade and rain shelters.
        - Lighting needs? Mostly operating during daylight.
    - Canyonlands would ultimately dream about getting a 14,000-pound jet boat out of river but requires more water.
    - It was asked about correcting the course of the River and putting it back into its original channel. It was noted that is not within the scope of the project.

Thursday December 20, 2 p.m. to 3:30 p.m. MT, Virtual
Listening Session with CUAs
Attendees:
Jacobs: Erika Rosenstein, Megan Ruiz, Brendan Madsen, Michele Holland, Nancy Shelton
NPS: Heidie Grigg, Nichele Rich, Billy Schott, Jennifer Hardin, Amy Hribar, Timm Kennedy, Chad Nelson

Other:

Bill Diak – Mayor of Page AZ

Mona – Glen Canyon Commercial Services Office

Keith District Director for Tom O'Holland

John – Lake Powell Experience

Judy – Chamber of Commerce (husband is ambassador Guides and Outfitters)

Greg Owen – North Lake Management Specialist

Randy – Skoony's Lake Powell Adventure

Greg Martinez - City of Page Economic Development

Jim Householder – Dive Center

- Overwhelmingly, attendees at this meeting were looking for updates rather than giving input on design. Jacobs and NPS provided some informational updates:
    - Looking at design water elevation of 3450 to make sure there is a long-term solution
    - This design will not address the 2022 season
    - NPS is working to secure funding for construction- Jacobs work is funded by money from last year
    - Project is still at early phases of design development and funding
    - This project does not include the Dangling Rope Marina but the Park is looking into fuel supply and other needs for the area
    - At Bullfrog the team is looking at relocating new ramp in Stanton Creek Area, including relocating the marina and the mooring fields
    - At Antelope the team is evaluating the significant regrade to deep water
- What does a successful design look like to you?
    - "Would like to see that we have options. Pressure on Wahweap is extreme. Need more options at other areas of lower lake. Need multiple ramps open. The coverage of BF, Halls, Ant answers this concern"
    - Having courtesy docks is very important to us. Also distance to parking. These are important to the sporting outfitters. (This is a Wahweap concern)
    - No concerns noted on construction affecting businesses
    - Ramps must be designed as multi use- kayaks and inflatables prefer to have a side area off of the ramps

Tuesday, February 1, 9 a.m. to 10:30 a.m. MT, Virtual
Listening Session with Navajo Nation
Attendees:
Jacobs: Megan Ruiz, Brendan Madsen, Nancy Shelton
NPS: Billy Schott, Jennifer Hardin, Amy Hribar, Timm Kennedy, Chad Nelson, Vanessa Glynn Linaris

Other:

J Davis – Navajo Nation office of the President and VP

JT J Willi – Economic Development Navajo Nation

Tony Penny – Navajo Nation Economic Development

Arbin

Elain Young – Economic Development Small Business

Jonathan Nez

Katherine Belzowski

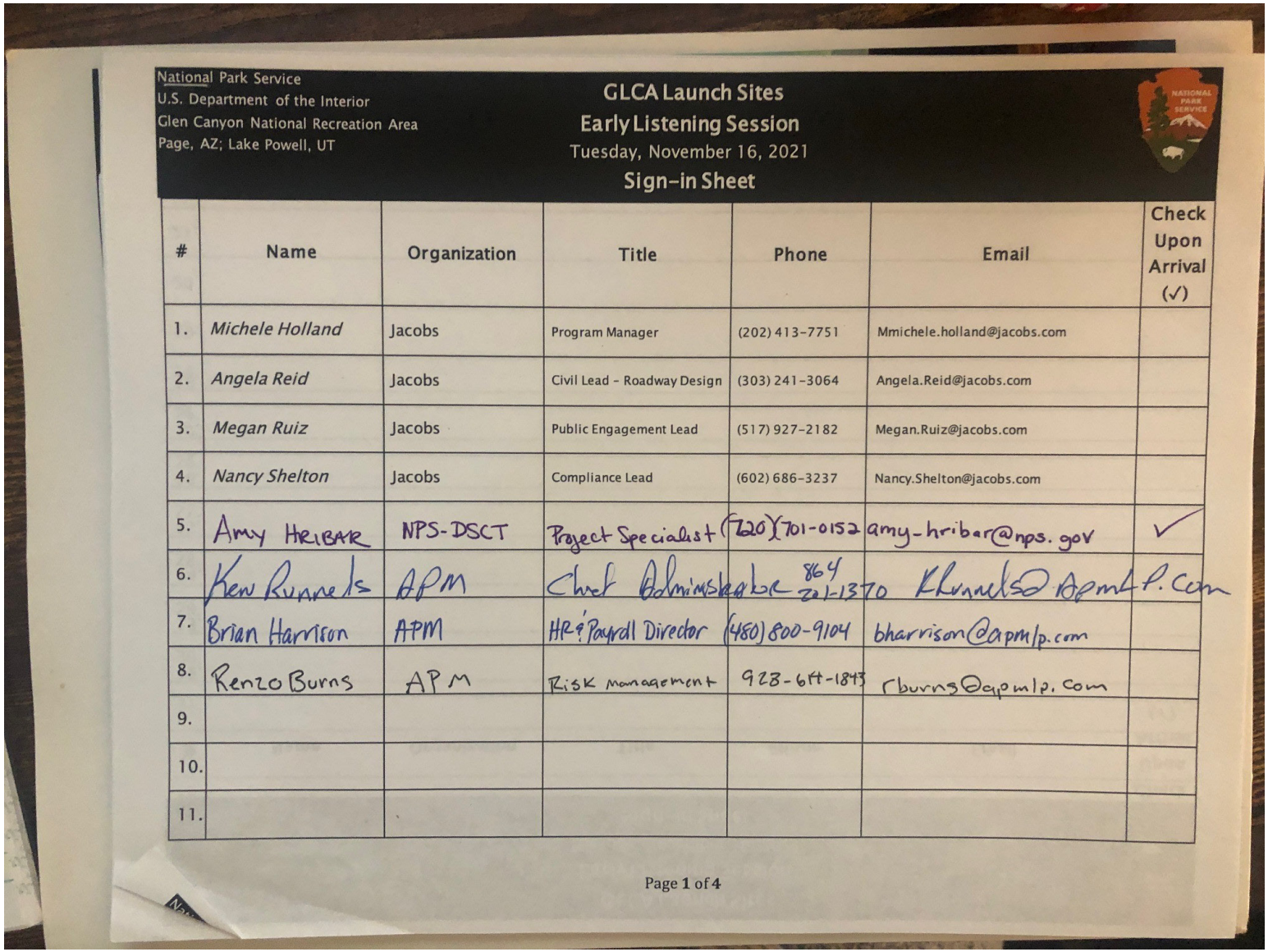
Greg B Hansen

Michele Yazzie

- It is noted this meeting provided less input on design than other early listening sessions however provided an opportunity to hear Navajo Nation concerns and current challenges with low water issues at Antelope
    - There are significant jobs impacted through Antelope Point from the temporary closures
    - The Dry storage side has not been able to launch in past 1-2 years
    - There is concern that the low water issue has been known for some time and is seemingly only being addressed now (too late). It was noted by the NPS team that the original BOR projections for this area were 40 feet higher than the current reality and the Park has been caught off guard by this sudden unexpected change. These conditions are unprecedented.
- Navajo Nation sees potential development opportunities in hotels/ resorts and future businesses that could come in
    - Goal of site is not just access but having improved facilities
    - There is infrastructure bill funding as well as American Recovery funding and Navajo Nation resources
- Antelope Point Holdings has received proposals for pedestrian and expansion of the business ramp, they are not asking Park to reimburse through lease hold on those
- Navajo Nation expressed interest in having participation in the Jacobs/ NPS planning team, specifically there is an interest for local chapter reps to be part of the planning meetings and to review concepts.

Attachment 1
In Person Meetings, Sign-in Sheets

Tuesday, November 16, 9 a.m. to 10:30 a.m., Antelope Point

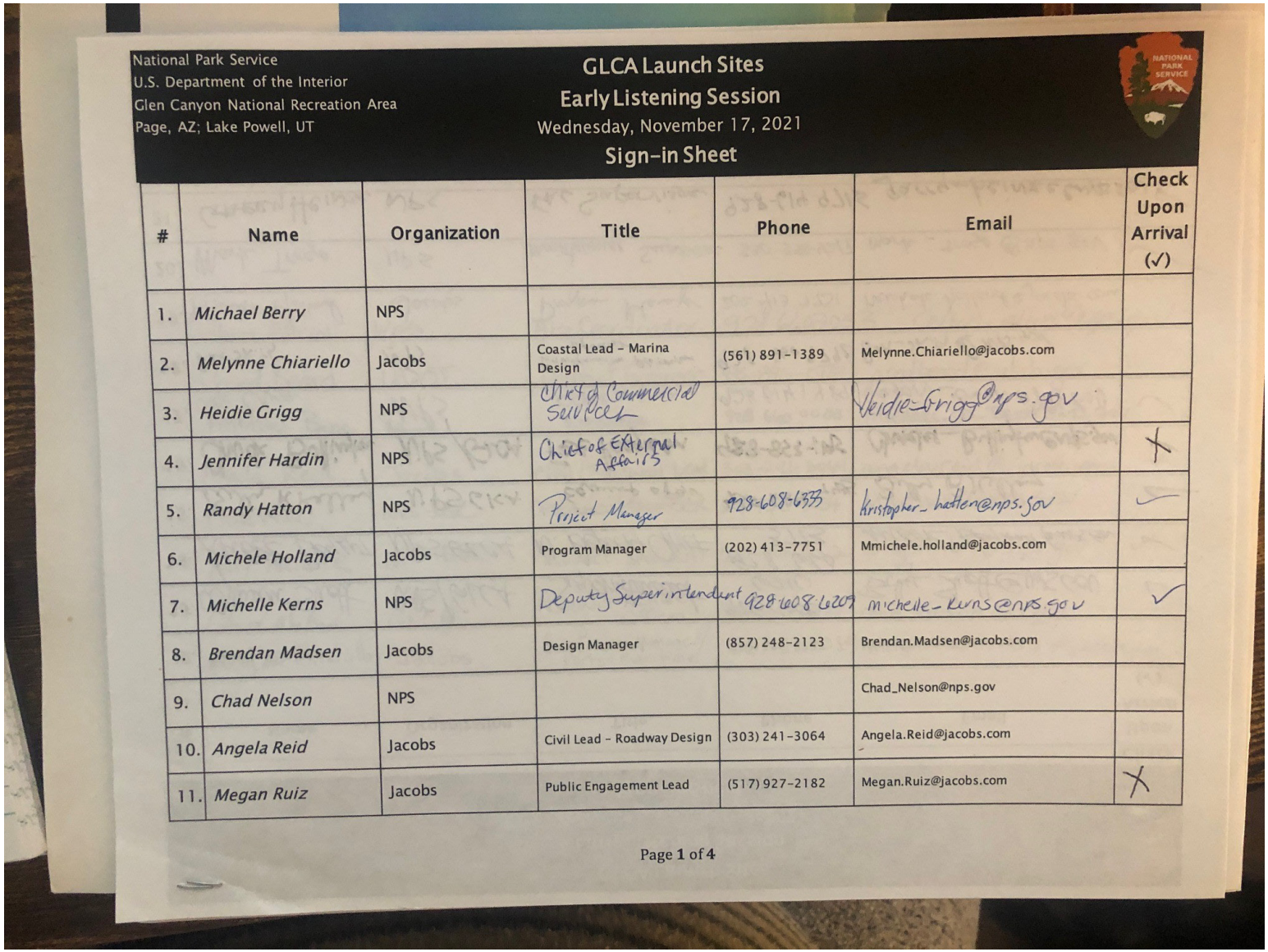


National Park Service
U.S. Department of the Interior
Glen Canyon National Recreation Area
Page, AZ; Lake Powell, UT

GLCA Launch Sites
Early Listening Session
Tuesday, November 16, 2021
Sign-in Sheet

#	Name	Organization	Title	Phone	Email	Check Upon Arrival (✓)
1.	*Michele Holland*	Jacobs	Program Manager	(202) 413-7751	Mmichele.holland@jacobs.com	
2.	*Angela Reid*	Jacobs	Civil Lead - Roadway Design	(303) 241-3064	Angela.Reid@jacobs.com	
3.	*Megan Ruiz*	Jacobs	Public Engagement Lead	(517) 927-2182	Megan.Ruiz@jacobs.com	
4.	*Nancy Shelton*	Jacobs	Compliance Lead	(602) 686-3237	Nancy.Shelton@jacobs.com	
5.	Amy Hribar	NPS-DSCT	Project Specialist	(720)701-0152	amy-hribar@nps.gov	✓
6.	Ken Runnels	APM	Chief Administrator	864 201-1370	Krunnels@apmlp.com	
7.	Brian Harrison	APM	HR & Payroll Director	(480) 800-9104	bharrison@apmlp.com	
8.	Renzo Burns	APM	Risk management	928-614-1843	rburns@apmlp.com	
9.						
10.						
11.						

Wednesday, November 17, 4 p.m. to 4:30 p.m., Bullfrog:



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GLCA Launch Sites
Early Listening Session
Wednesday, November 17, 2021
Sign-in Sheet

#	Name	Organization	Title	Phone	Email	Check Upon Arrival (✓)
1.	*Michael Berry*	NPS				
2.	*Melynne Chiariello*	Jacobs	Coastal Lead - Marina Design	(561) 891-1389	Melynne.Chiariello@jacobs.com	
3.	*Heidie Grigg*	NPS	Chief of Commercial Services		Heidie_Grigg@nps.gov	
4.	*Jennifer Hardin*	NPS	Chief of External Affairs			X
5.	*Randy Hatton*	NPS	Project Manager	928-608-6333	kristopher_hatten@nps.gov	✓
6.	*Michele Holland*	Jacobs	Program Manager	(202) 413-7751	Mmichele.holland@jacobs.com	
7.	*Michelle Kerns*	NPS	Deputy Superintendent	928-608-6209	michelle_kerns@nps.gov	✓
8.	*Brendan Madsen*	Jacobs	Design Manager	(857) 248-2123	Brendan.Madsen@jacobs.com	
9.	*Chad Nelson*	NPS			Chad_Nelson@nps.gov	
10.	*Angela Reid*	Jacobs	Civil Lead - Roadway Design	(303) 241-3064	Angela.Reid@jacobs.com	
11.	*Megan Ruiz*	Jacobs	Public Engagement Lead	(517) 927-2182	Megan.Ruiz@jacobs.com	X

Page **1** of **4**

National Park Service
U.S. Department of the Interior
Glen Canyon National Recreation Area
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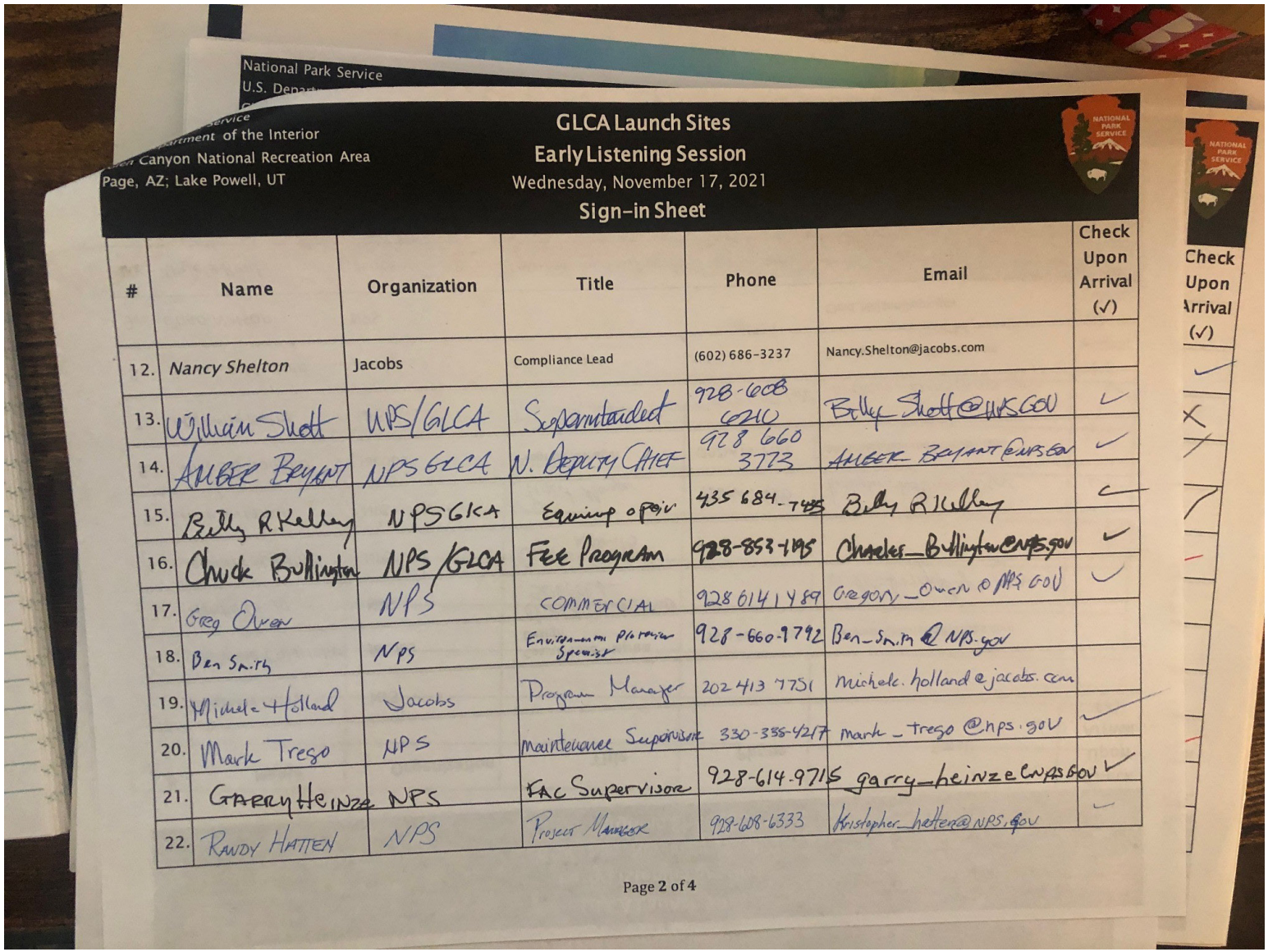
GLCA Launch Sites
Early Listening Session
Wednesday, November 17, 2021
Sign-in Sheet

#	Name	Organization	Title	Phone	Email	Check Upon Arrival (✓)
23.	Colleen Allew	NPS	AIS Coordinator	928 6602053	Colleen_allew@nps.gov	✓
24.	Jared Beard	UDOT	District Engineer	435-896-0729	jaredbeard@utah.gov	
25.	Michael Berg		ENGINEER	928 660 0088	MICHAEL_D_BERRY@NPS.GOV	
26.	Angela Reid	Jacobs	Civil/Roadway Lead	303-241-3064	angela.reid@jacobs.com	✓
27.	Mike Will	NPS-DSC	PROJECT MANAGER	303-956-5054	MIKE_WILL@NPS.GOV	
28.	Amy Hribar	NPS-DSC	PROJECT SPECIALIST	720-701-0152	amy_hribar@nps.gov	✓
29.	Chad Nelson	GLCA	Administrative Officer	928-660-2179	chad_nelson@nps.gov	
30.	Melynne Chiariello	Jacobs	Sr Project Manager/ Ports+Maritime	561-891-1389	melynne.chiariello@jacobs.com	
31.						
32.						
33.						



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Canyon National Recreation Area
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GLCA Launch Sites
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#	Name	Organization	Title	Phone	Email	Check Upon Arrival (✓)
12.	*Nancy Shelton*	Jacobs	Compliance Lead	(602) 686-3237	Nancy.Shelton@jacobs.com	
13.	William Shott	NPS/GLCA	Superintendent	928-608-6210	Billy_Shott@NPS.GOV	✓
14.	AMBER BRYANT	NPS GLCA	N. Deputy Chief	928 660 3773	AMBER_BRYANT@NPS.GOV	✓
15.	Billy R Kelley	NPS GLCA	Equipment Oper.	435 684-7485	Billy R Kelley	✓
16.	Chuck Bullington	NPS/GLCA	Fee Program	928-853-7195	Charles_Bullington@NPS.gov	✓
17.	Greg Owen	NPS	COMMERCIAL	928 614 1489	Gregory_Owen@NPS.GOV	✓
18.	Ben Smith	NPS	Environmental Protection Specialist	928-660-7792	Ben_Smith@NPS.gov	
19.	Michele Holland	Jacobs	Program Manager	202 413 7751	michele.holland@jacobs.com	
20.	Mark Trego	NPS	Maintenance Supervisor	330-338-4217	mark_trego@nps.gov	✓
21.	GARRY HEINZE	NPS	FAC Supervisor	928-614-9715	garry_heinze@NPS.GOV	✓
22.	RANDY HATTEN	NPS	Project Manager	928-608-6333	Kristopher_hatten@NPS.gov	

Thursday, November 18th, 10 a.m. to 11 a.m., Hite

National Park Service
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Page, AZ; Lake Powell, UT

GLCA Launch Sites
Early Listening Session
Thursday, November 18, 2021
Sign-in Sheet

#	Name	Organization	Title	Phone	Email	Check Upon Arrival (✓)
1.	*Michael Berry*	NPS	ENGINEER	928 660 0088	MICHAEL_D_BERRY@NPS.GOV	✓
2.	*Melynne Chiariello*	Jacobs	Coastal Lead – Marina Design	(561) 891-1389	Melynne.Chiariello@jacobs.com	X
3.	*Heidie Grigg*	NPS				✓
4.	*Jennifer Hardin*	NPS				✓
5.	*Randy Hatton*	NPS	Project Manager GLCA		kristopher_hatten@nps.gov	✓
6.	*Michele Holland*	Jacobs	Program Manager	(202) 413-7751	Mmichele.holland@jacobs.com	X
7.	*Michelle Kerns*	NPS				
8.	*Brendan Madsen*	Jacobs	Design Manager	(857) 248-2123	Brendan.Madsen@jacobs.com	
9.	*Chad Nelson*	NPS	Admin. Officer GLCA		Chad_Nelson@nps.gov	✓
10.	*Angela Reid*	Jacobs	Civil Lead – Roadway Design	(303) 241-3064	Angela.Reid@jacobs.com	X
11.	*Megan Ruiz*	Jacobs	Public Engagement Lead	(517) 927-2182	Megan.Ruiz@jacobs.com	X

Service
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Sign-in Sheet

#	Name	Organization	Title	Phone	Email	Check Upon Arrival (✓)
12.	*Nancy Shelton*	Jacobs	Compliance Lead	(602) 686-3237	Nancy.Shelton@jacobs.com	
13.	*William Shott*	NPS	Superintendent			
14.	Amy Hreibar					
15.	Mike Will					
16.	Bobby Bowring	Recapture Investment Group (Phil Lyman)	Accountant / Development	435-678-2411	Bobby@RIGUT.com	
17.	Tyson Kirk	RECAPTURE INVESTMENT GROUP	ACCOUNTANT/DEVELOPMENT	435-678-2411	Tyson@RIGUT.com	
18.	Ben Smith	~~Environmental protection~~ Specialist NPS	Environmental protection Specialist		Ben_Smith@NPS.gov	
19.						
20.						
21.						
22.						

Appendix B – Project Design Criteria

Jacobs

GLCA Launch Ramps Design Criteria

Date: March 3, 2022

I. Introduction

In partnership with the Park, and input from other stakeholders during early listening sessions, Jacobs developed site specific design criteria to address project needs for the launch ramp concept designs.

II. Design Standards

1. Codes
    a. Local Building Codes for Arizona and Utah
        i. 2018 International Building Code (IBC 2018)
        ii. Building Code requirements for Structural Concrete (ACI 318-14)
    b. Launch Ramp Materials
        i. Concrete – Building Code requirements for Structural Concrete (ACI 318-14)
        ii. Steel – American institute of Steel Construction Steel Manual (AISC-14)
    c. Ramp and Marina
        i. California Boat Launching Facilities – Design Handbook
        ii. UFC 4-152-07 Design: Small Craft Berthing Facilities
    d. Roads
        i. AASHTO Green Book (GDHS -7)
        ii. Park Road Standards – National Park Service 1984
2. Loads (Dead, Live, Snow and Wind)
    a. Seismic is not considered since for a slab on ground (without piles), the slab will move with the ground and there is not a structure period associated with it (different from pile-supported slab).
    b. However, seismic shear may need to be considered for the grade beams; further work required to confirm.
    c. Load combinations (per Table 5.3.1 of ACI 318-14)

IV. Environmental Conditions

1. Water level
    a. Current site water level is 3535 ft. (as of January 10, 2022)
    b. Existing ramps were designed for a water level between 3540 to 3580 ft.
    c. Design low water level for this project is 3450 ft.

2. Precipitation
    a. ASCE 7-16 Ice/Snow
3. Wind
    a. ASCE 7-16 Basic Wind Speed 120 mph based on a Risk Category of III or IV
    b. Wind is applied to the side of the large houseboat (described under the Vessels section for each site), which creates an overturning moment. This overturning moment is applied to the ramp as a compression load on the leeward side.
4. Atmospheric Conditions
    a. Atmospheric Conditions are derived from the following NOAA stations:
        i. BULLFROG BASIN, UT US – ID GHCND:USC00421020
        ii. Page, Page Municipal Airport (KPGA)

V. Bullfrog Site Design Criteria

1. Existing Public Ramp Geometry
    a. Existing Ramp– (Reference 3128 in NPS eTic Data). Main Boat ramp – 124 feet by 1,250 feet (running surface 110 feet wide), slope 9%. Low Water Boat ramp – 60 feet by 720 feet, slope 5.56%.
    b. Low Water Ramp Extension – ramp extended and expanded to be 150 feet by feet by 1,165 feet (reference 60024 in NPS eTic Data). Slope 9.6%.
2. New Ramp Location Siting and Geometry
    a. Bullfrog bay has very low water, siting will have to be closer to the main river channel within the bay or over to Stanton Creek site.
    b. Desired ramp width 150 feet, 5- to 30-foot-wide ramp lanes.
    c. Desired ramp slope is 10.5% in order to put in and take out larger houseboats.
    d. Top of slab elevation at bottom of ramp will be 3445 ft. and have a minimum of 5 ft of water.
    e. Two options have been considered:
        i. Combined high and low water ramp to go from Elevation 3700 to 3450.
        ii. Separate high and low water ramps. From Elevation 3700 to 3580 (existing ramp) and 3580 to 3450 (new ramp).
3. Vessels
    a. UDOT Ferry – Approximately 155 feet long, 50 feet wide and 8 feet draft.
    b. Large Houseboats – Up to 125 feet long, 22 feet wide, maximum of 5 feet draft, registered 250 Tons of displacement and 100 Tons of actual displacement as determined through engineering judgment.
    c. Small Recreational Craft

4. Vehicles
    a. Vehicle Types and Loads – Some of the large houseboats require multiple trucks or even tractor trailers, loading assumptions:
        i. Loading from large houseboat vessels is spread over enough axles to make it road legal
        ii. Loading assumed in structural model is a variation on HS-20 loading condition with a houseboat trailer attached. This critical loading condition consists of a 6-axle vehicle with a 16-kip front axle (Axle 1), followed by a 32-kip axle (Axle 2) set back 14 feet on center from Axle 1, followed by four 32-kip tandem axles (Axles 3 through 6) with the first setback 30 feet on center from Axle 2 and each subsequent tandem axle spaced 4 feet on center axle to axle.
5. Gangways
    a. CSA 46 Boarding Floats and Gangways (Reference 70383 in NPS eTic Data)
        i. Loading floats 114-foot-long, Gangway 40-foot-long.
    b. Ramp utilizes UDOT Ferry Gangways/Floats – Wedges are 22 feet wide
6. Marina
    a. Requested minimum water depth – 20 feet, but it has been stated that the concessionaire could operate in 10 feet of water, or even as little as 6 feet of water as an extreme scenario.
    b. The intent of the concept design has been to replace the marina in-kind. Jacobs has proposed a relocation location for each of the two Bullfrog concept options, both allowing for a minimum of 20 feet of water. The marina will need to be reconfigured to fit in the desired new footprint, but the number of slips and docking areas remains the same as the existing marina.
    c. Phasing/Temporary storage – Jacobs has identified an intermediate marina location. This intermediate move provides a temporary location for the marina to be located entirely within the 3,495-foot water elevation contour. It is anticipated that this temporary relocation could be used down to water elevation of 3505 feet, which allows for a minimum of 10 feet of water depth.
7. Roadways, Parking and Turnaround
    a. Siting and Access, provide access from existing facilities and road to Stanton creek site.
    b. Roadway classification: Class II - Connector Park Road.
    c. Terrain – rolling to mountainous.
    d. Existing access road has posted speed of 35 mph. Design speed = 40 mph
    e. Design Volume – unknown.

f. Cross Section: Two 11 ft lanes with 3 ft shoulders are the minimum width requirements for the access road. The existing Bullfrog access road consists of two 12 ft lanes with 6 ft paved shoulders.
g. 9% max grade for the access road (based on design speed of 40 mph and rolling terrain, 12% max grade for mountainous)
h. Minimum curve radius 573 ft (max superelevation 0.04 ft/ft)
i. A primitive dirt/gravel parking lot will be required, size requirements need to be determined but current design is to provide the same area currently at the existing Bullfrog ramp.
j. Design Vehicle is WB-67
k. Minimum Turning radius 46.3 feet.

8. Geotechnical conditions
    a. Geotechnical investigations are being planned, and data shall be incorporated in the next phase of design.
    b. Currently assumed to be a stiff rock subgrade.
    c. Assumed cut and fill slopes of 1:2 (V:H).
9. Utilities – The concept design currently assumes the need for potable water, sewer, electric, and communications, this shall be further evaluated in the next phase of design.

VI. Halls Crossing Site Design Criteria

1. Ramp Geometry:
    a. Existing - 2 sections, Section 1 - 60 feet by 1, 500 feet boat ramp with a 44 feet by 330 feet approach road and 200 feet by 400 feet Parking Lot. Section 2 - 60 feet by 1,100 feet boat ramp. Sections one and two are side by side from Sta. 0+00 to 11+00. Station 0+00 is at the start of the boat ramp. Parking Lot 200 feet by 400 feet.
    b. Existing Ramp Extension – Reference 60009 in NPS eTic Data. 300 feet inland extension to replace approach road.
        i. Slope of existing approximately 10.67 percent.
2. Ramp Locations/Siting
    a. Desired ramp width 150 feet, 5- to 30-foot-wide ramp lanes.
    b. Desired ramp slope is 10.5% in order to put in and take out larger houseboats.
    c. Top of slab elevation at bottom of ramp will be 3445 ft. and have a minimum of 5 ft of water.
    d. Two options primary options have been considered:
        i. Regrading, extension, and expansion of the current Halls crossing ramp to accommodate the new design water line.
        ii. Evaluate regarding the Ferry Ramp and turning into a mixed-use ramp. This is not feasible.

3. Vessels
    a. UDOT Ferry – Approximately 155-foot-long, 50-foot-wide and 8 feet draft.
    b. Large Houseboats – Up to 125-foot-long, 22 feet wide, maximum of 5 feet draft, registered 250 Tons of displacement and 100 Tons of actual displacement as determined through engineering judgment.
    c. Small Recreational Craft
4. Vehicles
    a. Vehicle Types and Loads – Some of the large houseboats require multiple trucks or even tractor trailers, assumptions:
        i. Loading from large houseboat vessels is spread over enough axles to make it road legal
        ii. Loading assumed in structural model is a variation on HS-20 loading condition with a houseboat trailer attached. This critical loading condition consists of a 6-axle vehicle with a 16-kip front axle (Axle 1), followed by a 32-kip axle (Axle 2) set back 14 feet on center from Axle 1, followed by four 32-kip tandem axles (Axles 3 through 6) with the first setback 30 feet on center from Axle 2 and each subsequent tandem axle spaced 4 feet on center axle to axle.
10. Gangways
    a. CSA 46 Boarding Floats and Gangways (Reference 70383)
        i. Loading floats 114-foot-long, Gangway 40-foot-long, Water depth approximately 15 feet at end of loading ramp.
    b. Ramp utilizes UDOT Ferry Gangways/Floats – Wedges are 22-foot-wide
11. Geotechnical conditions
    a. Geotechnical investigations are being planned, and data shall be incorporated in the next phase of design.
    b. Currently assumed to be a stiff rock subgrade.
    c. Assumed cut and fill slopes of 1:2 (V:H).
12. Utilities – The concept design currently assumes the need for electric and communications, this shall be further evaluated in the next phase of design.

VII. Antelope Point Site Design Criteria

1. Ramp Geometry: Width, extension into water
    a. Existing – Ramp width 120 feet by 900 feet, Reference 60057 in NPS eTic Data
    b. Existing Concessionaire ramp - Reference 140655 in NPS eTic Data
2. Ramp Locations/Siting
    a. Look into regarding the existing ramp and incorporating kayak and valet lanes or spurs.
    b. Desired ramp width 150 feet.
    c. Top of slab elevation at bottom of ramp will be 3,445 feet. and have a minimum of 5 feet of water.

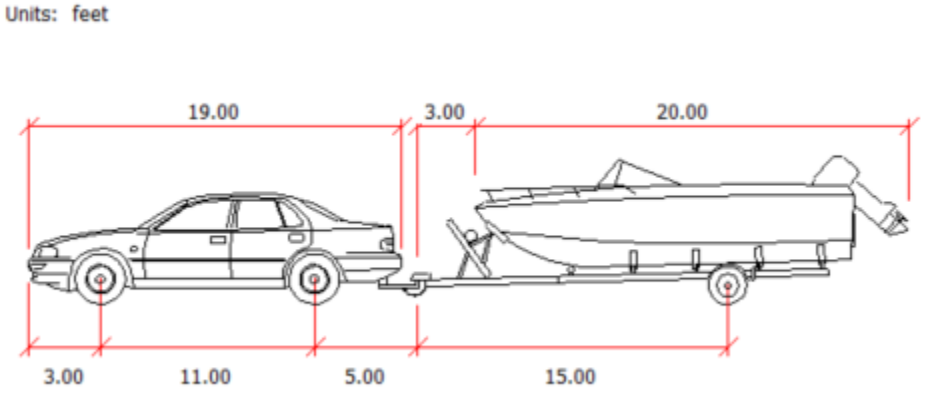
3. Vessels
    a. Large Houseboats – Up to 125-foot-long, 22-foot-wide, maximum of 5 feet draft, registered 250 Tons of displacement and 100 Tons of actual displacement as determined through engineering judgment.
    b. Small Recreational Craft
4. Vehicles
    a. Vehicle Types and Loads – Some of the large houseboats require multiple trucks or even tractor trailers, assumptions:
        i. Loading from large houseboat vessels is spread over enough axles to make it road legal
        ii. Loading assumed in structural model is a variation on HS-20 loading condition with a houseboat trailer attached. This critical loading condition consists of a 6-axle vehicle with a 16-kip front axle (Axle 1), followed by a 32-kip axle (Axle 2) set back 14 feet on center from Axle 1, followed by four 32-kip tandem axles (Axles 3 through 6) with the first setback 30 feet on center from Axle 2 and each subsequent tandem axle spaced 4 feet on center axle to axle.
13. Gangways
    a. CSA 46 Boarding Floats and Gangways (Reference 70383 in NPS eTic Data)
        i. Loading floats 114-foot-long, Gangway 40-foot-long.
14. Geotechnical conditions
    a. Geotechnical investigations are being planned, and data shall be incorporated in the next phase of design.
    b. Currently assumed to be a stiff rock subgrade.
    c. Assumed cut slope is 1:1 (V:H) and assumed fill slope is 1:2 (V:H).
15. Utilities – The concept design currently assumes the need for electric and communications, this shall be further evaluated in the next phase of design.

VIII. Hite Site Design Criteria

1. Summarized below are the anticipated Hite Design Criterion for a concept level design. To this point, Jacobs has only conducted a feasibility analysis, summarized in the Hite River Access Analysis Technical Memorandum. The below design criteria are subject to further discussion and evaluation once the Hite concept design is initiated.
2. Launch Ramp
    a. Ramp Width – 35 feet wide
    b. 3.5 ft min depth at the boat ramp during the operational season from spring through fall for J-boats. If this is not feasible, NPS has stated that a staging area for concessionaires to disassemble J-boats, load and haul away would be acceptable.

c. From design guides, a 12 to 15% ramp slope is preferred, with 14% being the optimal slope for small crafts. Other sites have utilized a slope as low as 10.5% to allow for retrieval of large houseboats. Ramp slope needs would be evaluated further in the concept design.

3. Access Road and Parking lot
   a. Siting and Access, provide access from existing facilities and road to new Hite Take out site.
   b. Roadway classification: Class IV - Primitive Park Road.
      i. Per NPS Park Road Standards, “these roads frequently have no minimum design standards and their use may be limited to specially equipped vehicles”.
      ii. Design to be based on accommodating Ford F350 pickup truck. Use of road will be for launch and take-out of-J boats.
   c. Terrain – rolling to mountainous.
   d. Design Volume – unknown, assume <50 vehicles per day.
   e. Cross Section: 18 feet wide roadway with roadside ditches in cut sections. Design Assumptions: road will primarily be used for one way traffic, but allows width for two-way traffic needed. Note: Ditch capacity needed unknown. Roadside ditches were modeled with 2 feet bottom width and 4:1 side slopes.
   f. Design Vehicle used: AASHTO P-B (passenger vehicle towing boat). Overall vehicle length 42 ft



   g. Minimum Turning radius 24 feet.
   h. Minimum curve radius 50 ft (based on design speed of 15 mph and Auto turn modeling of design vehicle P-B)
   i. Access road has a max grade of 12% (for design speed of 15 mph, rolling terrain = 11% max, mountainous terrain = 17% max)
   j. Roadway surface: gravel

4. Geotechnical conditions

a. No investigations currently planned, to be planned and conducted in concept design.
b. Currently assumed to be a stiff rock subgrade.

Appendix C – Site Visit Photos

Jacobs

GLCA Site Visit Photo Log

Photos

Photo 1: View looking down the existing Bullfrog public ramp showing the ramp and temporary spur no longer reaching the lake water level. (Photo taken 11/17/2021).

Photo 2: View of the Marina and current access to the Marina at Bullfrog Basin; Utility floats are no longer connected to the land and the utilities are now draped over the natural landscape. (Photo taken 11/17/2021).

Photo 3: View of the Stanton Creek area of Bullfrog Basin, which is being considered as a location for a future launch ramp. (Photo taken 11/17/2021).

Photo 4: Lakeside view of the Halls Crossing Public Ramp. (Photo taken 11/17/2021).

Photo 5: View of end of Halls Crossing public ramp showing that the ramp no longer reaches the lake elevation. (Photo taken 11/17/2021).

Photo 6: View of the end of the Antelope public ramp, showing that the lake level is significantly below the toe of the launch ramp. (Photo taken 11/16/2021).

Photo 7: View of the End of the Antelope business ramp, showing the steep side slopes and marina slips beyond. (Photo taken 11/16/2021).

Photo 8: View of the existing and functionally obsolete Hite public ramp. This ramp is approximately 2000 feet away from the current river edge to the right of the photo. (Photo taken 11/18/2021).

Photo 9: View down the Dirty Devil Confluence at Hite, a source of significant river sediment. (Photo taken 11/18/2021).

Photo 10: View of the Hite Bridge, locations near here are being considered for concept evaluation. (Photo taken 11/18/2021).

Appendix D – Topobathymetric LiDAR Report

NV5 GEOSPATIAL
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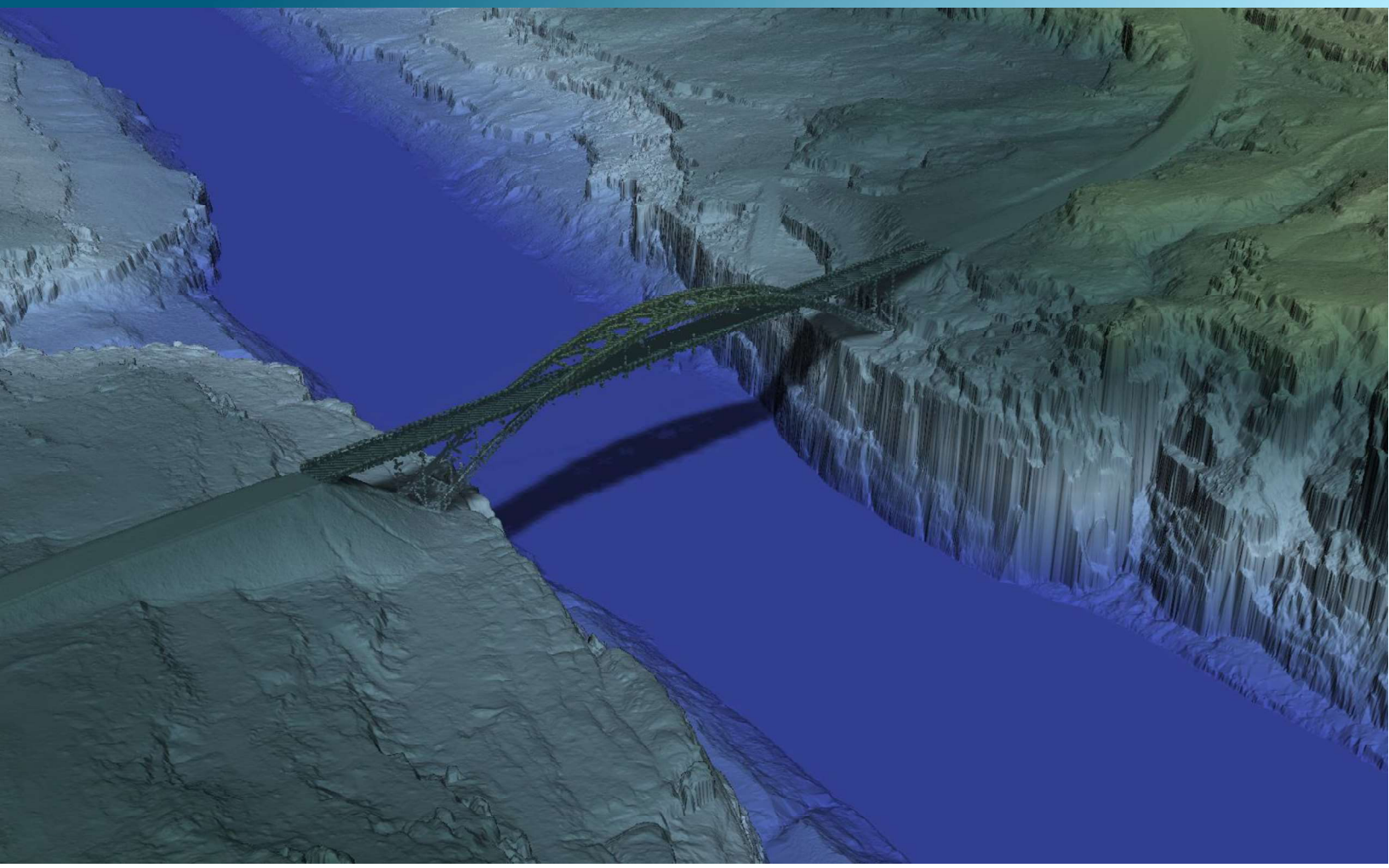
January 27, 2022



Lake Powell, Arizona and Utah

Topobathymetric Lidar Technical Data Report

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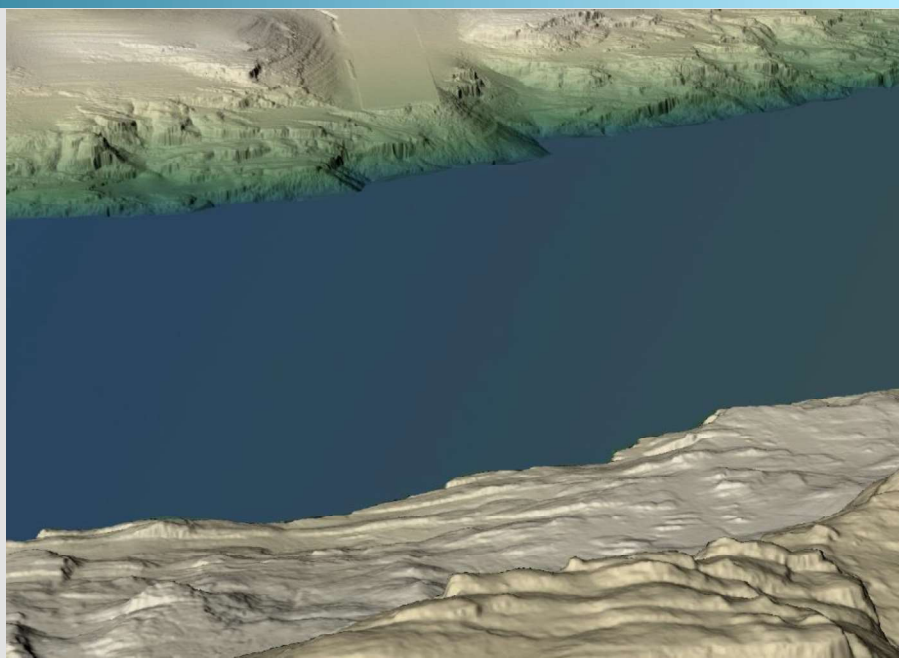
Cover Photo: A view looking southwest towards the Hite Crossing Bridge over the Colorado River. The image was created from the lidar bare earth model colored by elevation and overlayed with the above ground point cloud points making up the bridge feature.

INTRODUCTION

This image shows a south view towards the boat launch ramp in the Antelope Point project area. The image was created from the lidar bare earth model colored by elevation.



In October 2021, NV5 Geospatial (NV5) was contracted by Jacobs Engineering (Jacobs) to collect topobathymetric Light Detection and Ranging (lidar) data and digital imagery in the fall of 2021 for three boat launch ramp sites on Lake Powell in Arizona and Utah; Hite, Bullfrog, and Antelope Point. Traditional near-infrared (NIR) lidar was fully integrated with green wavelength return data (bathymetric) lidar in order to provide a seamless topobathymetric lidar dataset. Data were collected to aid Jacobs in assessing the topobathymetric surface of the study area to support engineering projects along Lake Powell and the Colorado River.

This report accompanies the delivered topobathymetric lidar data and imagery, and documents contract specifications, data acquisition procedures, processing methods, and analysis of the final dataset including lidar accuracy, and density. Acquisition dates and acreage are shown in Table 1, a complete list of contracted deliverables provided to Jacobs is shown in Table 2, and the project extent is shown in Figure 1.

Table 1: Acquisition dates, acreage, and data types collected on the Lake Powell site

Project Site	Contracted Acres	Buffered Acres	Acquisition Dates	Data Type
Lake Powell, Arizona and Utah	13,390	14,517	10/24/2021 – 10/25/2021	Topobathymetric Lidar
			10/25/2021	3 band (RGB) Digital Imagery

Deliverable Products

Table 2: Products delivered to Jacobs for the Lake Powell site

Lake Powell Lidar Products Projection: UTM Zone 12 North Horizontal Datum: NAD83 (2011) Vertical Datum: NAVD88 (GEOID18) Units: US Survey Feet	
Topobathymetric Lidar	
Points	LAS v 1.4 • All Classified Returns
Rasters	3.0 foot ESRI Grids • Void Clipped Topobathymetric Bare Earth Digital Elevation Model (DEM) • Highest Hit Digital Surface Model (DSM) 1.5 foot GeoTiffs • Green Sensor Intensity Images • NIR Sensor Intensity Images
Vectors	Shapefiles (*.shp) • Project boundary • LIdar/Photo Tile Index • Waters Edge Breaklines • Bathymetric Coverage Polygon
3 Band (RGB) Digital Imagery	
Rasters	3 inch GeoTiffs • Tiled Imagery Mosaics (RGB) 3 inch ECW Compression • AOI Imagery Mosaic (RGB)
Vectors	Shapefiles (*.shp) • Camera Exterior Orientations • Air Target Points

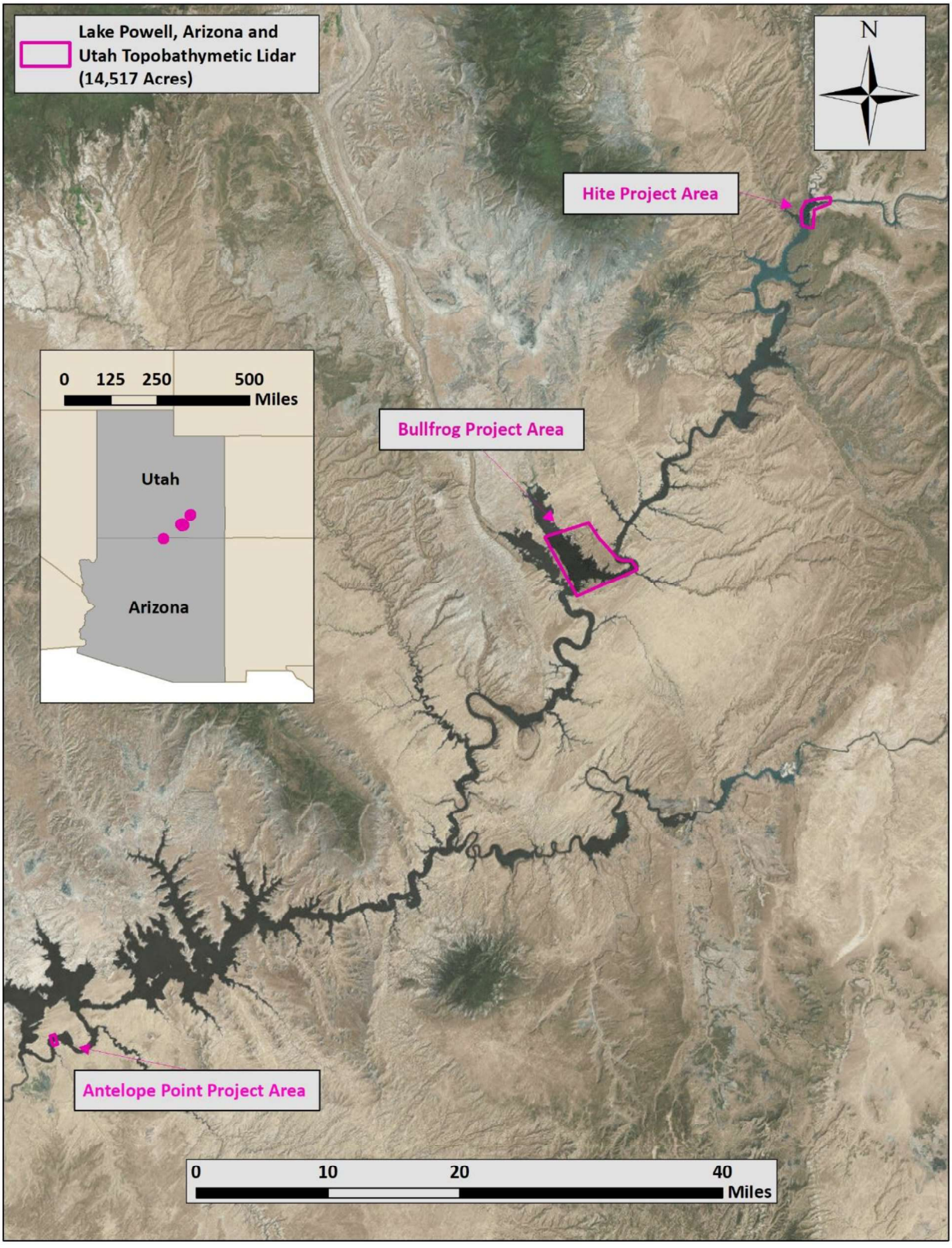
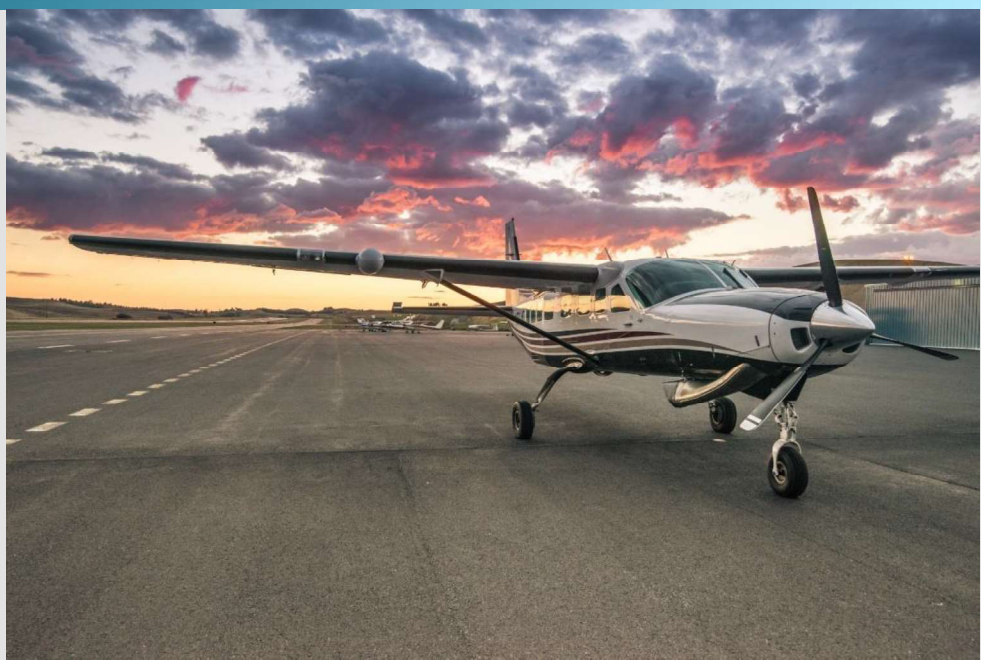


Figure 1: Location map of the Lake Powell site in Arizona and Utah

ACQUISITION

NV5's Cessna Caravan



Planning

In preparation for data collection, NV5 reviewed the project area and developed a specialized flight plan to ensure complete coverage of the Lake Powell Lidar study area at the target combined point density of ≥8 points/m^2. Acquisition parameters including orientation relative to terrain, flight altitude, pulse rate, scan angle, and ground speed were adapted to optimize flight paths and flight times while meeting all contract specifications.

Factors such as satellite constellation availability and weather windows must be considered during the planning stage. Any weather hazards or conditions affecting the flight were continuously monitored due to their potential impact on the daily success of airborne and ground operations. In addition, logistical considerations including private property access and potential air space restrictions were reviewed.

Airborne Survey

Lidar

The lidar survey was accomplished using a Riegl VQ-880-GII green laser system mounted in a Cessna Caravan. The Riegl VQ-880-GII has a higher pulse rate (up to 550 kHz), higher scanning speed, small laser footprint, and wide field of view which allows for seamless collection of high resolution data of both topographic and bathymetric surfaces. The green wavelength (ʎ=532 nm) laser is capable of collecting high resolution topography data, as well as penetrating the water surface with minimal spectral absorption by water. The Riegl VQ-880-GII contains an integrated NIR laser (ʎ=1064 nm) that adds additional topography data and aids in water surface modeling. The recorded waveform enables range measurements for all discernible targets for a given pulse. The typical number of returns digitized from a single pulse range from 1 to 8 for the Lake Powell project area. It is not uncommon for some types of surfaces (e.g., dense vegetation or water) to return fewer pulses to the lidar sensor than the laser originally emitted. The discrepancy between first return and overall delivered density will vary depending on terrain, land cover, and the prevalence of water bodies. All discernible laser returns were processed for the output dataset. Table 3 summarizes the settings used to yield an average pulse density of ≥8 pulses/m^2 over the Lake Powell project area.

Table 3: Lidar specifications and survey settings

Lidar Survey Settings & Specifications		
Acquisition Dates	10/24/2021 – 10/25/2021	10/24/2021 – 10/25/2021
Aircraft Used	Cessna Caravan	Cessna Caravan
Sensor	Riegl	Riegl
Laser	VQ-880-GII-G	VQ-880-GII-IR
Maximum Returns	8	8
Resolution/Density	Average 8 pulses/m^2	Average 8 pulses/m^2
Nominal Pulse Spacing	0.35m	0.35m
Survey Altitude (AGL)	400 m	400 m
Survey speed	145 knots	145 knots
Field of View	40°	42°
Mirror Scan Rate	80 Lines Per Second	Uniform Point Spacing
Target Pulse Rate	200 kHz	300 kHz
Pulse Length	1.5 ns	3 ns
Laser Pulse Footprint Diameter	28 cm	8 cm
Central Wavelength	532 nm	1064 nm
Pulse Mode	Multiple Times Around (MTA)	Multiple Times Around (MTA)
Beam Divergence	0.7 mrad	0.2 mrad
Swath Width	291 m	307 m
Swath Overlap	60 %	60 %
Intensity	16-bit	16-bit
Accuracy	$RMSE_Z \leq 15$ cm	$RMSE_Z \leq 15$ cm

All areas were surveyed with an opposing flight line side-lap of ≥50% (≥100% overlap) in order to reduce laser shadowing and increase surface laser painting. To accurately solve for laser point position (geographic coordinates x, y and z), the positional coordinates of the airborne sensor and the attitude of the aircraft were recorded continuously throughout the lidar data collection mission. Position of the aircraft was measured twice per second (2 Hz) by an onboard differential GPS unit, and aircraft attitude was measured 200 times per second (200 Hz) as pitch, roll and yaw (heading) from an onboard inertial measurement unit (IMU). To allow for post-processing correction and calibration, aircraft and sensor position and attitude data are indexed by GPS time.

Digital Imagery

Aerial imagery was co-acquired (with the lidar) using a PhaseOne iXM-RS100F digital camera (Table 4). The PhaseOne is a medium format aerial mapping camera which collects imagery in three spectral bands (Red, Green, Blue).

Table 4: Camera manufacturer's specifications

PhaseOne iXM-RS100F	
Focal Length	70 mm
Spectral Bands	Red, Green, Blue
Pixel Size	4.6 µm
Image Size	11,608 x 8,708 pixels
Frame Rate	GPS triggered
FOV	42° x 32°
Date Format	8bit TIFF

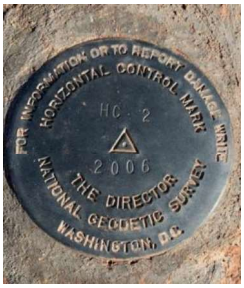
For the Lake Powell site, 664 images were collected with 60% along track overlap and 30% sidelap between frames. The acquisition flight parameters were designed to yield a native pixel resolution of ≤ 0.25 ft. Orthophoto specifications particular to the Lake Powell project are in Table 5.

Table 5: Project-specific orthophoto specifications

Digital Orthophotography Specifications	
Ground Sampling Distance (GSD)	≤ 0.25 ft pixel size
Along Track Overlap	≥60%
Cross Track Overlap	≥30%
Height Above Ground Level (AGL)	1,000 m
GPS PDOP	≤3.0
GPS Satellite Constellation	≥6

Ground Survey

Ground control surveys, including monumentation, aerial targets, and ground survey points (GSPs) were carried out by Jacobs to support NV5 Geospatial's airborne acquisition. Ground control data were used to geospatially correct the aircraft positional coordinate data and to perform quality assurance and accuracy assesments on final lidar data and orthoimagery products.



Existing NGS Monument

Base Stations

Jacobs occupied ten base stations to support the Lake Powell project. Base station locations were selected with consideration for satellite visibility, field crew safety, and optimal location for GSP coverage. (Table 6, Figure 2)

Table 6: Monument positions for the Lake Powell acquisition. Coordinates are on the NAD83 (2011) datum, epoch 2010.00

Monument ID	Latitude	Longitude	Ellipsoid (meters)
200	36° 57′ 27.57264″	-111° 26′ 13.86087″	1118.585
201	36° 57′ 00.69839″	-111° 25′ 41.60834″	1123.667
BEEHIVE SOUTH BASE	36° 56′ 55.82367″	-111° 30′ 28.00756″	1244.453
BF 1	37° 30′ 42.06015″	-110° 43′ 05.23097″	1108.963
E 78	36° 56′ 17.01085″	-111° 28′ 45.51352″	1134.862
GCNRA	36° 55′ 32.56714″	-111° 28′ 41.51596″	1163.691
HC 2	37° 27′ 51.25336″	-110° 42′ 53.06979″	1117.939
HITE 1	37° 52′ 24.71992″	-110° 23 40.91703″	1112.696
HITE 2	37° 52′ 38.52628″	-110° 23′ 10.06192″	1158.999
HITE 3	37° 52′ 39.37209″	-110° 22′ 53.30451″	1178.930

Air Targets

Air target points (ATP) were collected, by Jacobs, throughout the project area prior to imagery acquisition to refine the exterior orientation parameters of the camera and conduct an accuracy assessment of the final orthophoto product.

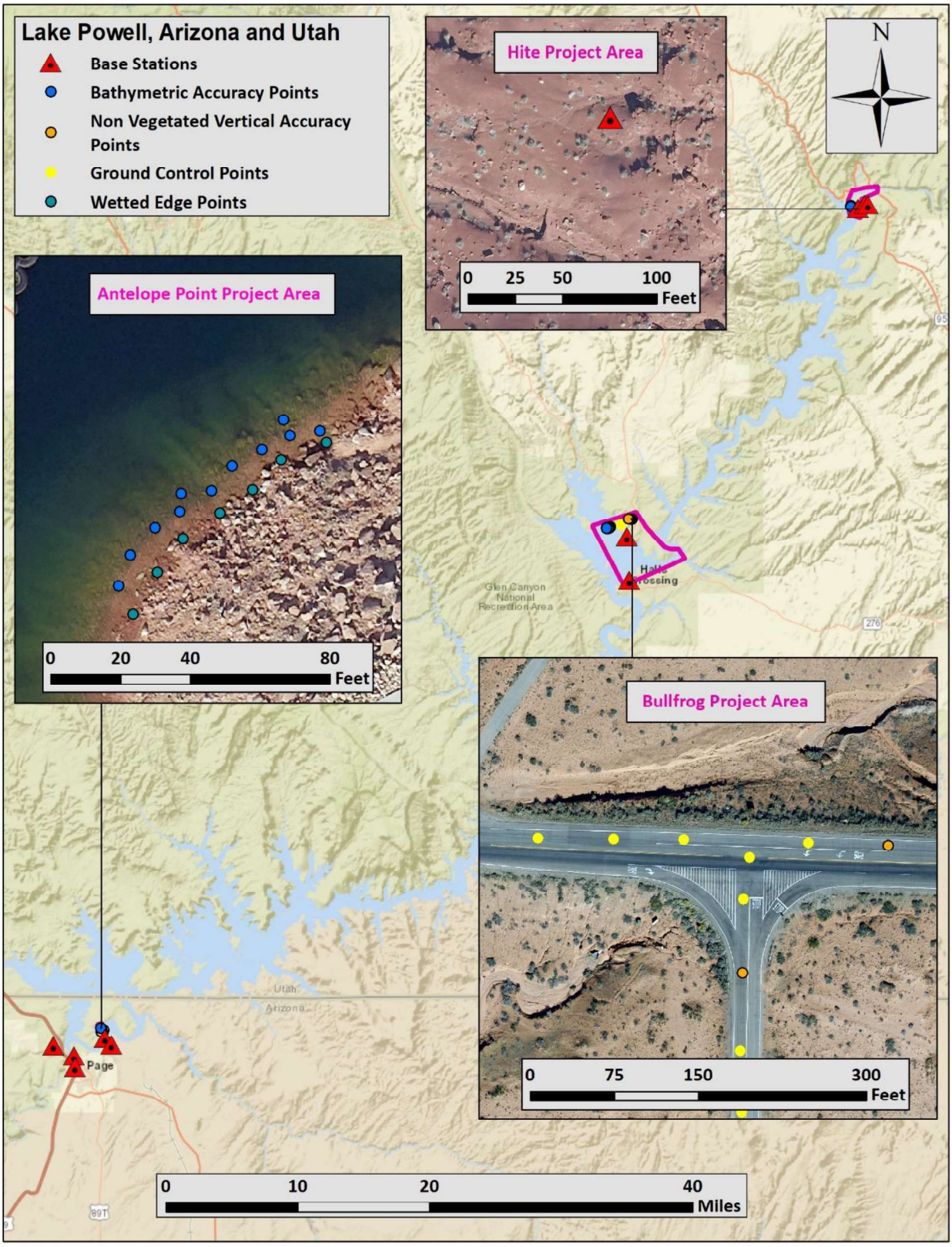
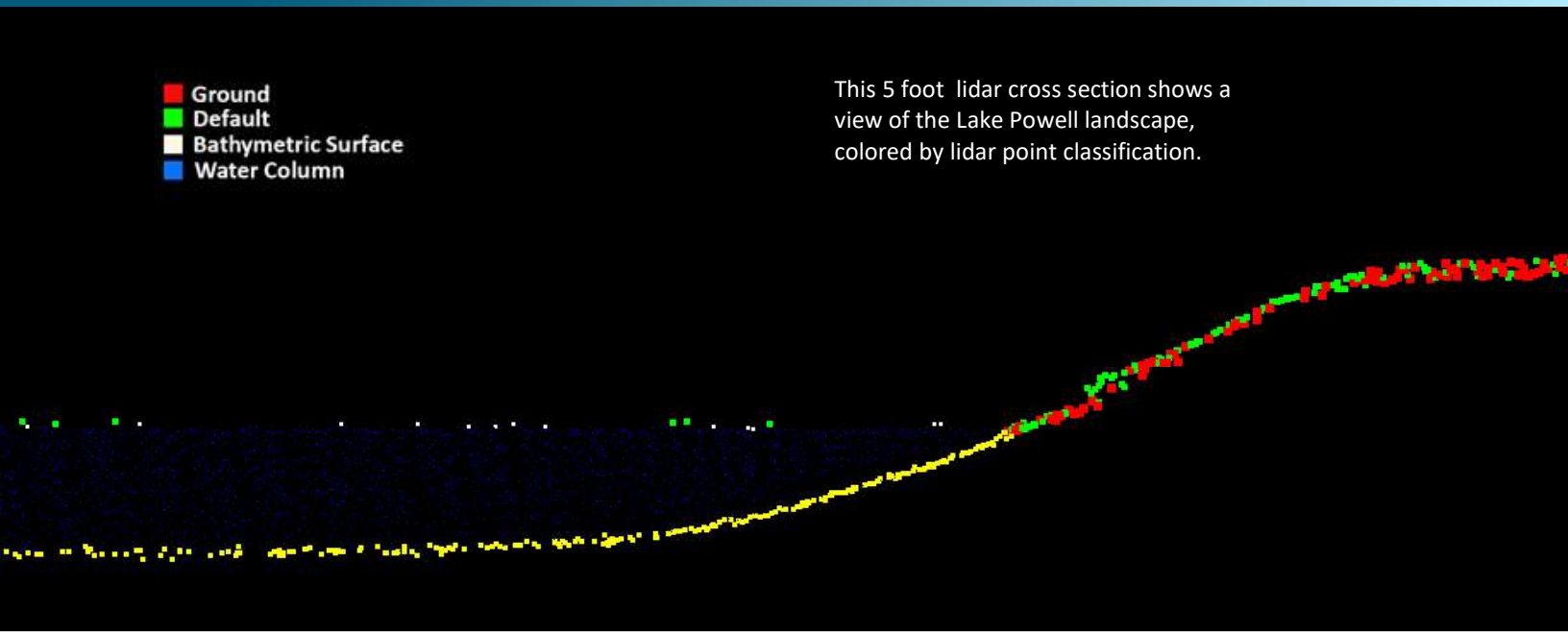


Figure 2: Ground survey location map



This 5 foot lidar cross section shows a view of the Lake Powell landscape, colored by lidar point classification.

Topobathymetric Lidar Data

Upon completion of data acquisition, NV5 processing staff initiated a suite of automated and manual techniques to process the data into the requested deliverables. Processing tasks included GPS control computations, smoothed best estimate trajectory (SBET) calculations, kinematic corrections, calculation of laser point position, sensor and data calibration for optimal relative and absolute accuracy, and lidar point classification (Table 7).

Riegl's RiProcess software was used to facilitate bathymetric return processing. Once bathymetric points were differentiated, they were spatially corrected for refraction through the water column based on the angle of incidence of the laser. NV5 refracted water column points using NV5's proprietary LAS processing software, Las Monkey. The resulting point cloud data was classified using both manual and automated techniques. Processing methodologies were tailored for the landscape. Brief descriptions of these tasks are shown in Table 8.

Table 7: ASPRS LAS classification standards applied to the Lake Powell dataset

Classification Number	Classification Name	Classification Description
1	Default/Unclassified	Laser returns that are not included in the ground class, composed of vegetation and anthropogenic features
2	Ground	Laser returns that are determined to be ground using automated and manual cleaning algorithms
9	Water	Laser returns that are determined to be water using automated and manual cleaning algorithms
40	Bathymetric Bottom	Refracted green laser returns that fall within the water's edge breakline which characterize the submerged topography.
41	Water Surface	Green laser returns that are determined to be water surface points using automated and manual cleaning algorithms.
45	Water Column	Refracted green laser returns that are determined to be water using automated and manual cleaning algorithms.

Table 8: Lidar processing workflow

Lidar Processing Step	Software Used
Resolve kinematic corrections for aircraft position data using kinematic aircraft GPS, static ground GPS data, and Applanix PPRTX data. Develop a smoothed best estimate of trajectory (SBET) file that blends post-processed aircraft position with sensor head position and attitude recorded throughout the survey.	POSPac MMS v.8.5 Pofimport v.1.7.4
Calculate laser point position by associating SBET position to each laser point return time, scan angle, intensity, etc. Create raw laser point cloud data for the entire survey in *.las (ASPRS v. 1.2) format. Convert data to orthometric elevations by applying a geoid correction.	Georun v.6.1.1 TerraMatch v.19
Using ground classified points per each flight line, test the relative accuracy. Perform automated line-to-line calibrations for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift. Calculate calibrations on ground classified points from paired flight lines and apply results to all points in a flight line. Use every flight line for relative accuracy calibration.	BayesMap-StripAlign v.2.19
Apply refraction correction to all subsurface returns.	Las Monkey 2.4 (NV5 proprietary software)
Import calibrated points in manageable blocks for editing.	TerraScan v.19
Classify resulting data to ground and other client designated ASPRS classifications (Table 7). Assess statistical absolute accuracy via direct comparisons of ground classified points to ground control survey data.	TerraScan v.19 TerraModeler v.19
Generate bare earth models as triangulated surfaces. Generate highest hit models as a surface expression of all classified points. Export all surface models as ESRI GRIDs at a 3.0 foot pixel resolution.	Las Product Creator 3.0 (NV5 proprietary software) ArcMap v. 10.8.1
Export intensity images as GeoTIFFs at a 1.5 foot pixel resolution.	ArcMap v. 10.8.1 Las Product Creator 3.0 (NV5 proprietary software)

Bathymetric Refraction

Green lidar pulses that enter the water column must have their position corrected for refraction of the light beam as it passes through the water and its resulting decreased speed. NV5 has developed proprietary software (Las Monkey) to perform this processing based on Snell's law. The first step is to develop a water surface model (WSM) from the NIR lidar water surface returns. The water surface model used for refraction is generated using NIR points within the breaklines defining the water's edge. Points are filtered and edited to obtain the most accurate representation of the water surface and are used to create a water surface model TIN. A TIN model is preferable to a raster based water surface model to obtain the most accurate angle of incidence during refraction.

Once the WSM is generated, the Las Monkey refraction software then intersects the partially submerged green pulses with the WSM to determine the angle of incidence with the water surface and the submerged component of the pulse vector. This provides the information necessary to correct the position of underwater points by adjusting the submerged vector length and orientation. After refraction, the points are compared against bathymetric check points to assess accuracy.

Lidar Derived Products

Because hydrographic laser scanners penetrate the water surface to map submerged topography, this affects how the data should be processed and presented in derived products from the lidar point cloud. The following discusses certain derived products that vary from the traditional (NIR) specification and delivery format.

Topobathymetric DEMs

Bathymetric bottom returns can be limited by depth, water clarity, and bottom surface reflectivity. Water clarity and turbidity affects the depth penetration capability of the green wavelength laser with returning laser energy diminishing by scattering throughout the water column. Additionally, the bottom surface must be reflective enough to return remaining laser energy back to the sensor at a detectable level. Although the predicted depth penetration range of the Riegl VQ-880-GII sensor is 1.5 Secchi depths on brightly reflective surfaces, it is not unexpected to have no bathymetric bottom returns in turbid or non-reflective areas. To assist in evaluating performance results of the sensor, a polygon layer was created to delineate areas where bathymetry was successfully mapped.

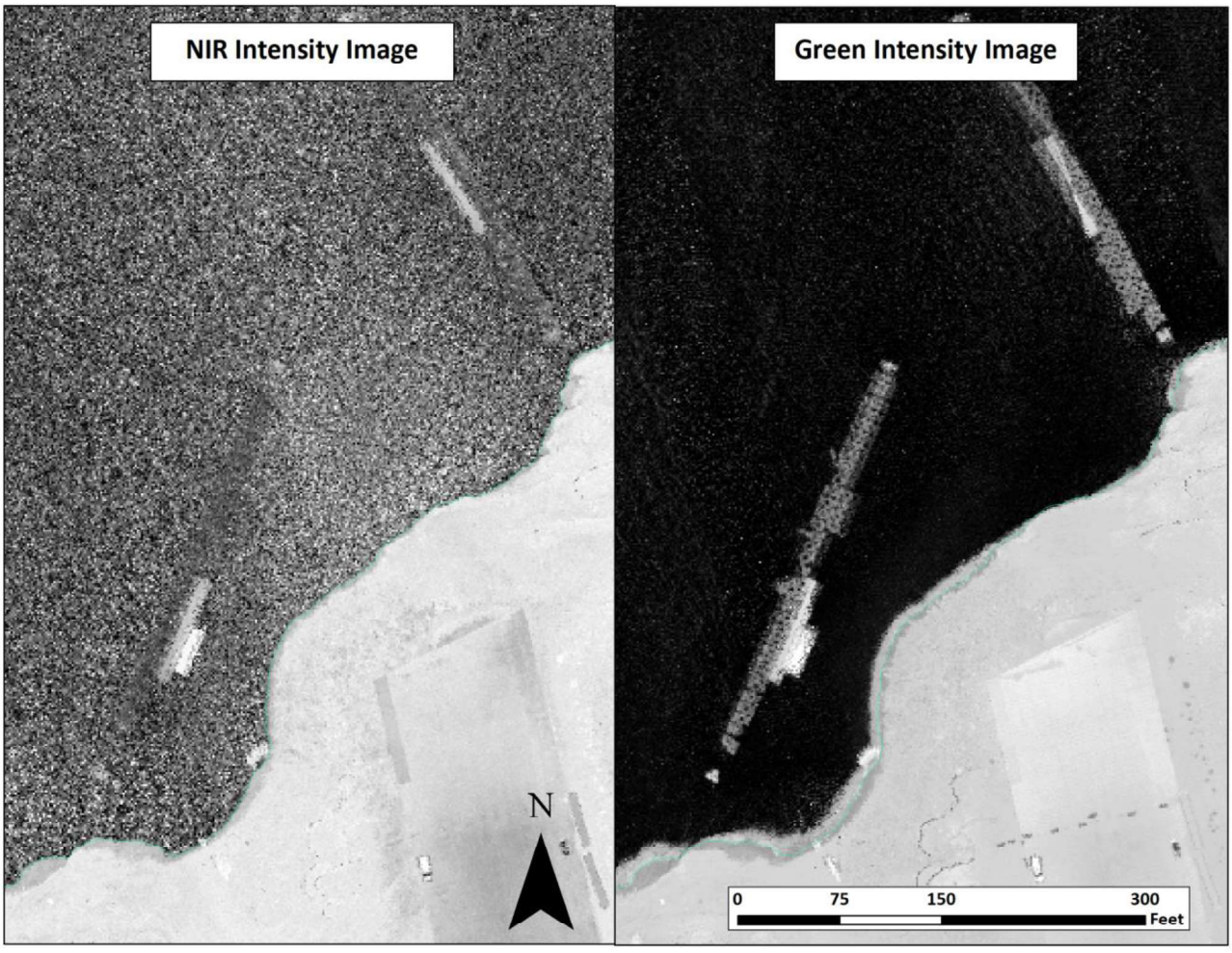
As a result, creating digital elevation models (DEMs) presents a challenge with respect to interpolation of areas with no returns. Traditional DEMs are "unclipped", meaning areas lacking ground returns are interpolated from neighboring ground returns, with the assumption that the interpolation is close to reality. In bathymetric modeling, these assumptions are prone to error because a lack of bathymetric returns can indicate a change in elevation that the laser can no longer map due to increased depths. The resulting void areas may suggest greater depths, rather than similar elevations from neighboring bathymetric bottom returns. Therefore, NV5 created a water polygon with bathymetric coverage to delineate areas with successfully mapped bathymetry. This shapefile was used to control the extent of the delivered clipped topobathymetric model to avoid false triangulation (interpolation from TIN'ing) across areas in the water with no bathymetric returns. In the case of the Lake Powell project, NV5 only delivered the "clipped" versions of the topobathymetric models to avoid providing Jacobs with large tinning artifacts in the ground and topobathymetric model.

Intensity Images

In traditional NIR lidar, intensity images are often made using first return information. For bathymetric lidar however, it is most often the last returns that capture features of interest below the water's surface. Therefore, a first return intensity image would display intensity information of the water's surface, obscuring the features of interest below.

With bathymetric lidar a more detailed and informative intensity image can be created by using all or selected point classes, rather than relying on return number alone. If intensity information of the bathymetry is the primary goal, water surface and water column points can be excluded. However, water surface and water column points often contain potentially useful information about turbidity and submerged but unclassified features such as vegetation. For the Lake Powell project, NV5 created one set of intensity images from all NIR laser first returns, as well as one set of intensity images from all green laser returns, in order to display more detail in intensity values (Figure 3).

Figure 3: A comparison of Intensity Images from Green and NIR returns in the Lake Powell area



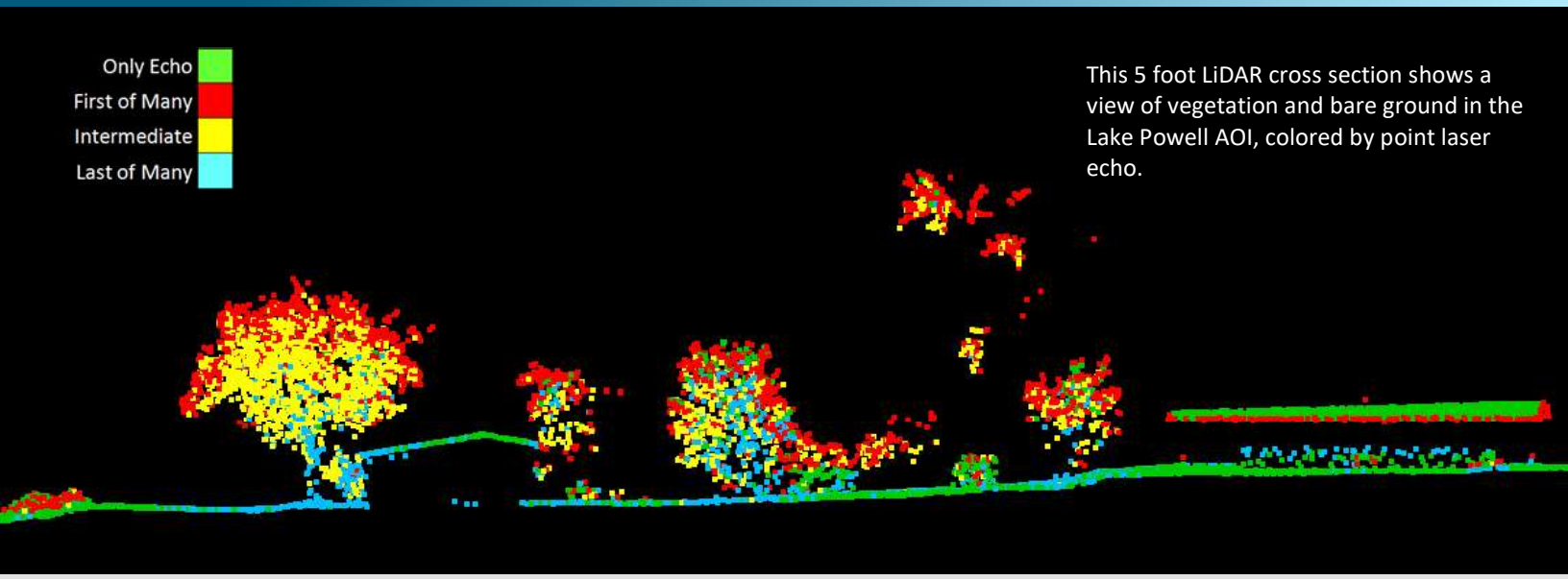
Digital Imagery

As with the lidar, the collected digital photographs went through multiple processing steps to create final orthophoto products. Initially, raw PhaseOne images were converted to geometrically corrected Tiff images using camera calibration parameters. Photo position and orientation were then calculated by linking the time of image capture to the smoothed best estimate of trajectory (SBET) file created during lidar post-processing. Within Inpho Match AT, an automated aerial triangulation was performed to tie images together and adjust the photo block to align with ground control.

Adjusted images were orthorectified using the lidar-derived bare earth model to remove displacement effects from topographic relief inherent in the imagery. Automated seamlines were generated for the orthorectified images using feature detection techniques to avoid cutlines through objects found in image overlap areas. The final mosaics were corrected for any remaining radiometric differences between images using Inpho's OrthoVista. The processing workflow for orthophotos is summarized in Table 9.

Table 9: Orthophoto processing workflow

Orthophoto Processing Step	Software Used
Resolve GPS kinematic corrections for the aircraft position data using kinematic aircraft GPS (collected at 2 Hz) and Applanix PPRTX data.	POSPac MMS v.8.5
Develop a smooth best estimate trajectory (SBET) file that blends post-processed aircraft position with attitude data. Sensor heading, position, and attitude are calculated throughout the survey.	POSPac MMS v.8.5
Create an exterior orientation file (EO) for each photo image with omega, phi, and kappa.	POSPac MMS v.8.5
Convert raw imagery data into geometrically corrected Tiff image files.	iX Capture v.3.4
Apply EO to photos, measure ground control points and perform aerial triangulation.	Inpho Match AT v.10.0.2
Import DEM and orthorectify image frames	Inpho OrthoMaster v.10.0.2
Mosaic orthorectified imagery blending automated and manually drawn seams between photos and applying global color balancing to the project.	Inpho OrthoVista/Seameditor v.10.0.2



This 5 foot LiDAR cross section shows a view of vegetation and bare ground in the Lake Powell AOI, colored by point laser echo.

Bathymetric Lidar

An underlying principle for collecting hydrographic lidar data is to survey near-shore areas that can be difficult to collect with other methods, such as multi-beam sonar, particularly over large areas. In order to determine the capability and effectiveness of the bathymetric lidar, several parameters were considered; bathymetric return density and spatial accuracy.

Mapped Bathymetry and Depth Penetration

To assist in evaluating performance results of the sensor, a polygon layer was created to delineate areas where bathymetry was successfully mapped. This shapefile was used to control the extent of the delivered clipped topo-bathymetric model and to avoid false triangulation across areas in the water with no returns. Insufficiently mapped areas were identified by triangulating bathymetric bottom points with an edge length maximum of 15.2 feet. This ensured all areas of no returns (> 97 ft_2), were identified as data voids.

Lidar Point Density

First Return Point Density

The acquisition parameters were designed to acquire an average first-return density of 8 points/m^2. First return density describes the density of pulses emitted from the laser that return at least one echo to the system. Multiple returns from a single pulse were not considered in first return density analysis. Some types of surfaces (e.g., breaks in terrain, water and steep slopes) may have returned fewer pulses than originally emitted by the laser.

First returns typically reflect off the highest feature on the landscape within the footprint of the pulse. In forested or urban areas the highest feature could be a tree, building or power line, while in areas of unobstructed ground, the first return will be the only echo and represents the bare earth surface.

The average first-return density of the Lake Powell Lidar project was 3.35 points/ft^2 (36.08 points/m^2) (Table 10). The statistical and spatial distributions of all first return densities per 100 m x 100 m cell are portrayed in Figure 4 and Figure 6.

Bathymetric and Ground Classified Point Densities

The density of ground classified lidar returns and bathymetric bottom returns were also analyzed for this project. Terrain character, land cover, and ground surface reflectivity all influenced the density of ground surface returns. In vegetated areas, fewer pulses may have penetrated the canopy, resulting in lower ground density. Similarly, the density of bathymetric bottom returns was influenced by turbidity, depth, and bottom surface reflectivity. In turbid areas, fewer pulses may have penetrated the water surface, resulting in lower bathymetric density.

The ground and bathymetric bottom classified density of lidar data for the Lake Powell project was 1.57 points/ft^2 (16.91 points/m^2)(Table 10). The statistical and spatial distributions ground classified and bathymetric bottom return densities per 100 m x 100 m cell are portrayed in Figure 5 and Figure 6.

Additionally, for the Lake Powell project, density values of only bathymetric bottom returns were calculated for areas containing at least one bathymetric bottom return. Areas lacking bathymetric returns (voids)were not considered in calculating an average density value. Within the successfully mapped area, a bathymetric bottom return density of 0.014 points/ft^2 (0.15 points/m^2) was achieved.

Table 10: Average Lidar point densities

Density Type	Point Density
First Returns	3.35 points/ft^2 36.08 points/m^2
Ground and Bathymetric Bottom Classified Returns	1.57 points/ft^2 16.92 points/m^2
Bathymetric Bottom Classified Returns	0.056 points/ft^2 0.60 points/m^2

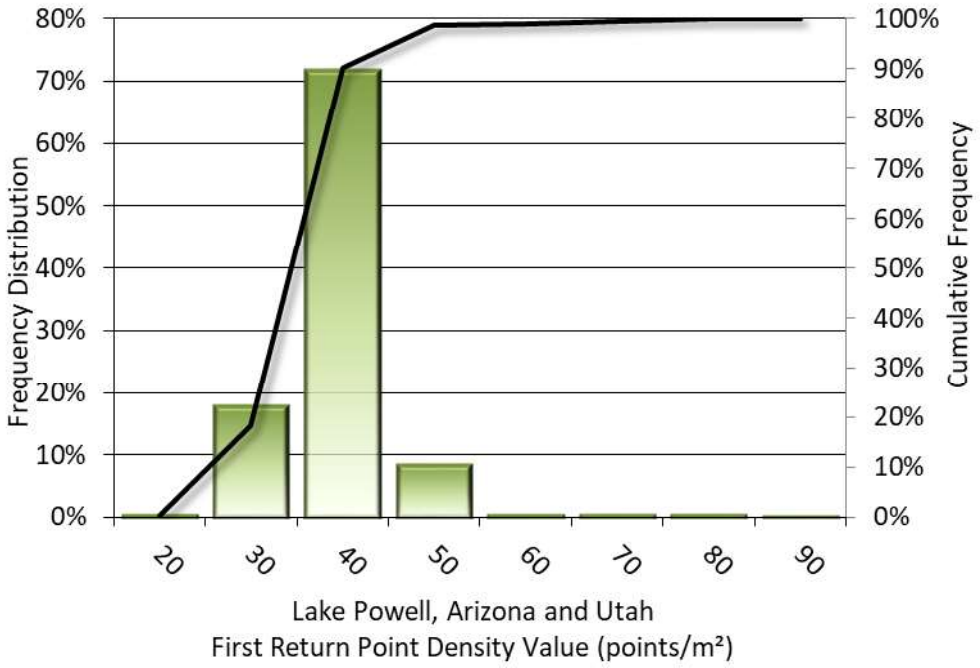


Figure 4: Frequency distribution of first return densities per 100 x 100 m cell

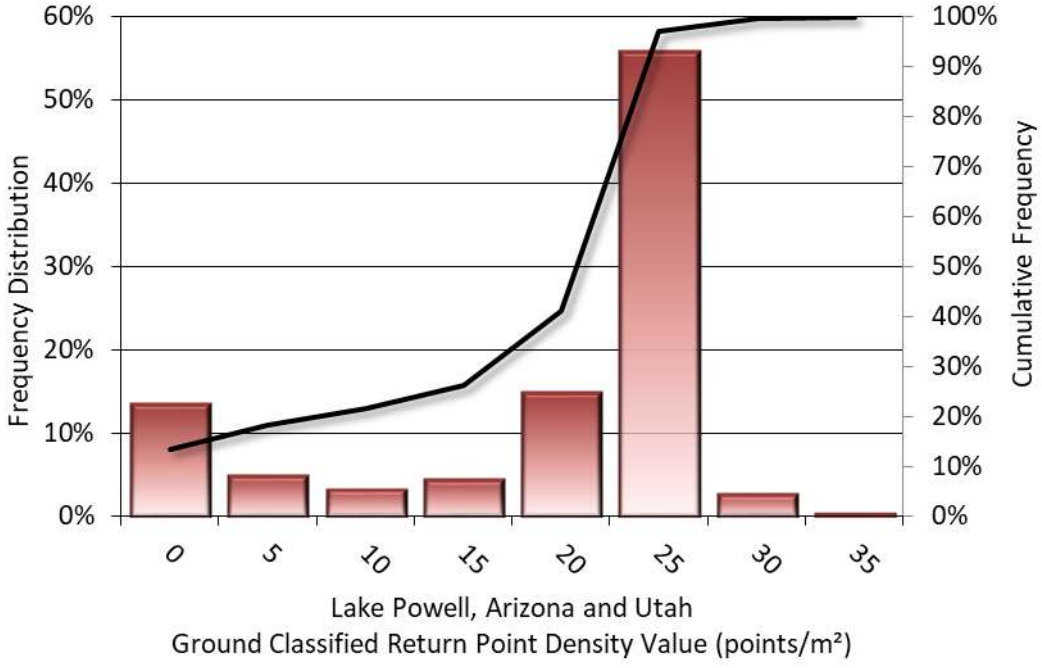


Figure 5: Frequency distribution of ground and bathymetric bottom classified return densities per 100 x 100 m cell

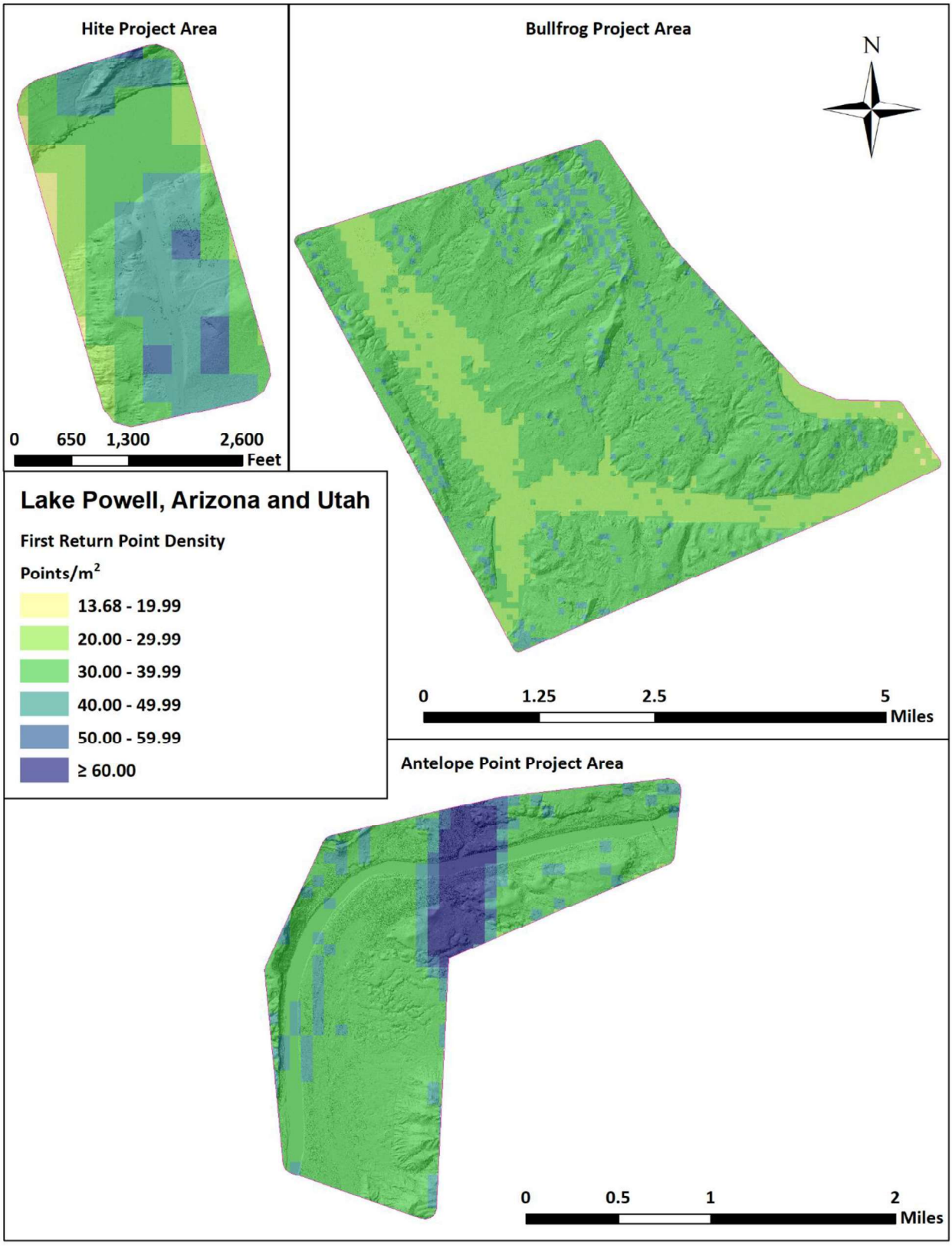


Figure 6: First return density map for the Lake Powell site (100 m x 100 m cells)

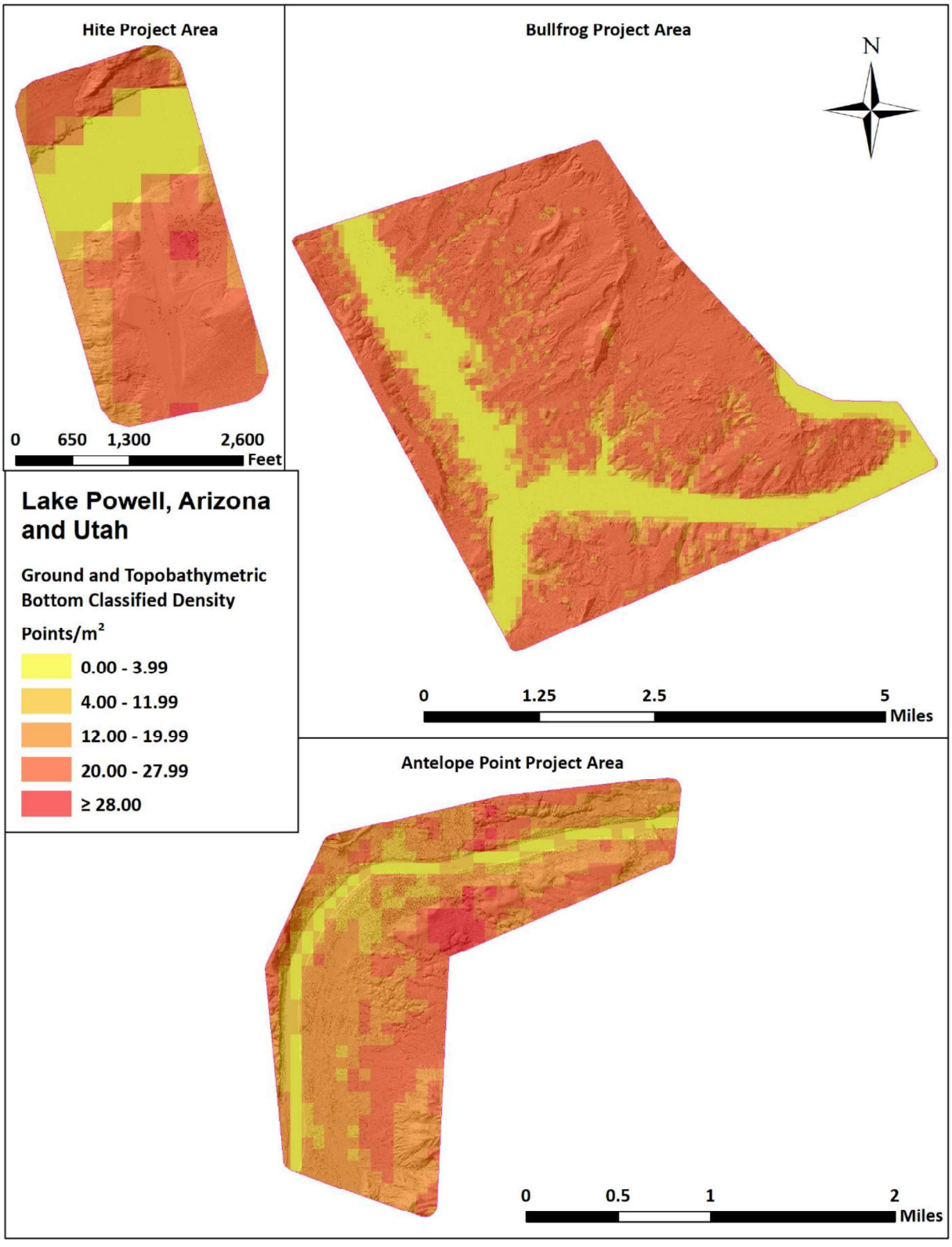


Figure 7: Ground and bathymetric bottom density map for the Lake Powell site (100 m x 100 m cells)

Lidar Accuracy Assessments

The accuracy of the lidar data collection can be described in terms of absolute accuracy (the consistency of the data with external data sources) and relative accuracy (the consistency of the dataset with itself). See Appendix A for further information on sources of error and operational measures used to improve relative accuracy.

Lidar Non-Vegetated Vertical Accuracy

Absolute accuracy was assessed using Non-vegetated Vertical Accuracy (NVA) reporting designed to meet guidelines presented in the FGDC National Standard for Spatial Data Accuracy[1]. NVA compares known ground check point data that were withheld from the calibration and post-processing of the lidar point cloud to the triangulated surface generated by the classified lidar point cloud as well as the derived gridded bare earth DEM. NVA is a measure of the accuracy of lidar point data in open areas where the lidar system has a high probability of measuring the ground surface and is evaluated at the 95% confidence interval (1.96 * RMSE), as shown in Table 11.

The mean and standard deviation (sigma σ) of divergence of the ground surface model from ground check point coordinates are also considered during accuracy assessment. These statistics assume the error for x, y and z is normally distributed, and therefore the skew and kurtosis of distributions are also considered when evaluating error statistics. For the Lake Powell survey, 20 ground check points were withheld from the calibration and post-processing of the lidar point cloud, with resulting non-vegetated vertical accuracy of 0.019 meters (0.061 feet) , as compared to the classified LAS and 0.023 meters (0.076 feet) against the bare earth DEM, with 95% confidence (Figure 8, Figure 9).

NV5 also assessed absolute accuracy using 115 ground control points. Although these points were used in the calibration and post-processing of the lidar point cloud, they still provide a good indication of the overall accuracy of the lidar dataset, and therefore have been provided in Table 11 and Figure 10.

[1] Federal Geographic Data Committee, ASPRS POSITIONAL ACCURACY STANDARDS FOR DIGITAL GEOSPATIAL DATA EDITION 1, Version 1.0, NOVEMBER 2014. https://www.asprs.org/a/society/committees/standards/Positional_Accuracy_Standards.pdf.

Table 11: Absolute accuracy results

Absolute Vertical Accuracy			
	NVA, as compared to Classified LAS	**NVA, as compared to Bare Earth DEM**	**Ground Control Points**
Sample	20 points	20 points	115 points
95% Confidence (1.96*RMSE)	0.061 ft 0.019 m	0.076 ft 0.023 m	0.073 ft 0.022 m
Average	0.001 ft 0.000 m	0.001 ft 0.000 m	0.004 ft 0.001 m
Median	-0.003 ft -0.001 m	0.003 ft 0.001 m	0.000 ft 0.000 m
RMSE	0.031 ft 0.009 m	0.039 ft 0.012 m	0.037 ft 0.011 m
Standard Deviation (1σ)	0.032 ft 0.010 m	0.040 ft 0.012 m	0.037 ft 0.011 m

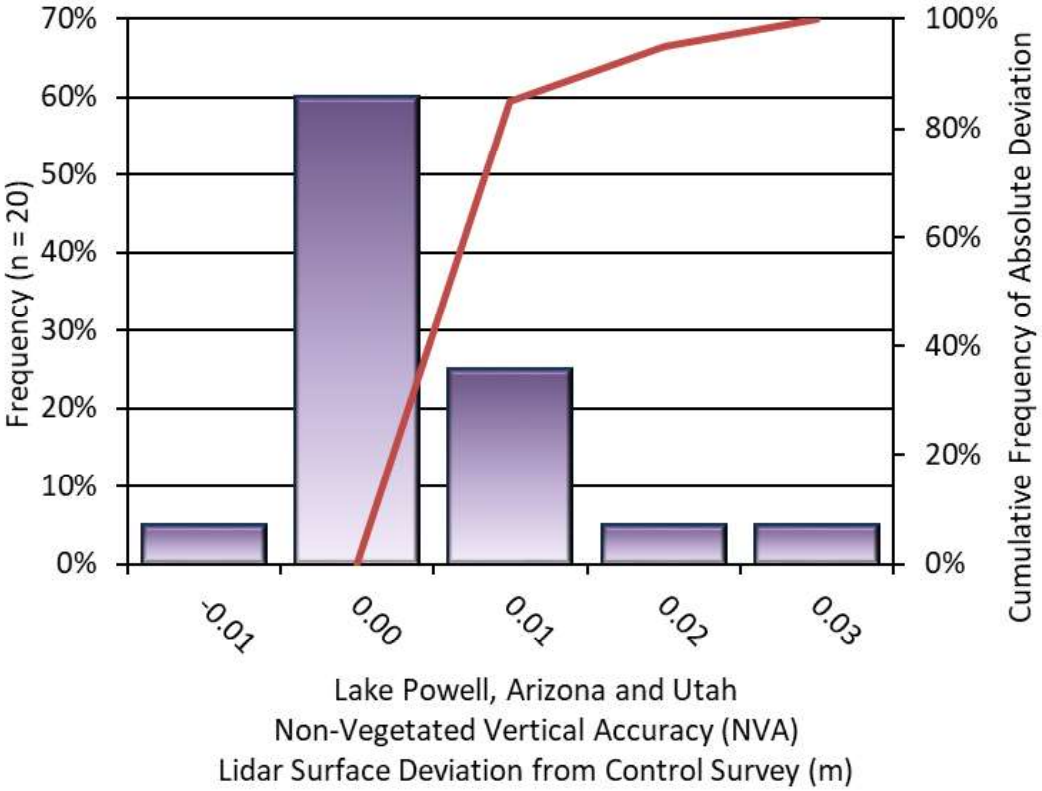


Figure 8: Frequency histogram for classified LAS deviation from ground check point values

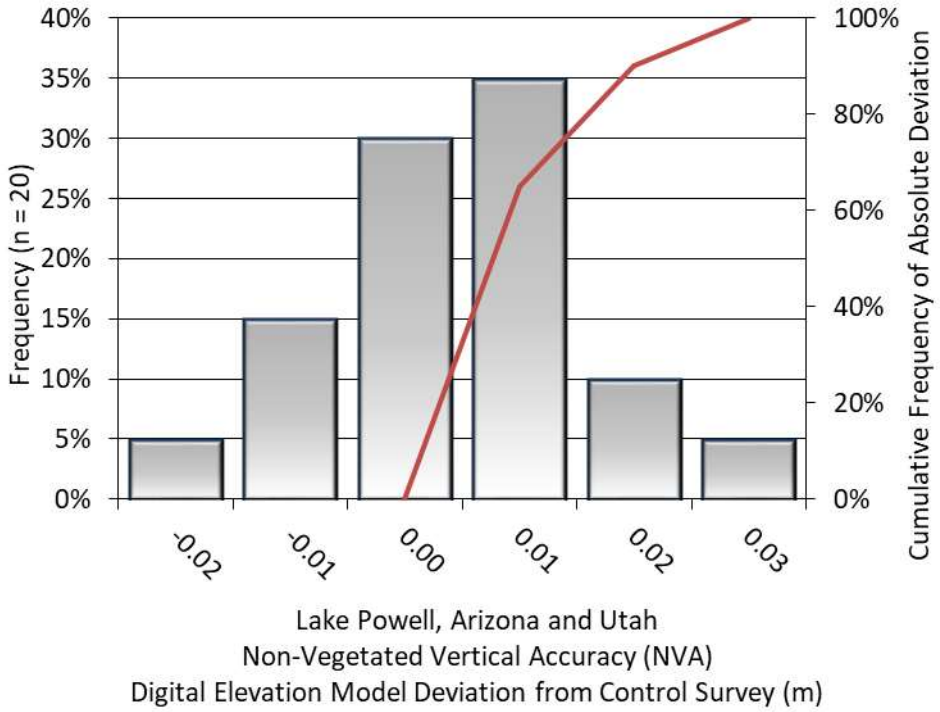


Figure 9: Frequency histogram for lidar bare earth DEM deviation from ground check point values

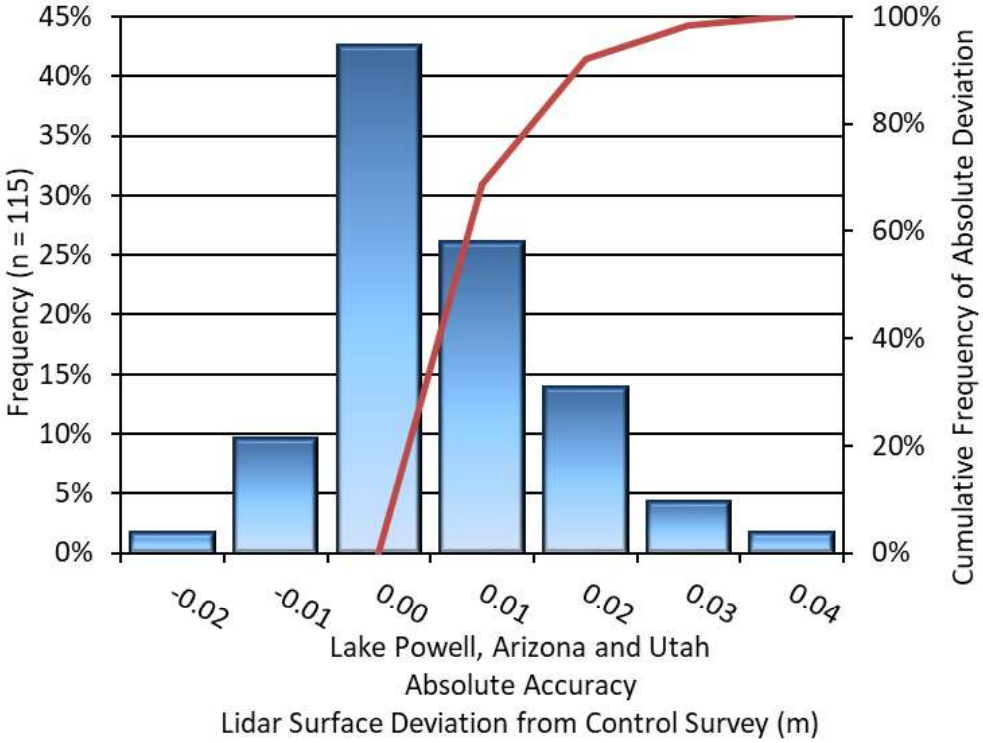


Figure 10: Frequency histogram for lidar surface deviation ground control point values

Lidar Bathymetric Vertical Accuracies

Bathymetric (submerged or along the water's edge) check points were also collected in order to assess the submerged surface vertical accuracy. 11 of the client provided submerged bathymetric check points were withheld from the accuracy assessment as they were taken in areas of deep water areas where no lidar returns were collected. Assessment of the remaining 30 submerged bathymetric check points resulted in a vertical accuracy of 0.195 meters (0.641 feet), while assessment of 20 wetted edge check points resulted in a vertical accuracy of 0.174 meters (0.571 feet), evaluated at 95% confidence interval (Table 12, Figure 11, Figure 12).

Table 12: Bathymetric Vertical Accuracy for the Lake Powell Project

Bathymetric Vertical Accuracy		
	Submerged Bathymetric Check Points	**Wetted Edge Bathymetric Check Points**
Sample	30 points	20 points
95% Confidence (1.96*RMSE)	0.641 ft 0.195 m	0.571 ft 0.174 m
Average Dz	0.235 ft 0.072 m	0.028 ft 0.009 m
Median	0.254 ft 0.077 m	0.084 ft 0.025 m
RMSE	0.327 ft 0.100 m	0.292 ft 0.089 m
Standard Deviation (1σ)	0.231 ft 0.070 m	0.298 ft 0.091 m

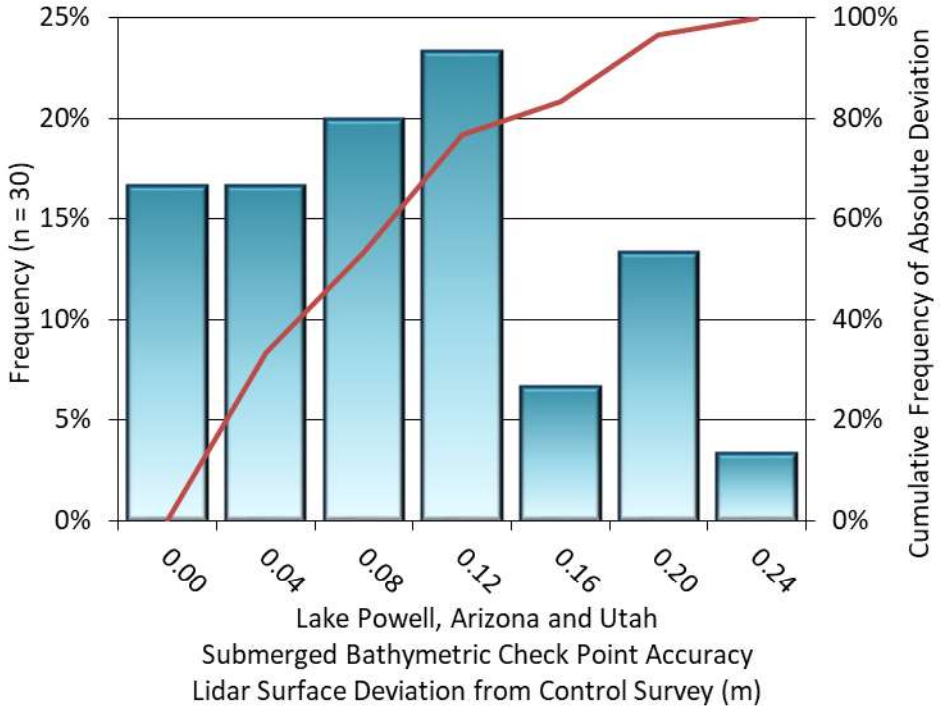


Figure 11: Frequency histogram for lidar surface deviation from submerged check point values

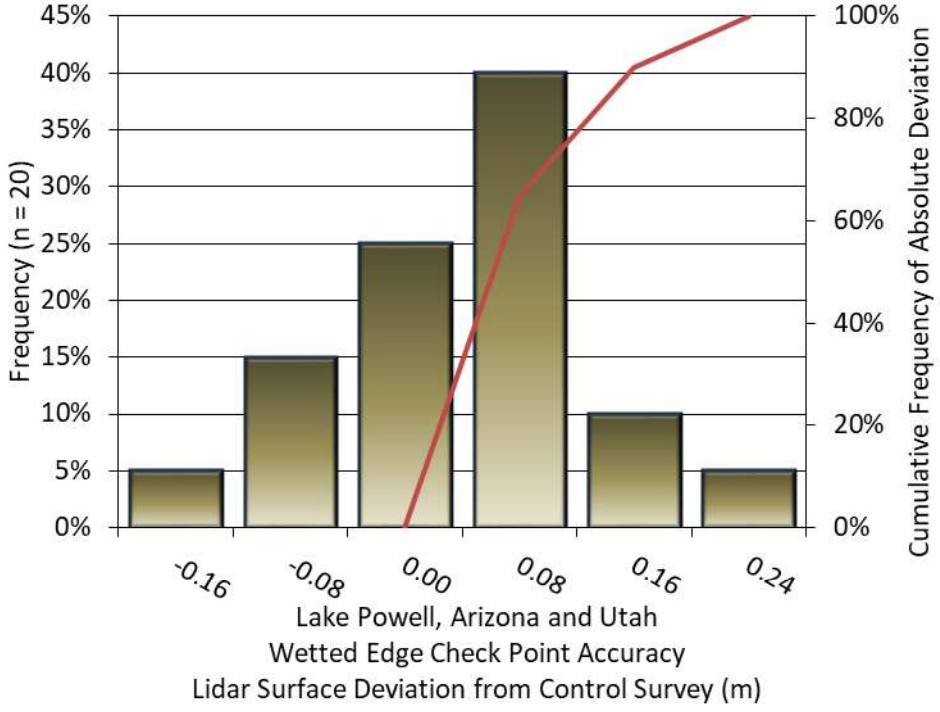


Figure 12: Frequency histogram for lidar surface deviation from wetted edge check point values

Supplemental Top of Bank Points

Jacobs also provided supplemental top of bank points to be used in accuracy assessment of steep bank areas above bathymetric surfaces. Assessment of the 13 check points resulted in a vertical accuracy of 0.084 meters (0.276 feet)), as compared to the classified LAS and 0.000 meters (0.000 feet) against the bare earth DEM, with 95% confidence (Table 13, Figure 13, Figure 14).

Table 13:Top of Bank Vertical Accuracy for the Lake Powell Project

Top of Bank Vertical Accuracy		
	Top of Bank Points as compared to Classified LAS	**Top of Bank Points as compared to Bare Earth DEM**
Sample	13 points	13 points
95% Confidence (1.96*RMSE)	0.276 ft 0.084 m	0.327 ft 0.100 m
Average Dz	0.021 ft 0.007 m	0.037 ft 0.011 m
Median	-0.036 ft -0.011 m	0.046 ft 0.014 m
RMSE	0.141 ft 0.043 m	0.167 ft 0.051 m
Standard Deviation (1σ)	0.145 ft 0.044 m	0.169 ft 0.052 m

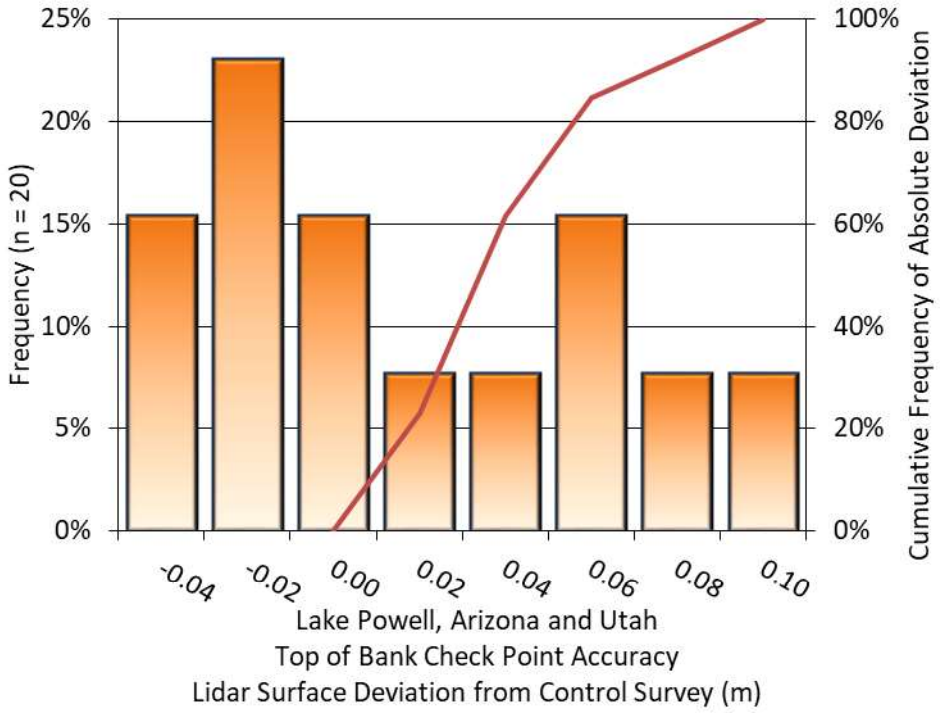


Figure 13: Frequency histogram for lidar surface deviation from top of bank check point values

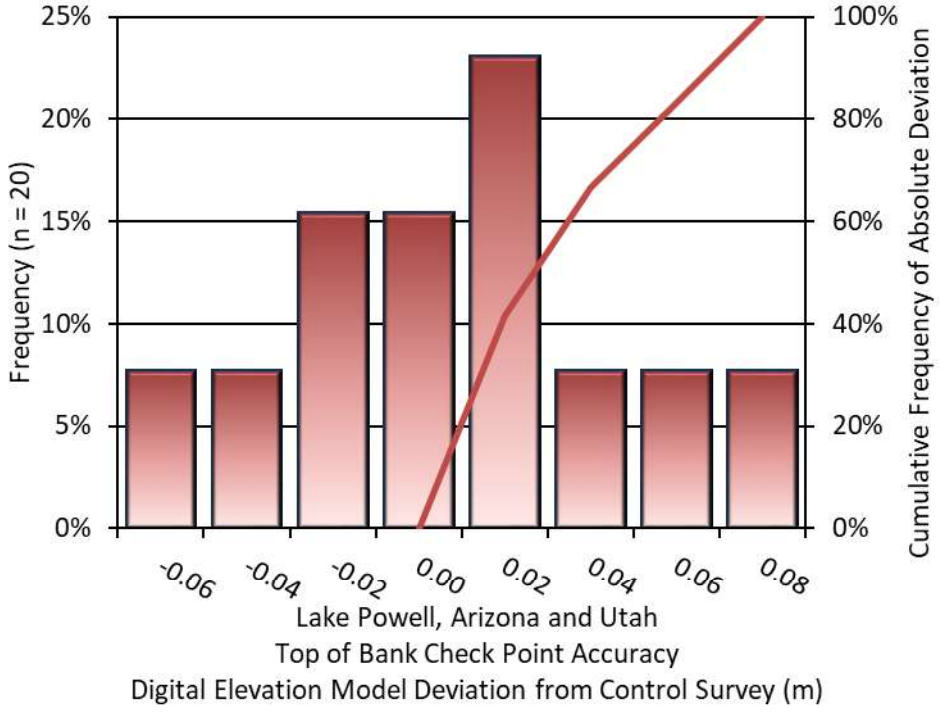


Figure 14: Frequency histogram for lidar bare earth DEM deviation from top of bank check point values

Lidar Relative Vertical Accuracy

Relative vertical accuracy refers to the internal consistency of the data set as a whole: the ability to place an object in the same location given multiple flight lines, GPS conditions, and aircraft attitudes. When the lidar system is well calibrated, the swath-to-swath vertical divergence is low (<0.10 meters). The relative vertical accuracy was computed by comparing the ground surface model of each individual flight line with its neighbors in overlapping regions. The average (mean) line to line relative vertical accuracy for the Lake Powell Lidar project was 0.015 meters (0.050 feet) (Table 14, Figure 15).

Table 14: Relative accuracy results

Relative Accuracy	
Sample	242 surfaces
Average	0.050 ft 0.015 m
Median	0.049 ft 0.015 m
RMSE	0.054 ft 0.016 m
Standard Deviation (1σ)	0.010 ft 0.003 m
1.96σ	0.020 ft 0.006 m

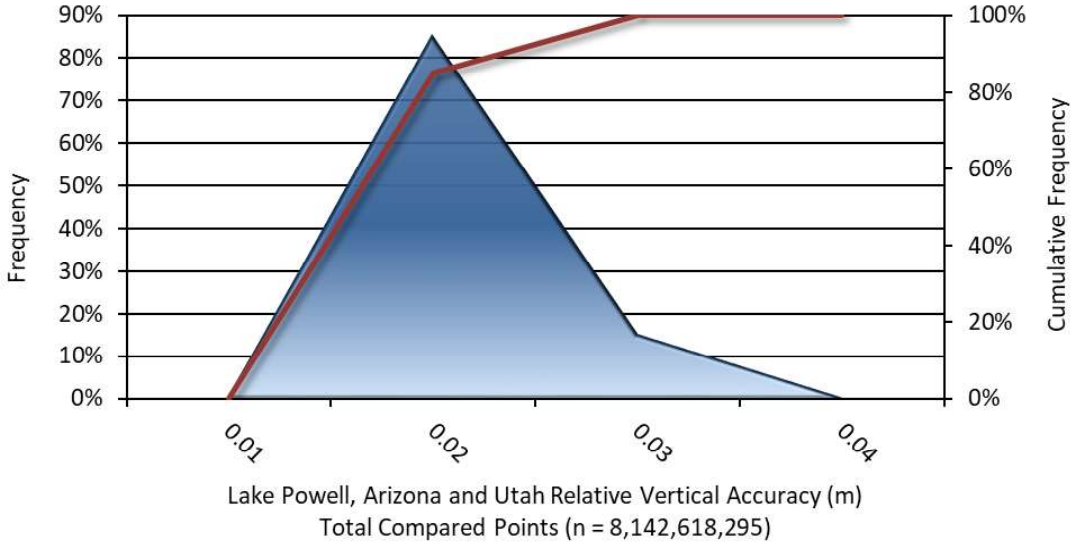


Figure 15: Frequency plot for relative vertical accuracy between flight lines

Lidar Horizontal Accuracy

Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial Data Accuracy (NSSDA) reporting standard where a theoretical point will fall within the obtained radius 95 percent of the time. Based on a flying altitude of 400 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.019 meters, this project was produced to meet 0.05 m (0.18 feet) horizontal accuracy at the 95% confidence level.

Table 15: Horizontal Accuracy

Horizontal Accuracy	
$RMSE_r$	0.10 ft 0.03 m
ACC_r	0.18 ft 0.05 m

Digital Imagery Accuracy Assessment

Image accuracy was assessed using a subset of air target points withheld from the aerial triangulation procedure as check points. Check points were found in the final orthophoto mosaics and the displacement was recorded for further statistical analysis. Aerial triangulation was performed in three separate blocks however accuracy statistics are presented as a cumulative table due to the relatively small number of control points available for processing. Table 16 presents the complete photo accuracy statistics.

Table 16: Orthophotography accuracy statistics for Lake Powell

Lake Powell Photo Accuracy							
		Check Points$_x$	Check Points$_y$	Check Points$_{xy}$	Control Points$_x$	Control Points$_y$	Control Points$_{xy}$
Count		n = 5			n = 8		
Mean	*ft*	0.128	-0.004	0.128	0.025	0.099	0.102
	m	0.039	-0.001	0.039	0.008	0.030	0.031
RMSE	*ft*	0.130	0.192	0.231	0.108	0.120	0.161
	m	0.040	0.058	0.071	0.033	0.036	0.049
1σ	*ft*	0.028	0.214	0.216	0.112	0.072	0.133
	m	0.008	0.065	0.066	0.034	0.022	0.041
1.96σ	*ft*	0.054	0.420	0.423	0.220	0.141	0.261
	m	0.017	0.128	0.129	0.067	0.043	0.080

CERTIFICATIONS

NV5 Geospatial provided lidar services for the Lake Powell project as described in this report.

I, Brian Von-Seggern, have reviewed the attached report for completeness and hereby state that it is a complete and accurate report of this project.

Brian Von Seggern (Jan 27, 2022 11:06 PST) Jan 27, 2022

Brian Von-Seggern
Project Manager
NV5 Geospatial

GLOSSARY

1-sigma (σ) Absolute Deviation: Value for which the data are within one standard deviation (approximately 68th percentile) of a normally distributed data set.

1.96 * RMSE Absolute Deviation: Value for which the data are within two standard deviations (approximately 95th percentile) of a normally distributed data set, based on the FGDC standards for Non-vegetated Vertical Accuracy (FVA) reporting.

Accuracy: The statistical comparison between known (surveyed) points and laser points. Typically measured as the standard deviation (sigma σ) and root mean square error (RMSE).

> **Absolute Accuracy:** The vertical accuracy of lidar data is described as the mean and standard deviation (sigma σ) of divergence of lidar point coordinates from ground survey point coordinates. To provide a sense of the model predictive power of the dataset, the root mean square error (RMSE) for vertical accuracy is also provided. These statistics assume the error distributions for x, y and z are normally distributed, and thus we also consider the skew and kurtosis of distributions when evaluating error statistics.
>
> **Relative Accuracy:** Relative accuracy refers to the internal consistency of the data set; i.e., the ability to place a laser point in the same location over multiple flight lines, GPS conditions and aircraft attitudes. Affected by system attitude offsets, scale and GPS/IMU drift, internal consistency is measured as the divergence between points from different flight lines within an overlapping area. Divergence is most apparent when flight lines are opposing. When the lidar system is well calibrated, the line-to-line divergence is low (<10 cm).
>
> **Root Mean Square Error (RMSE):** A statistic used to approximate the difference between real-world points and the lidar points. It is calculated by squaring all the values, then taking the average of the squares and taking the square root of the average.

Data Density: A common measure of lidar resolution, measured as points per square meter.

Digital Elevation Model (DEM): File or database made from surveyed points, containing elevation points over a contiguous area. Digital terrain models (DTM) and digital surface models (DSM) are types of DEMs. DTMs consist solely of the bare earth surface (ground points), while DSMs include information about all surfaces, including vegetation and man-made structures.

Intensity Values: The peak power ratio of the laser return to the emitted laser, calculated as a function of surface reflectivity.

Nadir: A single point or locus of points on the surface of the earth directly below a sensor as it progresses along its flight line.

Overlap: The area shared between flight lines, typically measured in percent. 100% overlap is essential to ensure complete coverage and reduce laser shadows.

Pulse Rate (PR): The rate at which laser pulses are emitted from the sensor; typically measured in thousands of pulses per second (kHz).

Pulse Returns: For every laser pulse emitted, the number of wave forms (i.e., echoes) reflected back to the sensor. Portions of the wave form that return first are the highest element in multi-tiered surfaces such as vegetation. Portions of the wave form that return last are the lowest element in multi-tiered surfaces.

Real-Time Kinematic (RTK) Survey: A type of surveying conducted with a GPS base station deployed over a known monument with a radio connection to a GPS rover. Both the base station and rover receive differential GPS data and the baseline correction is solved between the two. This type of ground survey is accurate to 1.5 cm or less.

Post-Processed Kinematic (PPK) Survey: GPS surveying is conducted with a GPS rover collecting concurrently with a GPS base station set up over a known monument. Differential corrections and precisions for the GNSS baselines are computed and applied after the fact during processing. This type of ground survey is accurate to 1.5 cm or less.

Scan Angle: The angle from nadir to the edge of the scan, measured in degrees. Laser point accuracy typically decreases as scan angles increase.

Native Lidar Density: The number of pulses emitted by the lidar system, commonly expressed as pulses per square meter.

APPENDIX A - ACCURACY CONTROLS

Relative Accuracy Calibration Methodology:

Manual System Calibration: Calibration procedures for each mission require solving geometric relationships that relate measured swath-to-swath deviations to misalignments of system attitude parameters. Corrected scale, pitch, roll and heading offsets were calculated and applied to resolve misalignments. The raw divergence between lines was computed after the manual calibration was completed and reported for each survey area.

Automated Attitude Calibration: All data was tested and calibrated using TerraMatch automated sampling routines. Ground points were classified for each individual flight line and used for line-to-line testing. System misalignment offsets (pitch, roll and heading) and scale were solved for each individual mission and applied to respective mission datasets. The data from each mission were then blended when imported together to form the entire area of interest.

Automated Z Calibration: Ground points per line were used to calculate the vertical divergence between lines caused by vertical GPS drift. Automated Z calibration was the final step employed for relative accuracy calibration.

Lidar accuracy error sources and solutions:

Type of Error	Source	Post Processing Solution
GPS (Static/Kinematic)	Long Base Lines	None
	Poor Satellite Constellation	None
	Poor Antenna Visibility	Reduce Visibility Mask
Relative Accuracy	Poor System Calibration	Recalibrate IMU and sensor offsets/settings
	Inaccurate System	None
Laser Noise	Poor Laser Timing	None
	Poor Laser Reception	None
	Poor Laser Power	None
	Irregular Laser Shape	None

Operational measures taken to improve relative accuracy:

Low Flight Altitude: Terrain following was employed to maintain a constant above ground level (AGL). Laser horizontal errors are a function of flight altitude above ground (about 1/3000th AGL flight altitude).

Focus Laser Power at narrow beam footprint: A laser return must be received by the system above a power threshold to accurately record a measurement. The strength of the laser return (i.e., intensity) is a function of laser emission power, laser footprint, flight altitude and the reflectivity of the target. While surface reflectivity cannot be controlled, laser power can be increased and low flight altitudes can be maintained.

Reduced Scan Angle: Edge-of-scan data can become inaccurate. The scan angle was reduced to a maximum of ±20° from nadir, creating a narrow swath width and greatly reducing laser shadows from trees and buildings.

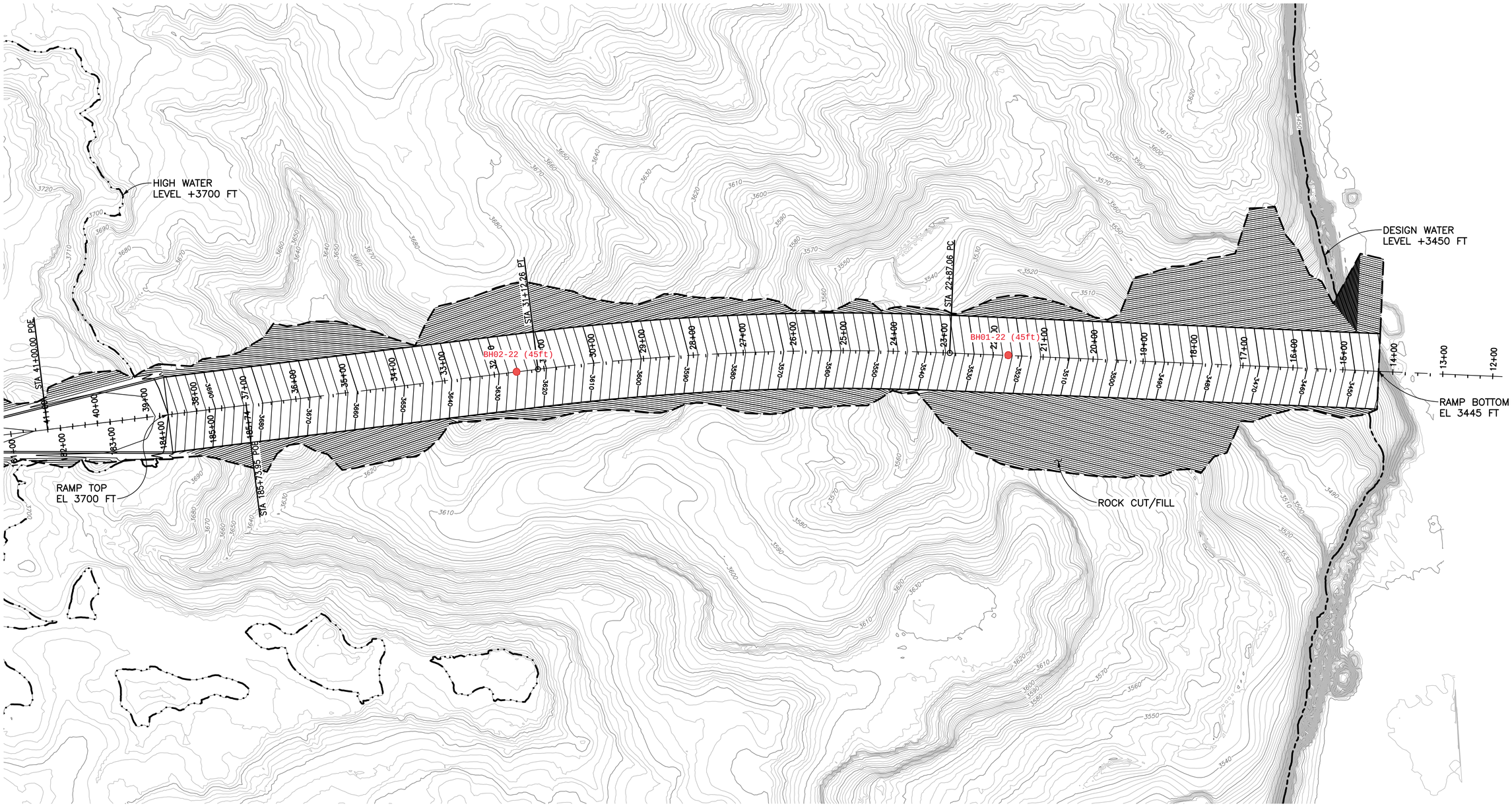
Quality GPS: Flights took place during optimal GPS conditions (e.g., 6 or more satellites and PDOP [Position Dilution of Precision] less than 3.0). Before each flight, the PDOP was determined for the survey day. During all flight times, a dual frequency DGPS base station recording at 1 second epochs was utilized and a maximum baseline length between the aircraft and the control points was less than 13 nm at all times.

Ground Survey: Ground survey point accuracy (<1.5 cm RMSE) occurs during optimal PDOP ranges and targets a minimal baseline distance of 4 miles between GPS rover and base. Robust statistics are, in part, a function of sample size (n) and distribution. Ground survey points are distributed to the extent possible throughout multiple flight lines and across the survey area.

50% Side-Lap (100% Overlap): Overlapping areas are optimized for relative accuracy testing. Laser shadowing is minimized to help increase target acquisition from multiple scan angles. Ideally, with a 50% side-lap, the nadir portion of one flight line coincides with the swath edge portion of overlapping flight lines. A minimum of 50% side-lap with terrain-followed acquisition prevents data gaps.

Opposing Flight Lines: All overlapping flight lines have opposing directions. Pitch, roll and heading errors are amplified by a factor of two relative to the adjacent flight line(s), making misalignments easier to detect and resolve.

Appendix E – Proposed Geotechnical Boring Locations



LEGEND

- ROCK CUT/FILL BOUNDARY
- 3580 EXISTING ELEVATION
- 3550 ELEVATION
- DESIGN WATER LEVEL +3450 FT
- HIGH WATER LEVEL +3700 FT

OPTION 1 – HIGH TO LOW RAMP (PLAN VIEW SHOWING CUT/FILL AREA)

TRUE NORTH / PROJECT NORTH

100 0 100 200
SCALE OF FEET

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	J. McRAE
CADD	E. FLORES
TECH. REVIEW:	
DATE:	FEBRUARY 2, 2022

SUB SHEET NO. SK-006

TITLE OF SHEET
STRUCTURAL
BULLFROG LAUNCH RAMP
LAUNCH RAMP SITE PLAN
OPTION 1
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

2/1/22 23:31 FLORESE R22 C:\PW_WORKDIR\DENJO3\CH2MHILL_FLORESE\D1353865\SK-006_LAUNCH_RAMP_SITE_PLAN_-_OPTION_1.DWG
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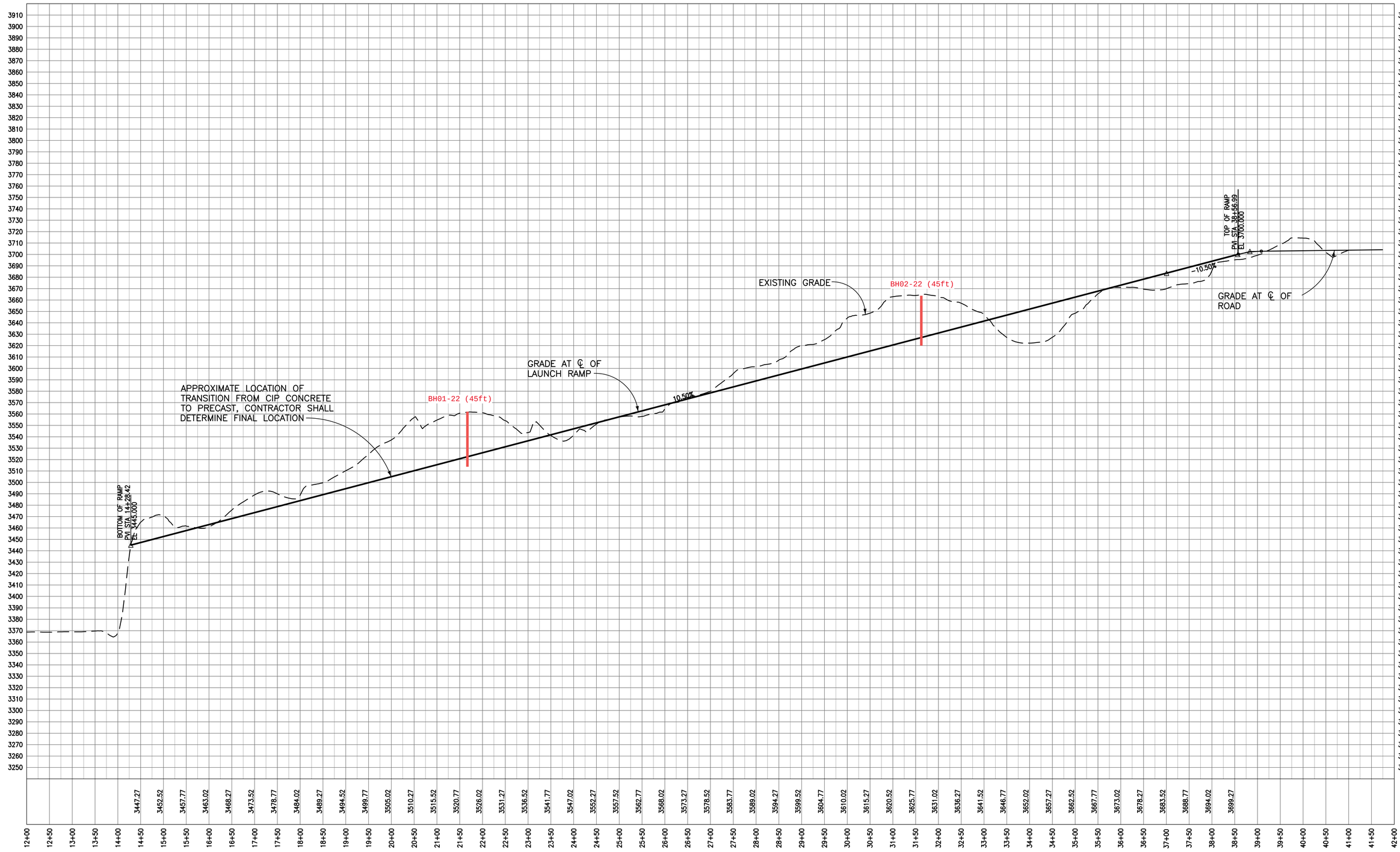
2/2/22, 17:35 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353865\SK-007 LAUNCH RAMP PROFILE - OPTION 1.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG; ..\D1318607\GLCA-MASTER-BULLFROG-OPTION1.DWG; ..\D1352712\GLCA_BOAT_LAUNCH_GIS_BASE_LAYERS_FEET.DWG;



40 0 40 80
SCALE OF FEET
VERTICAL

100 0 100 200
SCALE OF FEET
HORIZONTAL

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	J. McRAE
CADD	E. FLORES
TECH. REVIEW:	
DATE:	FEBRUARY 2, 2022

SUB SHEET NO.
SK-007

TITLE OF SHEET
STRUCTURAL
BULLFROG LAUNCH RAMP LAUNCH RAMP PROFILE OPTION 1
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

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DESIGN WATER LEVEL +3450 FT

ROCK CUT/FILL

BH01-22 (40 ft)

STA 28+21.78 PC

STA 32+17.21 PT

STA 43+93.36 EP

RAMP BOTTOM EL 3445 FT

RAMP TOP EL 3700 FT

HIGH WATER LEVEL +3700 FT

LEGEND

- ROCK CUT/FILL BOUNDARY
- 3580 EXISTING ELEVATION
- 3550 ELEVATION
- DESIGN WATER LEVEL +3450 FT
- HIGH WATER LEVEL +3700 FT

HALLS CROSSING RAMP (PLAN VIEW SHOWING CUT/FILL AREA)

TRUE NORTH

PROJECT NORTH

100 0 100 200

SCALE OF FEET

DRAFT

NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"

BAR MEASURES 1" LONG

DESIGNED:	J. McRAE
CADD	E. FLORES
TECH. REVIEW:	
DATE:	FEBRUARY 2, 2022

SUB SHEET NO.

SK-003

TITLE OF SHEET

STRUCTURAL

HALLS CROSSING LAUNCH RAMP LAUNCH RAMP SITE PLAN

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

APPROXIMATE LOCATION OF TRANSITION FROM CIP CONCRETE TO PRECAST, CONTRACTOR SHALL DETERMINE FINAL LOCATION

EXISTING GRADE

BH01-22 (40 ft)

GRADE AT ℄ OF LAUNCH RAMP

10.50%

TOP OF RAMP
STA = 41+44.64
ELEV = 3700.000

MATCH EXIST
STA = 16+31.31
ELEV = 3402.624

50.00%

END OF RAMP,
ELEV = 3445

40 0 40 80
SCALE OF FEET
VERTICAL

100 0 100 200
SCALE OF FEET
HORIZONTAL

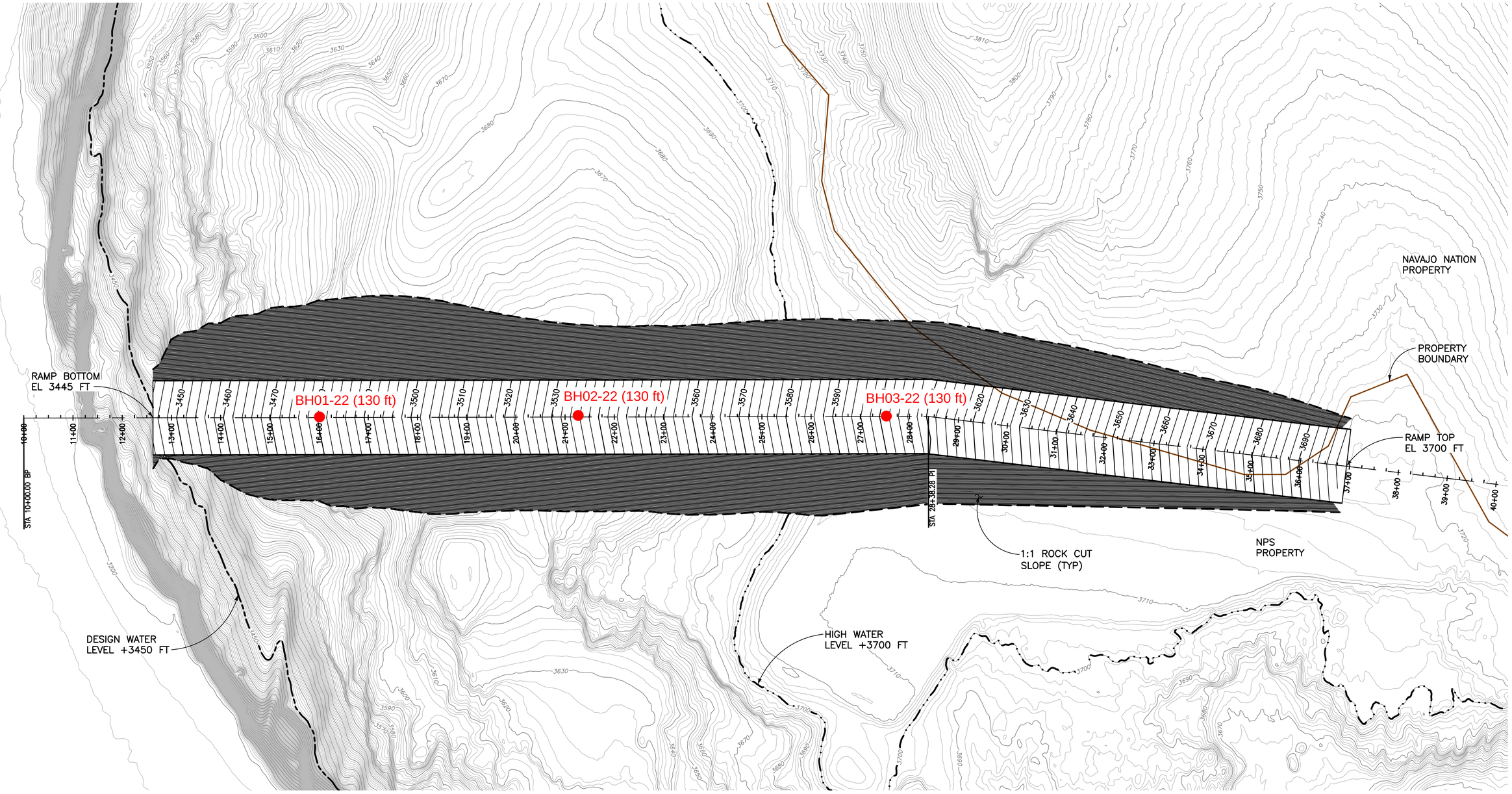
DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED: J. McRAE	SUB SHEET NO. SK-004
CADD E. FLORES	
TECH. REVIEW:	
DATE: FEBRUARY 2, 2022	

TITLE OF SHEET
STRUCTURAL
HALLS CROSSING LAUNCH RAMP
LAUNCH RAMP PROFILE
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

2/2/22 10:37 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353873\SK-004 LAUNCH RAMP PROFILE.DWG XREFS: ..\D1318626\XC-BORDER_GLCA_EXH.DWG;



LEGEND

- ROCK CUT/FILL BOUNDARY
- 3580 EXISTING ELEVATION
- 3550 ELEVATION
- DESIGN WATER LEVEL +3450 FT
- HIGH WATER LEVEL +3700 FT
- PROPERTY BOUNDARY

DRAFT
NOT FOR CONSTRUCTION

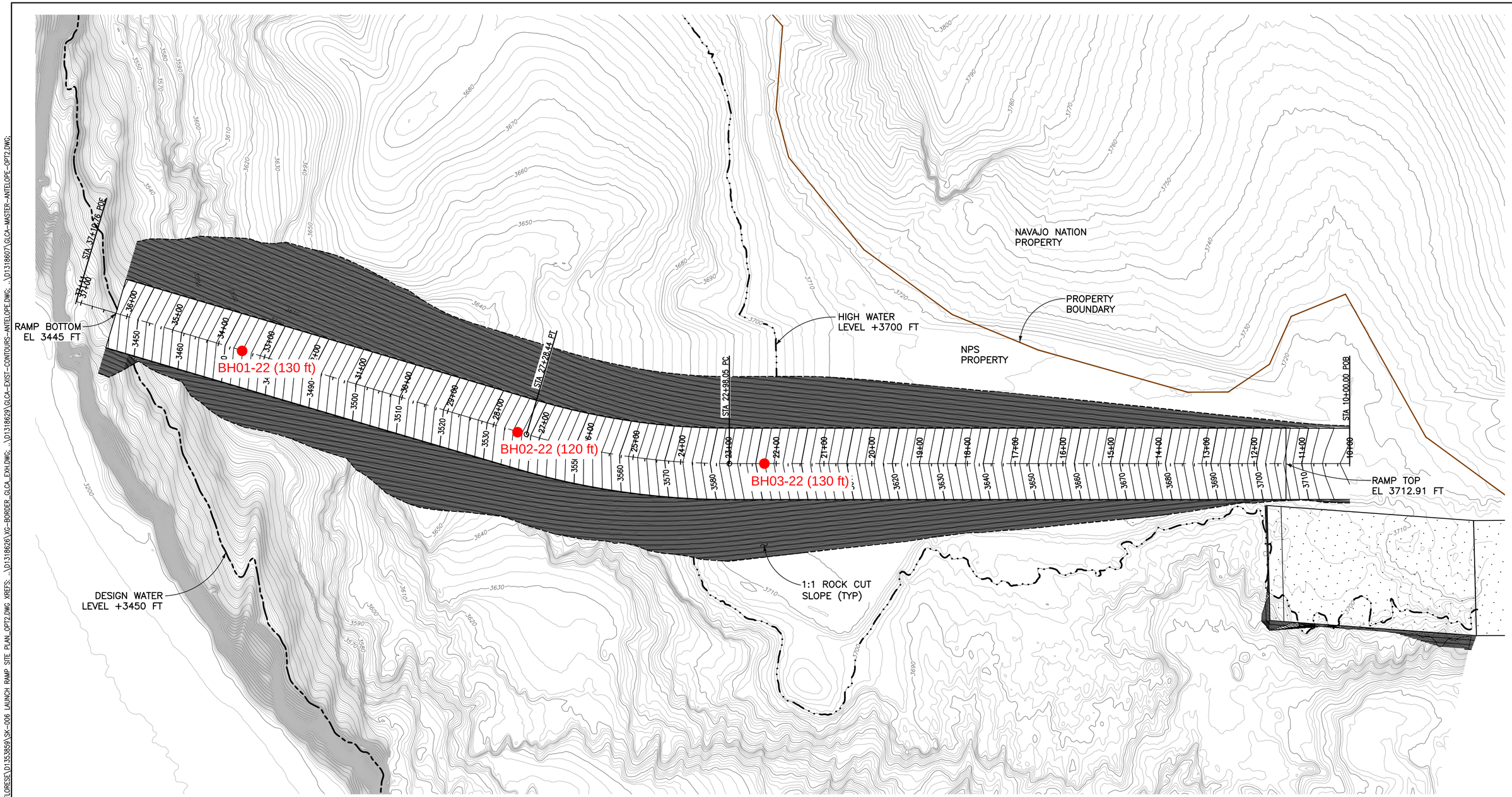
FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED: A. REID	SUB SHEET NO. SK-005
CADD E. FLORES	
TECH. REVIEW: B. MADSEN	
DATE: JUNE 10, 2022	

TITLE OF SHEET
STRUCTURAL
ANTELOPE POINT LAUNCH RAMP
LAUNCH RAMP SITE PLAN
OPTION 1
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/10/22, 12:41, FLORESE, R22, C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353859\SK-005 LAUNCH RAMP SITE PLAN_OPT1.DWG
XREFS: ..\D1318628\VG-BORDER_GLCA_EXH.DWG; ..\D1318629\GLCA-EXIST-CONTOURS-ANTELOPE.DWG; ..\D1318627\GLCA-MASTER-ANTELOPE-OPT1.DWG; ..\D1318623\GLCA-EXIST-CONTOURS-ANTELOPE.DWG;

6/10/22, 12:38, FLORESE, R22, C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353859\SK-006 LAUNCH RAMP SITE PLAN_OPT2.DWG, XREFS: ..\D1318628\VG-BORDER_GLCA_EXH.DWG; ..\D1318629\GLCA-EXIST-CONTOURS-ANTELOPE.DWG; ..\D1318607\GLCA-MASTER-ANTELOPE-OPT2.DWG;



TRUE NORTH / PROJECT NORTH

100 0 100 200
SCALE OF FEET

LEGEND

- ROCK CUT/FILL BOUNDARY
- 3580 EXISTING ELEVATION
- 3550 ELEVATION
- DESIGN WATER LEVEL +3450 FT
- HIGH WATER LEVEL +xxxx FT
- PROPERTY BOUNDARY

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED: A. REID	SUB SHEET NO.
CADD E. FLORES	SK-006
TECH. REVIEW: B. MADSEN	
DATE: JUNE 10, 2022	

TITLE OF SHEET

ANTELOPE POINT LAUNCH RAMP LAUNCH RAMP SITE PLAN OPTION 2

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/10/22, 12:35 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353859\SK-007 LAUNCH RAMP SITE PLAN_OPT3.DWG XREFS: ..\D1318628\XG-BORDER_GLCA_EXH.DWG; ..\D1318629\GLCA-EXIST-CONTOURS-ANTELOPE.DWG; ..\D1318607\GLCA-MASTER-ANTELOPE-OPT3.DWG;

PROPERTY BOUNDARY

NAVAJO NATION PROPERTY

NPS PROPERTY

STA 10+00.00 POB

STA 11+93.04 PI

RAMP TOP EL 3712.91 FT

HIGH WATER LEVEL +3700 FT

STA 18+26.67 PC

ENC: 17+57.48

BFS: 18+48.01

EFS: 24+90.04

BNC: 25+78.57

ENC: 27+81.38

BFS: 28+52.15

EFS: 29+42.06

BNC: 30+12.83

BH03-22 (65 ft)

BH02-22 (90 ft)

BH01-22 (130 ft)

STA 25+09.37 PT

STA 28+38.82 PC

STA 29+55.39 PT

STA 41+54.64 POE

RAMP BOTTOM EL 3445 FT

1:1 ROCK CUT SLOPE

DESIGN WATER LEVEL +3450 FT

TRUE NORTH

PROJECT NORTH

100 0 100 200

SCALE OF FEET

LEGEND

- ROCK CUT/FILL BOUNDARY
- 3580 EXISTING ELEVATION
- 3550 ELEVATION
- DESIGN WATER LEVEL +3450 FT
- HIGH WATER LEVEL +3700 FT
- PROPERTY BOUNDARY

DRAFT

NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E. FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 10, 2022

SUB SHEET NO.

SK-007

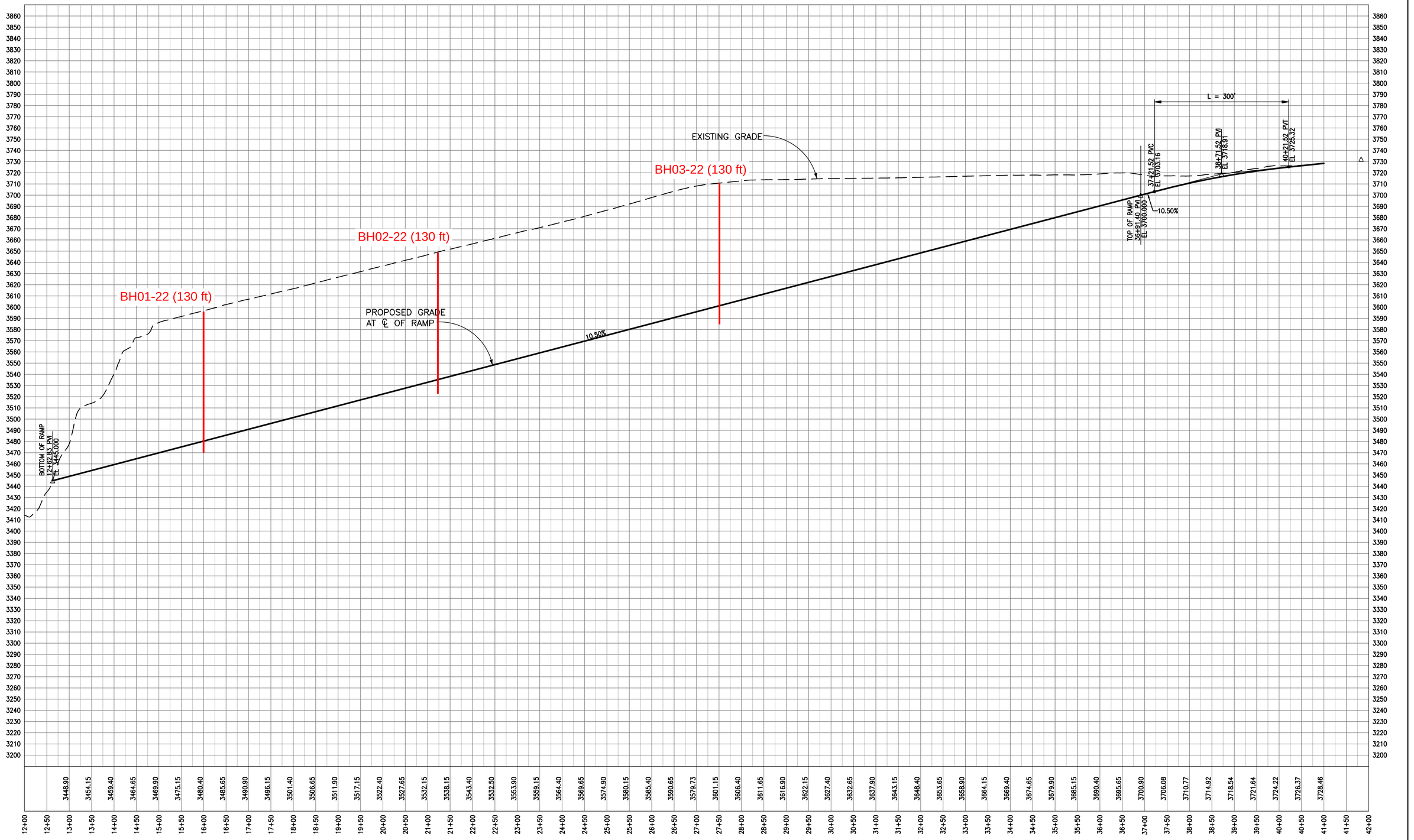
TITLE OF SHEET

STRUCTURAL

ANTELOPE POINT LAUNCH RAMP LAUNCH RAMP SITE PLAN OPTION 3

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/10/22 12:31 FLORES R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORES\D1353859\SK-008 LAUNCH RAMP PROFILE_OPT1.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG; ..\D1318607\GLCA-MASTER-BULLFROG-OPTION1.DWG; ..\D1352712\GLCA_BOAT_LAUNCH_GIS_BASE_LAYERS_FEET.DWG;



40 0 40 80
SCALE OF FEET
VERTICAL

100 0 100 200
SCALE OF FEET
HORIZONTAL

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E. FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 10, 2022

SUB SHEET NO.
SK-008

TITLE OF SHEET
ANTELOPE POINT LAUNCH RAMP
LAUNCH RAMP PROFILE
OPTION 1
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/10/22 12:30 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353859\SK-009 LAUNCH RAMP PROFILE_OPT2.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG; ..\D1318607\GLCA-MASTER-BULLFROG-OPTION1.DWG; ..\D1352712\GLCA_BOAT_LAUNCH_GIS_BASE_LAYERS_FEET.DWG;

BH03-22 (130 ft)

BH02-22 (120 ft)

BH01-22 (130 ft)

EXISTING GRADE

PROPOSED GRADE AT ℄ OF RAMP

-10.50%

MATCH EXIST
10+00.00 PVI
EL 3716.860

10+33.27 PVC
EL 3713.45
10+83.27 PVT
EL 3711.77

TOP OF RAMP
11+37.44 PVI
EL 3706.500

BOTTOM OF RAMP
35+21.91 PVI
EL 3445.000

L = 50'

40 0 40 80 VERTICAL
SCALE OF FEET

100 0 100 200 HORIZONTAL
SCALE OF FEET

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E. FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 10, 2022

SUB SHEET NO.

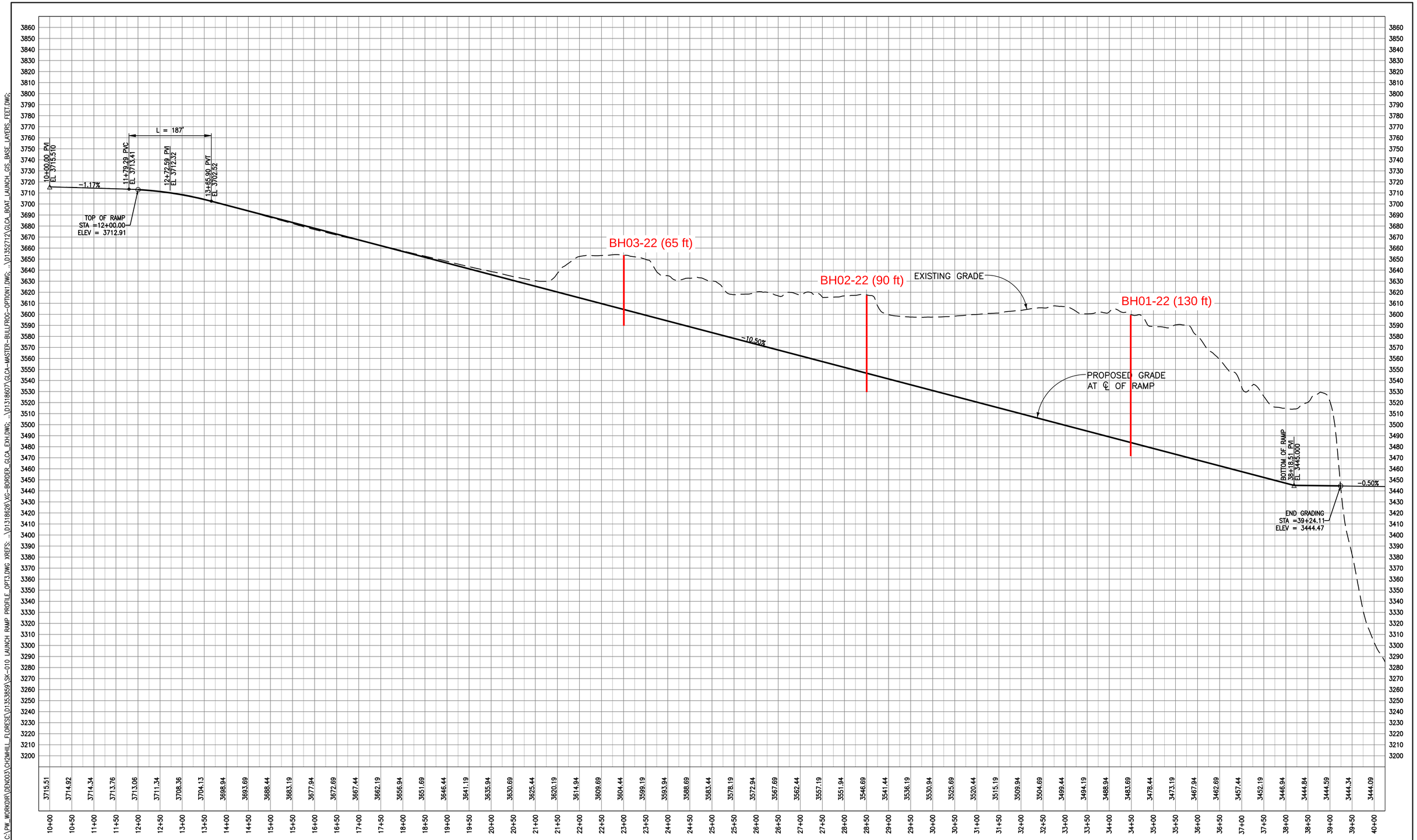
SK-009

TITLE OF SHEET

ANTELOPE POINT LAUNCH RAMP
LAUNCH RAMP PROFILE
OPTION 2

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/10/22 12:28 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353859\SK-010 LAUNCH RAMP PROFILE_OPT3.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG; ..\D1318607\GLCA-MASTER-BULLFROG-OPTION1.DWG; ..\D1352712\GLCA_BOAT_LAUNCH_GIS_BASE_LAYERS_FEET.DWG;



40 0 40 80 VERTICAL
SCALE OF FEET

100 0 100 200 HORIZONTAL
SCALE OF FEET

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E. FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 10, 2022

SUB SHEET NO.
SK-010

TITLE OF SHEET
STRUCTURAL
ANTELOPE POINT LAUNCH RAMP
LAUNCH RAMP PROFILE
OPTION 3
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/16/22 10:00 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353889\SK-003 ROADWAY PLAN_OPT1.DWG XREFS: ..\D1318626\VG-BORDER_GLCA_EXH.DWG; ..\D1318629\GLCA-EXIST-CONTOURS-HITE.DWG; ..\D1318607\GLCA-MASTER-HITE-UPPERNORTH-OPT1.DWG;

ROADWAY LENGTH
1,707 LF

SH 95

BH01-22 (50 ft)

BH04-22 (40 ft)

Location to be confirmed
after site reconnaissance.

ROCK CUT/FILL
(SLOPE VARIES)

DESIGN WATER
LEVEL +3596 FT

LAUNCH RAMP

C O L O R A D O R I V E R

LEGEND

- ROCK CUT/FILL BOUNDARY
- 3680 EXISTING ELEVATION
- 3650 ELEVATION
- DESIGN WATER LEVEL +3596 FT
- EXISTING ROAD

TRUE NORTH PROJECT NORTH

40 0 40 80
SCALE OF FEET

DRAFT
NOT FOR CONSTRUCTION

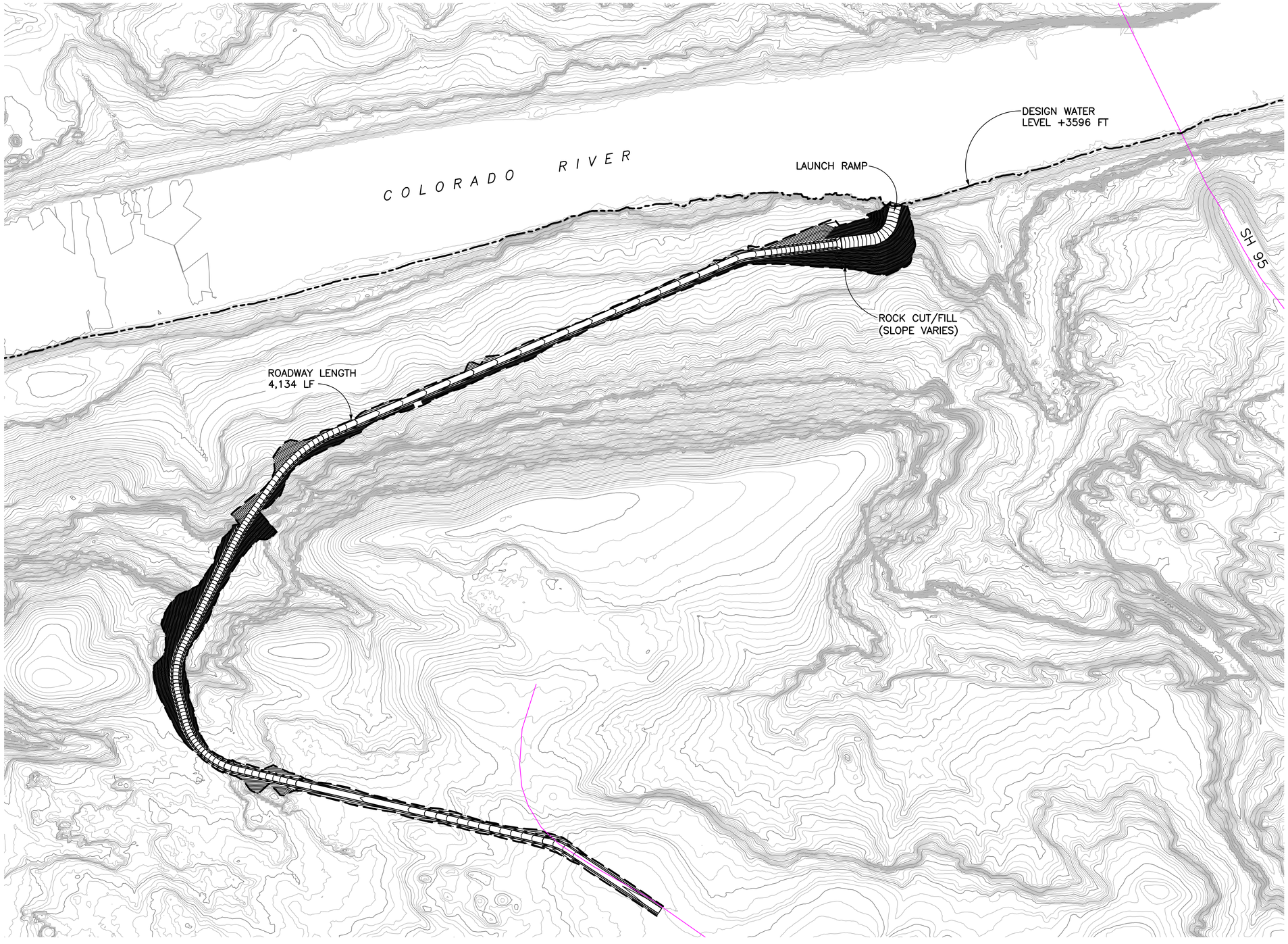
FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E. FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 16, 2022

SUB SHEET NO.
SK-003

TITLE OF SHEET
STRUCTURAL
HITE LAUNCH RAMP ROADWAY PLAN OPTION 1
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/16/22 10:10 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353889\SK-004 ROADWAY PLAN_OPT2.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG; ..\D1318629\GLCA-EXIST-CONTOURS-HITE.DWG; ..\D1318607\GLCA-MASTER-HITE-UPPERSOUTH-OPT2.DWG;



LEGEND

- ROCK CUT/FILL BOUNDARY
- DESIGN WATER LEVEL +3596 FT
- EXISTING ROAD

TRUE NORTH PROJECT NORTH

150 0 150 300

SCALE OF FEET

DRAFT

NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E. FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 16, 2022

SUB SHEET NO.

SK-004

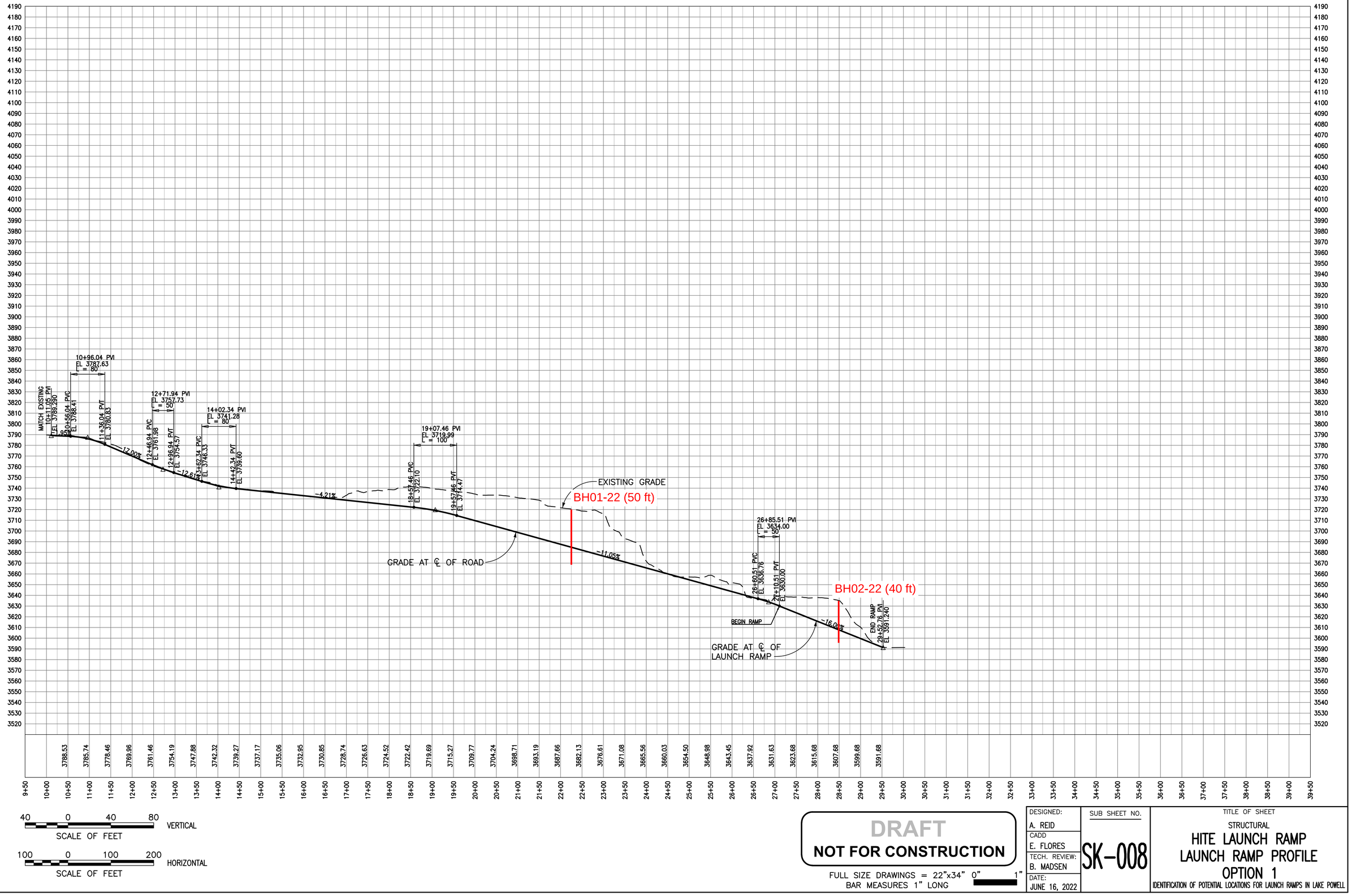
TITLE OF SHEET

STRUCTURAL

HITE LAUNCH RAMP ROADWAY PLAN OPTION 2

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/16/22 11:26 FLORESE R22 C:\PW_WORKDIR\DENO03\CH2MHILL_FLORESE\D1353889\SK-008 LAUNCH RAMP PROFILE_OPT1.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG;



40 0 40 80
SCALE OF FEET
VERTICAL

100 0 100 200
SCALE OF FEET
HORIZONTAL

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E. FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 16, 2022

SUB SHEET NO.

SK-008

TITLE OF SHEET

STRUCTURAL

HITE LAUNCH RAMP
LAUNCH RAMP PROFILE
OPTION 1

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/16/22 11:28 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353889\SK-009 LAUNCH RAMP PROFILE_OPT2_SHEET 1.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG;

MATCH EXIST
36+77.79 PVI
EL 3958.284

39+08.30 PVC
EL 3957.79

39+58.30 PVI
EL 3957.68
L = 100

40+08.30 PVT
EL 3954.57

-0.22%

BH01-22 (30 ft)

-6.23%

44+18.14 PVC
EL 3929.04

44+68.14 PVI
EL 3925.93
L = 100

45+18.14 PVT
EL 3925.33

-1.19%

47+60.65 PVC
EL 3922.45

48+10.65 PVI
EL 3921.86
L = 100

48+60.65 PVT
EL 3917.10

-9.53%

50+36.21 PVC
EL 3900.37

50+86.21 PVI
EL 3895.60
L = 100

:21 PVT
86.39

EXISTING GRADE

BH02-22 (60 ft)

GRADE AT ℄ OF ROAD

-18.42%

58+37.58 PVC
EL 3757.17

58+87.58 PVI
EL 3747.96
L = 100

59+37.58 PVT
EL 3741.75

-12.41%

62+17.50 PVC
EL 3707.02

62+67.50 PVI
EL 3700.82
L = 100

63+17.50 PVT
EL 3699.49

MATCHLINE STA 65+00 (SEE SHEET NO. SK-010)

36+00	36+50	37+00	37+50	38+00	38+50	39+00	39+50	40+00	40+50	41+00	41+50	42+00	42+50	43+00	43+50	44+00	44+50	45+00	45+50	46+00	46+50	47+00	47+50	48+00	48+50	49+00	49+50	50+00	50+50	51+00	51+50	52+00	52+50	53+00	53+50	54+00	54+50	55+00	55+50	56+00	56+50	57+00	57+50	58+00	58+50	59+00	59+50	60+00	60+50	61+00	61+50	62+00	62+50	63+00	63+50	64+00	64+50	65+00
3958.24	3958.13	3958.02	3957.91	3957.81	3957.18	3955.06	3951.97	3948.85	3945.74	3942.63	3939.51	3936.40	3933.28	3930.17	3927.31	3925.63	3924.95	3924.36	3923.77	3923.17	3922.58	3921.34	3918.06	3913.35	3908.58	3903.82	3898.97	3892.48	3883.85	3874.64	3865.42	3856.21	3847.00	3837.79	3828.58	3819.36	3810.15	3800.94	3791.73	3782.52	3773.30	3764.09	3754.93	3746.84	3740.21	3734.01	3727.80	3721.60	3715.40	3709.19	3703.50	3700.11	3698.63	3697.31	3695.98	3694.66

40 0 40 80 VERTICAL
SCALE OF FEET

100 0 100 200 HORIZONTAL
SCALE OF FEET

DRAFT
NOT FOR CONSTRUCTION

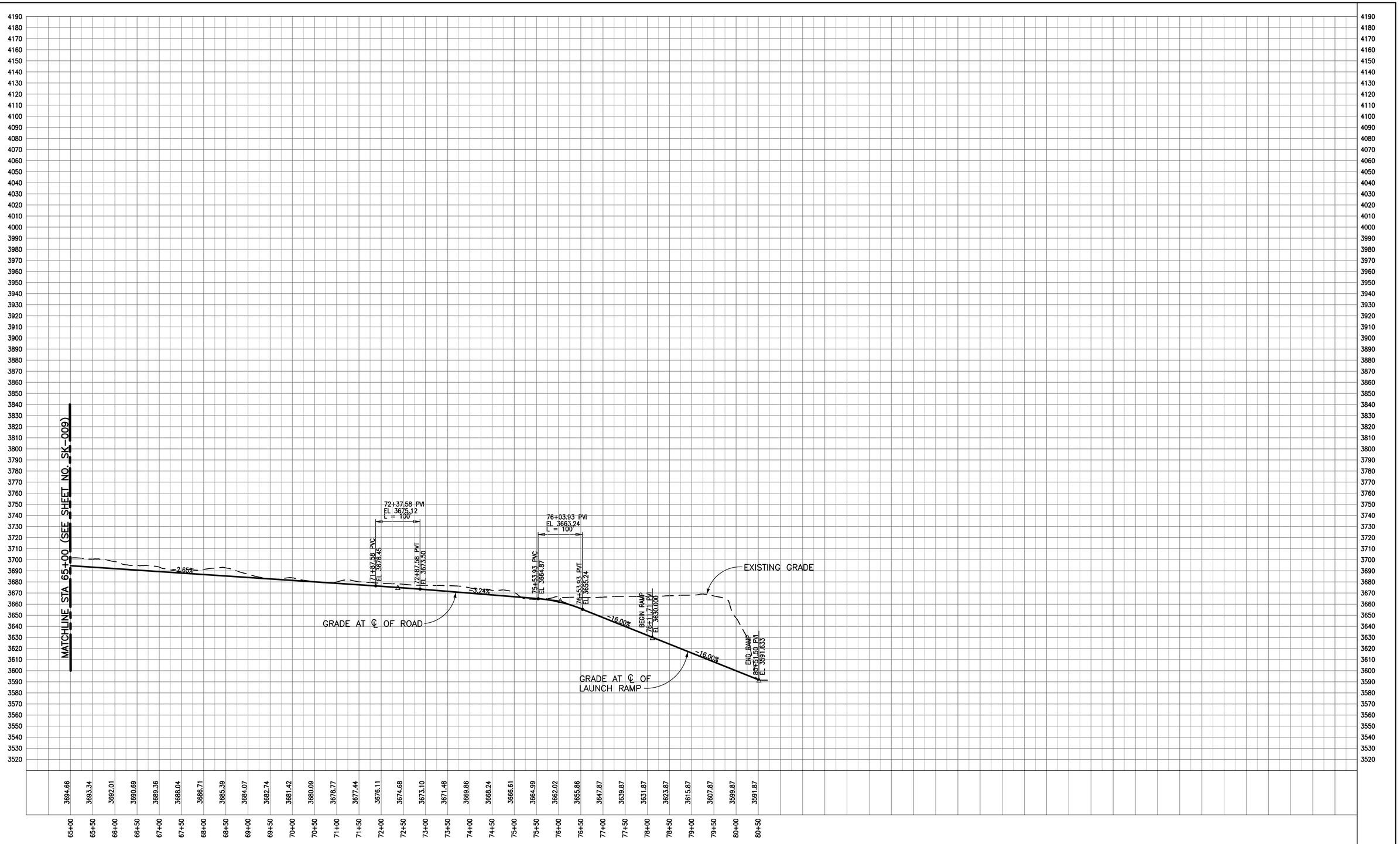
FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	A. REID
CADD	E.FLORES
TECH. REVIEW:	B. MADSEN
DATE:	JUNE 16, 2022

SUB SHEET NO.
SK-009

TITLE OF SHEET
HITE LAUNCH RAMP
LAUNCH RAMP PROFILE
OPTION 2 – SHEET 1 OF 2
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

6/16/22 11:33 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353889\SK-010 LAUNCH RAMP PROFILE_OPT2_SHEET 2.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DWG;



40 0 40 80
SCALE OF FEET
VERTICAL

100 0 100 200
SCALE OF FEET
HORIZONTAL

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

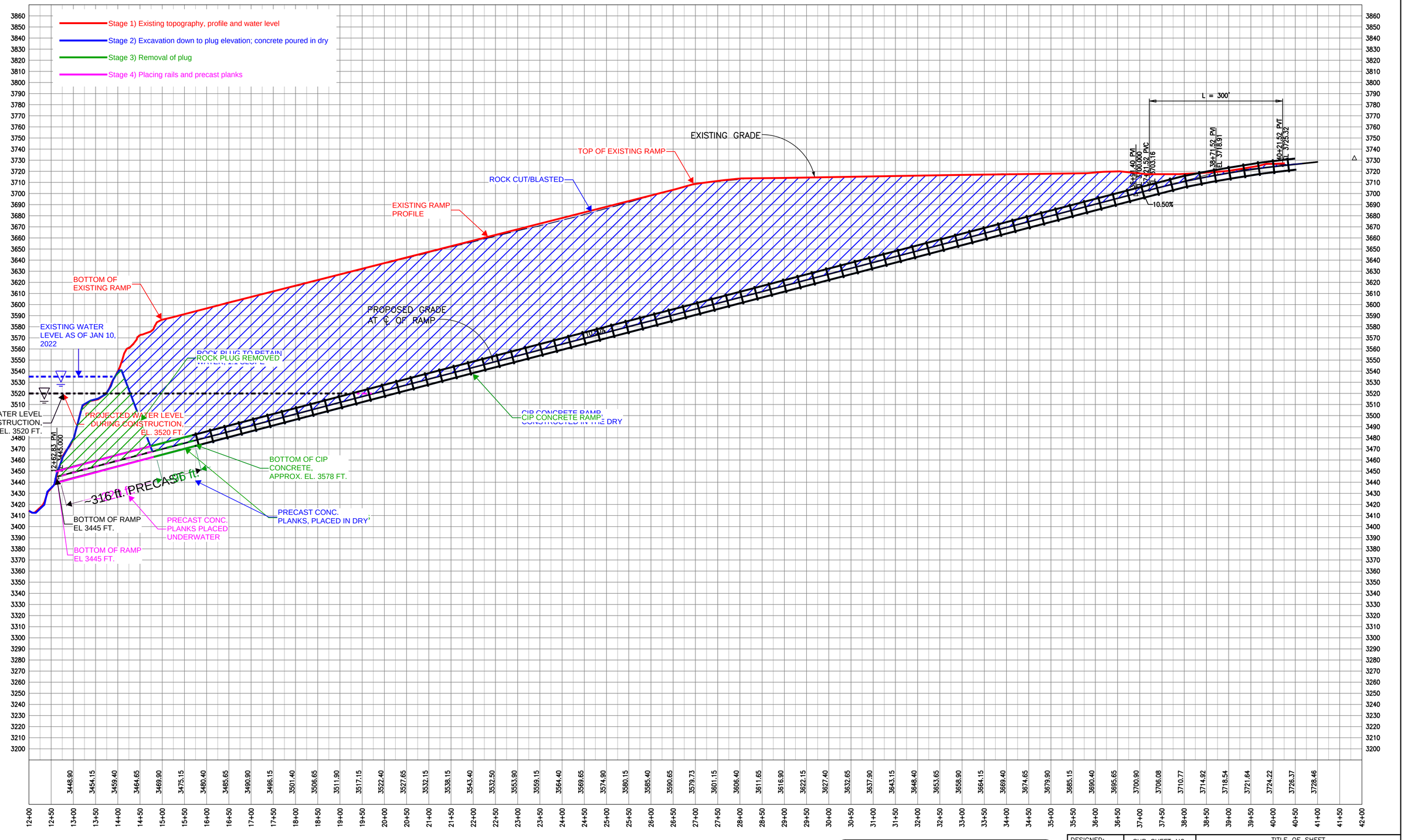
DESIGNED: A. REID	SUB SHEET NO. SK-010
CADD E. FLORES	
TECH. REVIEW: B. MADSEN	
DATE: JUNE 16, 2022	

TITLE OF SHEET

HITE LAUNCH RAMP
LAUNCH RAMP PROFILE
OPTION 2 – SHEET 2 OF 2

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

Appendix F – Construction Phasing Diagrams



40 0 40 80 VERTICAL
SCALE OF FEET

100 0 100 200 HORIZONTAL
SCALE OF FEET

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED: J. McRAE	SUB SHEET NO.	TITLE OF SHEET
CADD E. FLORES	SK-004	STRUCTURAL
TECH. REVIEW:		ANTELOPE POINT LAUNCH RAMP LAUNCH RAMP PROFILE
DATE: JANUARY 13, 2022		IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

1/27/22 00:55 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353859\SK-004 LAUNCH RAMP PROFILE.DWG XREFS: ..\D1318626\XG-BORDER_GLCA_EXH.DW

Stage 1) Existing topography, profile and water level

Stage 2) Excavation down to plug elevation; concrete poured in dry

Stage 3) Removal of plug

Stage 4) Placing rails and precast planks

EXISTING WATER LEVEL AS OF JAN 10, 2022, EL. 3535 FT.

PROJECTED WATER LEVEL DURING CONSTRUCTION, EL. 3520 FT.

APPROXIMATE LOCATION OF TRANSITION FROM CIP CONCRETE TO PRECAST, CONTRACTOR SHALL DETERMINE FINAL LOCATION

ROCK CUT/BLASTED

ROCK PLUG REMOVED

ROCK PLUG TO RETAIN WATER, 1:1 SLOPE

GRADE AT ℄ OF LAUNCH RAMP

EXISTING GRADE

ROCK CUT/BLASTED

FILL ADDED

GRADE AT ℄ OF ROAD

TOP OF RAMP PVI STA 38+56.99 EL. 3700.000

CIP CONCRETE RAMP; CIP CONCRETE RAMP; CONSTRUCTED IN THE DRY

BOTTOM OF CIP CONCRETE, APPROX. EL. 3520 FT.

~115 ft.

~720 ft. PRECAST

PRECAST CONC. PLANKS PLANKS, PLACED IN DRY

BOTTOM OF RAMP PVI STA 14+28.42 EL. 3445.000

BOTTOM OF RAMP EL 3445 FT.

BOTTOM OF RAMP EL 3445 FT.

PRECAST CONC. PLANKS PLACED UNDERWATER

40 0 40 80 SCALE OF FEET VERTICAL

100 0 100 200 SCALE OF FEET HORIZONTAL

DRAFT

NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	J. McRAE
CADD	E. FLORES
TECH. REVIEW:	
DATE:	FEBRUARY 2, 2022

SUB SHEET NO. SK-007

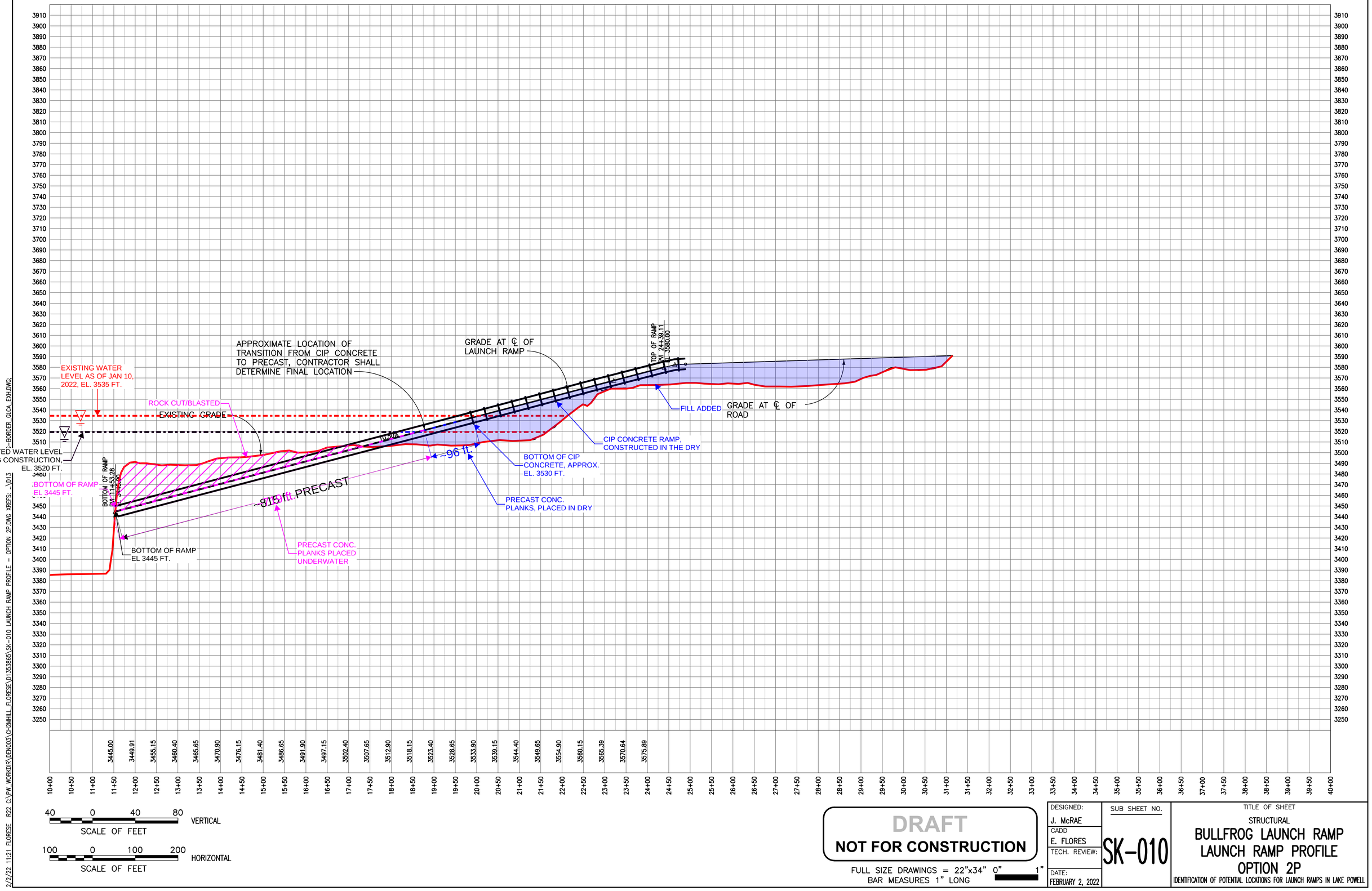
TITLE OF SHEET

STRUCTURAL

BULLFROG LAUNCH RAMP LAUNCH RAMP PROFILE OPTION 1

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

2/2/22 17:37 FLORESE R22 C:\PW_WORKDIR\DEN003\C42MHILL_FLORESE\D1353865\SK-007 LAUNCH RAMP PROFILE - OPTION 1.DWG XREFS: ..\D1318607\GLCA-MASTER-BULLFROG-OPTION1.DWG; ..\D1352712\GLCA_BOAT_LAUNCH_GIS_BASE_LAYERS_FEET.DWG; BORDER_GLCA_EXH.DWG; ..\D1318607\GLCA-MASTER-BULLFROG-OPTION1.DWG; ..\D1352712\GLCA_BOAT_LAUNCH_GIS_BASE_LAYERS_FEET.DWG; ..\D131



DRAFT

NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	J. McRAE
CADD	E. FLORES
TECH. REVIEW:	
DATE:	FEBRUARY 2, 2022

SUB SHEET NO.

SK-010

TITLE OF SHEET

STRUCTURAL

BULLFROG LAUNCH RAMP LAUNCH RAMP PROFILE OPTION 2P

IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

2/2/22, 11:21 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353865\SK-010 LAUNCH RAMP PROFILE — OPTION 2P.DWG XREFS: ..\D13...-BORDER_GLCA_EXH.DWG;

TOP OF RAMP
STA = 41+44.64
ELEV = 3700.000

TOP OF EXISTING RAMP

EXISTING RAMP PROFILE

BOTTOM OF EXISTING RAMP

APPROXIMATE LOCATION OF TRANSITION FROM CIP CONCRETE TO PRECAST, CONTRACTOR SHALL DETERMINE FINAL LOCATION

EXISTING GRADE

EXISTING WATER LEVEL AS OF JAN 10, 2022, EL. 3535 FT.

GRADE AT ℄ OF LAUNCH RAMP

CIP CONCRETE RAMP, CONSTRUCTED IN THE DRY

BOTTOM OF CIP CONCRETE, BASED ON COST ESTIMATE, APPROX. EL. 3530 FT.

PROJECTED WATER LEVEL DURING CONSTRUCTION, EL. 3520 FT.

MATCH EXIST
STA = 16+31.31
ELEV = 3405.624

END OF RAMP, ELEV = 3445

BOTTOM OF RAMP EL 3445 FT.

50.00%

719+815 ft.

-96 ft.

FILL ADDED

PRECAST CONC. PLANKS, PLACED IN DRY

BOTTOM OF RAMP EL 3445 FT.

FILL ADDED

PRECAST CONC. PLANKS PLACED UNDERWATER

40 0 40 80
SCALE OF FEET
VERTICAL

100 0 100 200
SCALE OF FEET
HORIZONTAL

DRAFT
NOT FOR CONSTRUCTION

FULL SIZE DRAWINGS = 22"x34" 0" 1"
BAR MEASURES 1" LONG

DESIGNED:	J. McRAE
CADD	E. FLORES
TECH. REVIEW:	
DATE:	FEBRUARY 2, 2022

SUB SHEET NO.
SK-004

TITLE OF SHEET
STRUCTURAL
HALLS CROSSING LAUNCH RAMP LAUNCH RAMP PROFILE
IDENTIFICATION OF POTENTIAL LOCATIONS FOR LAUNCH RAMPS IN LAKE POWELL

2/2/22 10:39 FLORESE R22 C:\PW_WORKDIR\DEN003\CH2MHILL_FLORESE\D1353873\SK-004 LAUNCH RAMP PROFILE.DWG XREFS: ..\D1318626\XG-B01 A_EXH.DWG;

Appendix G – NPS Permitting Assessment Form

Permitting Assessment for:
GLCA PMIS TBD

Project Meta Data					
PROJECT TITLE: GLCA Bullfrog Low Water Boat Ramps				PMIS #:	TBD
PARK: Glen Canyon National Recreation Area	Permitting Lead: Nancy Shelton	PROGRAM:		PEPC ID#:	TBD
1st PARK CONTACT: Tim Kennedy	2nd PARK CONTACT: Jennifer Hardin	REGION:	Intermountain Region		
DSC PM: Mike Will	DSC PS: Amy Hribar	Assessor's Name: Nancy Shelton			
A/E: Jacobs Engineering Group, Inc.	A/E CONTACT: Erika Rosenstein	Dates of Assessment -	First:3/14/2022	Most recent:	
Notes:					

Jurisdictional Assessment		
Questions Examining Jurisdiction - Who needs to be involved?		
Is the site COMPLETELY on NPS land?	Yes	The site is completely within GLCA
What is the classification of the jurisdiction for the Park at the site? See RM39-1, pg. 9. [1]	Exclusive (federal only)	Source: NPS per Public Law 92-593, Oct 27, 1972
Has the site's jurisdiction been DOCUMENTED?	Yes	GLCA boundaries defined in 16 U.S.C 460
Questions regarding circumstances that might give an agency jurisdiction at a site.		
Is there standing water on site?	Yes	Based on site reconnaissance and aerial photography
Are there water channels on site?	Yes	Based on site reconnaissance and aerial photography
Is there any know local jurisdiction on the site?	Yes	UDOT Ferry uses the docks when there is sufficient water
Have the site's structures been reviewed? (levees, utilities, etc.)?	Yes	Utilities considered during concept development; electricity, communication, distribution panel, light pole, and transformer included.
Other designations that may carry rights (special waters, critical habitat, easements etc.)?	Yes	Impaired water; https://deq.utah.gov/water-quality/water-quality-assessment-map

List other existing permits, easements, agreements, etc. that are in the site boundaries site:
Need to investigate if UDOT has easement for ferry ramp/highway
Can NPS confirm whether there are agreements or permits for the marina or existing ramp?

Notes on Jurisdictional Assessment:
Need to investigate if UDOT has easement for ferry ramp/highway
Need Bullfrog concessionaire agreement(s)

Impacts to Resource Topics - Compliance Related					
Part of project	Listed Species Incidental Take: Fish (NPS typically avoids incidental take)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:	NMFS and/or FWS	ESA § 7, 9		Based on informal IPaC and aerial photography--Field visit, prepare Biological Assessment (BA), Section 7 Consultation, if needed.
Unknown	State:	UT Div. of Wildlife Resourc	UT Code 23		Prepare BA and coordinate with UT Division of Wildlife Resources
No	Local:				
Basis of Decision: Informal IPAC obtained. Species identified include *Gila elegans, Ptychocheilus lucius, Gila cypha, and Xyrauchen texanus* . Will be confirmed based on official USFWS IPaC, field visit, and consultation with USFWS as needed.					
Not part of project	Listed Species Incidental Take: Marine Mammals (NPS typically avoids incidental take)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision: Inland location					
Part of project	Listed Species Incidental Take: Terrestrial (NPS typically avoids incidental take)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:	USFWS	ESA § 9, MBTA, BGEPA		Field visit, prepare BA, and Section 7 Consultation, if needed; review project for migratory birds, eagles
Unknown	State:				Prepare BA and coordinate with UT Division of Wildlife Resources for state species
No	Local:				
Basis of Decision: Informal IPAC obtained. Species identified include *Gymnogyps californianus, Strix occidentalis lucida, Empidonax traillii extimus, Coccyzus americanus, Danaus plexippus, Cycladenia humilis var jonesii, and Carex specuicola* . Will be confirmed based on official USFWS IPaC, field visit, and consultation with USFWS as needed.					
Part of project	Protected/Critical Habitat (NPS typically avoids incidental take)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:	USFWS	ESA § 7, 9		Based on informal IPaC, critical habitat for the Mexican Spotted Owl overlapses the project area. A field visit is needed to determine whether Primary Constituent Elements occur; will be documented in BA and Section 7 consultation, if needed.
Unknown	State:				
No	Local:				
Basis of Decision: Informal IPAC obtained. Critical habitat will be confirmed based on official USFWS IPaC, field visit, and consultation with USFWS as needed.					
Part of project	Waters of the US and Wetlands (or other Special Aquatic Sites)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:

Yes	Federal:	USACE, USEPA	CWA § 404, EO 11990	Section 404/10, 401	Dredge and fill activities would occur within the Water of the U.S. Prepare preliminary jurisdictional deliineation and permit applicated based on design; BA and cultural resource determinations would be attached to the permit application/notification.
No	State:				
No	Local:				

Basis of Decision: Permanent impacts based on design.

Unknown	Floodplain (Construction in)			
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:	FEMA	44 CFR, EO 11988,	NFIP Permit	No digital or printed data for the panel-4900654050B, 8/5/1986
No	State:				
No	Local:				

Basis of Decision: Floodplain designation unknown per the FEMA website.

Not part of project	Coastal Lands - Usually addressed in NEPA on NPS land. **If project is NOT on NPS land review this topic.**			
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	NOAA	CZMA		
No	State:				
No	Local:				

Basis of Decision:

Part of project	Navigable Waters			
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Yes	Federal:	USACE, USCG	33 U.S.C. 1344, 33 U.S.C. 403 (R&HA 1899 §§9-10)	Section 4040, Section 10	Develop Preliminary Jurisdictional Delineation (PJD) and permit application; permit determined based on design
No	State:				
No	Local:				

Basis of Decision: Colorado River is a navigable water.

Part of project	Water Quality Certification (required if project has federal permit)			
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Yes	Federal:	USACE	CWA § 404, EO 11990,	Section 404 dredge and fill	

Yes	State:	UDEQ	CWA § 401	401 certification	Certification if IP required; NWP then no cert required
No	Local:				

Basis of Decision: Will coordinate with the Corps to determine the appropriate permit. 401 certification is dependent on the level of permitting.

Not part of project	Mine Land			
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	DOI-OSM	SMCRA		
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Zoning - Not normally required on NPS land			
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Unknown	OTHER TOPIC:			
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				
Unknown	State:				
Unknown	Local:				

Basis of Decision:

Topics included in Design - Integrated into Plans					
Not part of project	Septic System				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Wastewater Collection System				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Wastewater Pump/Lift Station				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Wastewater Treatment Plant				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Pretreatment, i.e. Oil/Water Separator				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Unknown	Stormwater Management (permanent)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				

Unknown	State:				
No	Local:				

Basis of Decision:

Not part of project	Aggregation Pt. or Transfer Facility				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Landfill (NPS does not usually allow Landfills on NPS land)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:		RCRA, 36 CFR Part 6 §6.5[2], NPS Guidance[3],		
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Drinking Water Treatment Plant				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Well Construction (includes geothermal)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Underground Injection				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Tank Construction (AST or UST)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	US Code, Title 42, Chap 82, Sub chap IX		
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Hazardous Material/Waste Storage				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	RCRA , OSHA, and NESHAPS	Permit	
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Communication Tower				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	FCC		Permit	
No	State:				
No	Local:				

Basis of Decision:

Unknown	Roadway/Highway and Associated structures				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:	NPS			Improvements to Stanton Creek Road/new road segment to be constructed.
Unknown	State:	UDOT			Determine if there are any permits associated with the Ferry/Hwy?
No	Local:				

Basis of Decision: Need to determine if there are UT 273 easement(s) at ramps and ferry route.

Unknown	Work in Navigable Waters - Aids to Navigation				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:	USCG			
Unknown	State:				
Unknown	Local:				

Basis of Decision:

Unknown	OTHER TOPIC:				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				
Unknown	State:				
Unknown	Local:				

Basis of Decision:

Construction Topics (Based on Means and Methods)					
Unknown	Construction Air Pollution - Usually handled via Division 1 Specifications				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	Clean Air Act-Title II		
No	State:				
No	Local:				
Basis of Decision: No fugitive dust control plan is needed (UDEQ, utah.gov); temporary use of machinery/equipment in this area that is in attainment for criteria pollutants will not result in a public health hazard.					
Not part of project	Airport Hazard/Safety Clearances				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Railroad Crossing				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Unknown	Highway Encroachment Permit				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
Unknown	State:	UDOT			Need to determine if there is an easement for UT 273 at the ramp
No	Local:				
Basis of Decision: Coordination with UDOT required to determine easement/encroachment issues.					
Unknown	Traffic Control				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				
Unknown	State:				
Unknown	Local:				

Basis of Decision: Local traffic control may be needed around the project area during construction.

Unknown	Digging / Excavation Permit - Usually handled via Division 1 Specifications				
Needed?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				
Unknown	State:				
Unknown	Local:				

Basis of Decision:

Unknown	Noise Abatement - Usually handled via Division 1 Specifications				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				Determine potential for species to be present that may have seasonal contstraints on construction noise.
No	State:				
No	Local:				

Basis of Decision: Would be determined during the biological investigations.

Part of project	NPDES over an acre Construction Permit				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA			
Unknown	State:	UDEQ	UPDES		If more than 1 ac disturbed; general permit can be used if under 5 ac of disturbance
No	Local:				

Basis of Decision: UPDES permit to be determined based on area of disturbance

Unknown	Temporary Utilities (Communication, Electrical, Water, Sanitary Sewer, etc.)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				
Unknown	State:				
Unknown	Local:				

Basis of Decision:

Unknown	Hazardous Waste Removal, Transportation, and disposal				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	CAA, Section112	NESHAP	Determine presence of asbestos or lead paint if demolition occurs
Unknown	State:	UDEQ	UT Admin Code, Rule R307-801	UT State Asbestos Rule	Determine presence of asbestos or lead paint if demolition occurs
No	Local:				
Basis of Decision: Not anticipated; new construction. May be a consideration for relocation of marina/moorings.					

Unknown	Work in Navigable Waters - Notice to Mariners				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:	USCG			
Unknown	State:				
Unknown	Local:				
Basis of Decision:					

Unknown	OTHER TOPIC:				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				
Unknown	State:				
Unknown	Local:				
Basis of Decision:					

Operational Permits - Owner					
Not part of project	AST Operation				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	Clean Air Act Title V, NESHAP	Permit	
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	UST Operating				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	Clean Air Act Title V	Permit	
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Stationary Source Air Quality				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Solid Waste Incineration Unit				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Septic System				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Wastewater Treatment Plant				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Pretreatment (e.g. Oil/Water Separator)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Wastewater Pump Station				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Food Services (usually acquired by the Concessioner)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Drinking Water Treatment Plant				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	Safe Drinking Water Act	PWS permit	
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Well Construction (includes geothermal)				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Underground Injection Well				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Waste Transfer - Aggregation Facility				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Landfill				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				
No	Local:				

Basis of Decision:

Not part of project	Small Quality Generator				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:				
No	State:				

No	Local:				
Basis of Decision:					
Not part of project	Hazardous Material/Waste Storage				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	USEPA	RCRA-40 CFR Parts 264 and 270		
No	State:				
No	Local:				
Basis of Decision:					
Not part of project	Communication Tower				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
No	Federal:	FCC[4]		Permit	
No	State:				
No	Local:				
Basis of Decision:					
Unknown	OTHER TOPIC:				
Permit?	Jurisdiction:	Agency	Law, regulation, etc.	Permit Type:	Requirements, Actions, Etc.:
Unknown	Federal:				
Unknown	State:				
Unknown	Local:				
Basis of Decision:					
Unknown	OTHER TOPIC:				