PERMIT APPLICATION

Utah Lake Restoration Project

SPK 2018-00503

Prepared for:

Lake Restoration Solutions, LLC
1280 S 1380 West, Unit #11
Orem, UT 84058

Prepared by:

Geosyntec consultants

215 South State Street
Suite 500
Salt Lake City, Utah 84111

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ACRONYMS AND ABBREVIATIONS

%	percent
AADT	annual average daily traffic
AGRC	Automated Geographic Reference Center
AF	acre-feet
AKN	Avian Knowledge Network
amsl	above mean sea level
BLM	Bureau of Land Management
BMP	best management practice
BOR	Bureau of Reclamation
CFR	Code of Federal Regulations
CUPCA	Central Utah Project Completion Act
CWA	Clean Water Act
CWMU	cooperative wildlife management unit
DDT	dichloro-diphenyl-trichloroethane
DO	dissolved oxygen
DSM	deep soil mixing
EDRR	early detection rapid response
EFDC	Environmental Fluid Dynamics Code
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FES	Fisheries Experiment Station
FFSL	Forestry, Fire and State Lands
FLPMA	Federal Land Policy and Management Act
$g/m^2/d$	grams per square meters per 24 hours
GHG	greenhouse gas
GIS	global positioning system
GPI	Gardner Policy Institute

HAB	harmful algae bloom
IPaC	Information for Planning and Consultation
KOP	key observation point
LANDFIRE	Landscape Fire and Resource Management Planning Tool
LiDAR	light detection and ranging
LKSIM	Utah Lake Water Quality Salinity Model
LSZ	Landscape Similarity Zone
MBTA	Migratory Bird Treaty Act
MCS	Management Classification System
m	meter(s)
µg/L	microgram(s) per liter
mg/L	milligrams per liter
mL	milliliter(s)
MLID	monitoring location ID
MOVES	Motor Vehicle Emission Simulator
NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
PCB	polychlorinated biphenyl
PFYC	Potential Fossil Yield Classifications
ppb	parts per billion
PRDRP	Provo River Delta Restoration Project
PSOMAS	Psomas (Engineering and Environmental firm)

SAV	submerged aquatic vegetation
SDD	Secchi disc depth
SGCN	Species of Greatest Conservation Need
SR	State Route
SSURGO	Soil Survey Geographic
SWCA	SWCA Environmental Consultants
TAC	Technical Advisory Committee
TDS	total dissolved solids
TSI	trophic state index
UDAQ	Utah Division of Air Quality
UDNR	Utah Department of Natural Resources
UDOT	Utah Department of Transportation
UDWR	Utah Division of Wildlife Resources
UDWRe	Utah Division of Water Resources
UDWRi	Utah Division of Water Rights
UDWQ	Utah Division of Water Quality
UGS	Utah Geological Survey
ULRP	Utah Lake Restoration Project
ULWP	Utah Lake Wetland Preserve
URMCC	Utah Reclamation Mitigation and Conservation Commission
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UWCD	Uintah Water Conservancy District
VIA	Visual Impact Assessment
VRAP	Visual Resource Assessment Procedure

VRM	Visual Resource Management
WFZ	Wasatch Fault Zone
WWTP	wastewater treatment plant
YOY	young of year

1 INTRODUCTION

The Utah Lake Restoration Project (ULRP or Project) proposes to comprehensively restore and enhance Utah Lake. The Project includes dredging the majority of the lake bottom to remove nutrient-loaded sediment, replacing invasive plant and animal species with native species, and enhancing the water quality to a cleaner and more natural state. The dredged material will be placed in three types of newly formed containment areas (islands) within the lake: estuary islands, recreation islands, and development islands. Wildlife habitat areas and open space will be created on and around the containment areas and enhanced within and around the lake. Infrastructure (e.g., causeways, roads, utilities, boat ramps, and docks) will be constructed to facilitate access to and utilization of the development islands. This Individual Permit Application describes the existing environmental setting and conditions, regulatory framework, methods of analysis, potential environmental impacts, and mitigation and minimization measures for resources within the proposed Project area.

This report is prepared for the proposed Project’s Clean Water Act (CWA) Section 404 permit application to the United States Army Corps of Engineers (USACE) and to support the Environmental Impact Statement (EIS) for review under the National Environmental Policy Act (NEPA).

1.1 Applicant

APPLICANT:

Mr. Ryan D. Benson, CEO
Lake Restoration Solutions, LLC
1280 S 1380 West, Unit #11
Orem, UT 84058
Email: ryanbenson@lakerestorationsolutions.com
Cell Phone: (801) 870-5307

AGENT:

Mr. Scott Walker
Geosyntec Consultants, Inc
8217 Shoal Creek Boulevard, Suite 200
Austin, TX 78757
Email: scott.walker@geosyntec.com
Cell Phone: (361) 443-9454

1.2 General Location

The proposed ULRP is located within Utah Lake in Utah County, Utah, and is bounded by the city of Saratoga Springs and the Lake Mountains to the west; the cities of Lehi and American Fork to the north; the cities of Pleasant Grove, Lindon, Vineyard, Orem, Provo, and Springville to the east; and the city of Genola, agriculture land, and West Mountain to the south.

The proposed Project boundary is based on the Compromise Line for Utah Lake (representing an elevation of 4,489.045 feet above mean sea level [amsl]) and the state of Utah settled boundary line (Figure 1).

The proposed Project's area of analysis is generally defined as the Project boundary plus a 1-mile buffer and associated areas of interest that extend beyond the settled boundary line where the Project will tie into the shoreline. The area of analysis for each resource has been refined based on the specific analysis needs for each resource.

1.3 Preliminary Jurisdictional Determination and USACE Individual Permit Application Forms

The completed Application for Department of the Army Permit (ENG Form 4345) for the Project are included in the Preface of the application. Additional Project information is provided below and in the attached documents.

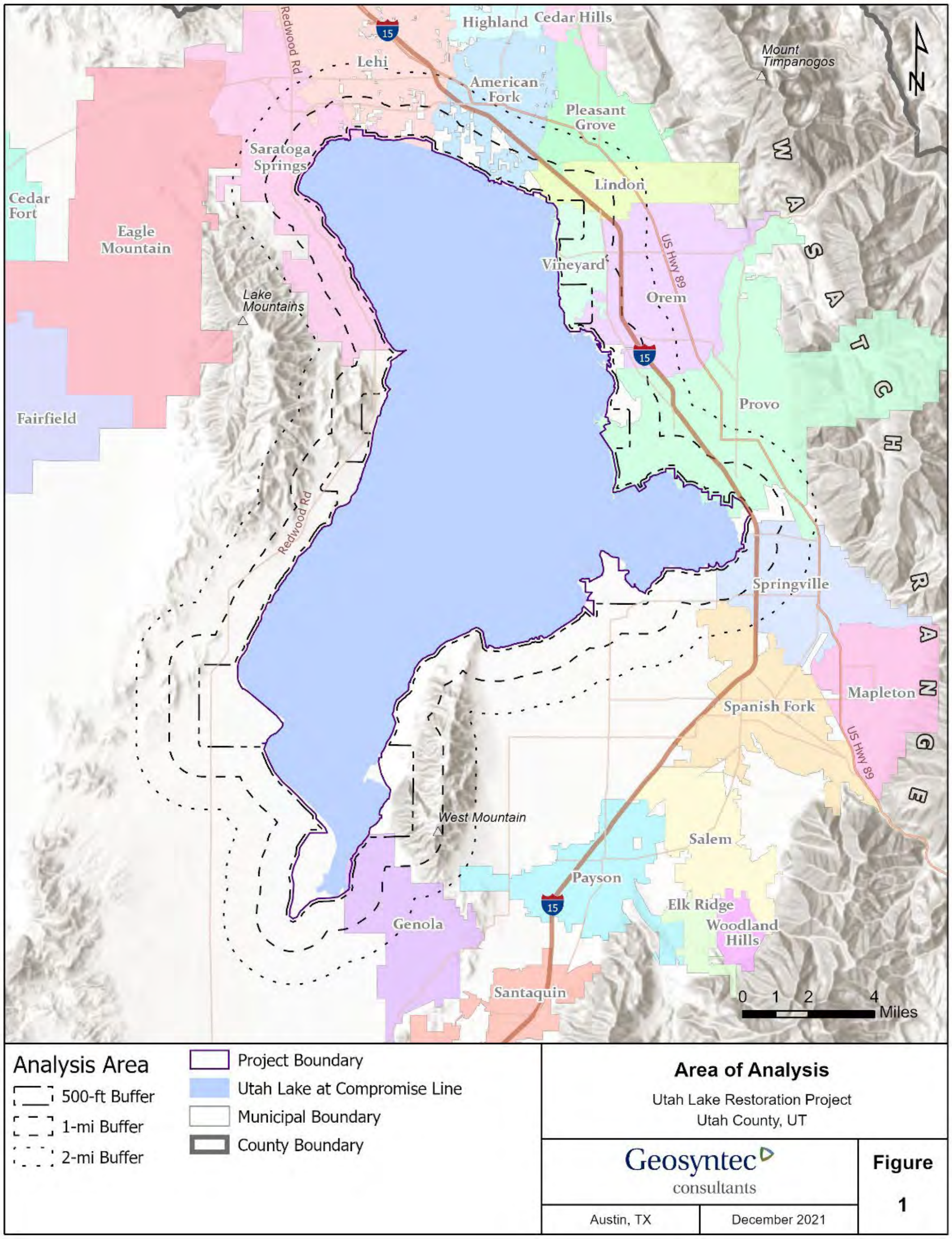

Figure 1. Utah Lake Project Area of Analysis

2 PURPOSE AND NEED

2.1 Basic Project Purpose

The basic Project purpose is to comprehensively restore and enhance Utah Lake, including dredge as needed, to recover the lake's ecosystem, build containment areas within the lake with the dredged material, and develop a portion of the containment areas to fund the enhancement and restoration efforts. Enhancement is the alteration of an ecosystem to produce conditions that did not previously exist to improve one or more values of a site (Lewis 1989). Restoration is the "return of an ecosystem to a close approximation of its condition prior to disturbance" (National Research Council [NRC] 1992). The Project entails both restoration and enhancement activities; including the dredging and deepening of Utah Lake and construction of islands, neither of which have been performed within Utah Lake. As a result of these activities, the Project has been deemed a water-dependent enhancement project.

2.2 Overall Project Purpose

In recent years, harmful and toxic algal blooms and the general ecological impairment of Utah Lake has become a significant concern. The state of Utah has begun pilot programs for restoration of various aspects of Utah Lake, including removing invasive common reed (*Phragmites australis*), removing non-native carp, restoring the native June sucker (*Chasmistes liorus*), and other efforts, to improve water quality through partnerships between the Utah Department of Natural Resources (UDNR), including the Utah Division of Forestry, Fire and State Lands (FFSL) and the Utah Division of Wildlife Resources (DWR); the Utah Department of Environmental Quality Division of Water Quality (DWQ); and the Utah Lake Commission. Despite significant efforts, Utah Lake continues to degrade. Without significant and comprehensive restoration and enhancement efforts, the future of Utah Lake, its plants, animal species, and use of the lake by residents of the state of Utah remains uncertain.

The Project purpose is to comprehensively restore and enhance Utah Lake, as defined by Utah H.B. 272 Utah Lake Restoration Act, including dredging as necessary to achieve those objectives. Utah Lake is located in waters of the United States (WOTUS) and subject to jurisdiction under Section 404 of the CWA. The work proposed includes the following:

- Dredging sediments from Utah Lake
- Placing the dredged material in newly formed containment areas (islands) also within Utah Lake to store and sequester nutrient-loaded sediments and put dredge material to beneficial use
- Restoring, enhancing, and creating new wetlands and littoral zones in and around the lake

- Constructing infrastructure (e.g., roadways, utility lines, boat ramps and docks) to facilitate access to and development of some of the containment areas to fund the restoration and enhancement activities

2.3 Agency and Stakeholder Coordination

LRS has worked diligently to coordinate with the agencies to guide the development of the Project. A summary of the agency and stakeholder coordination prior to submitting this application is in Appendix A.

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3 EXISTING CONDITIONS

The conditions currently present within the Project boundary and associated areas of analysis are described in this section. The section includes a description of cultural resources, biological resources including wetlands, aesthetics, land use, special management areas, social and economic setting, geology, soils, water resources, air quality and climate, and noise.

3.1 Biological Resources

Terrestrial and aquatic plant and animal species are described in this section on biological resources. This section describes the resource indicators and measures for biological analysis, the area of analysis for the various species, the method for analyzing impacts, and ecosystem and habitat types. This section also identifies endangered species, other flora and fauna, and the regulatory framework for evaluating impacts to biological resources.

3.1.1 Resource Indicators and Measures

Resource indicators used in terrestrial biological resource analysis include an evaluation of potential plant and animal species and their required habitat within the area of analysis and a description of the various habitat types. The size, quality, and availability of habitat is directly correlated with the capacity for it to support a diversity of plants and animals. Potential impacts of the Project to wildlife or its habitat may be measured either quantitatively through habitat acres removed or species lost or qualitatively in which cumulative impacts must be assessed to determine the long-term effects to the health or functionality of the habitat.

Resource indicators used in the fisheries and aquatic biological resource analysis include an evaluation of potential fish and aquatic species and their required habitat within the area of analysis. The size, quality, and availability of habitat is directly correlated with the capacity for it to support fish and a diversity of aquatic life. Potential impacts of the Project to fish and aquatic life and habitats may be measured either quantitatively through habitat acres removed or species lost or qualitatively in which cumulative impacts must be assessed to determine the long-term effects to the health or functionality of the habitat.

3.1.2 Area of Analysis

The Project's area of analysis for terrestrial biological resources is defined as the Project area boundary and associated additional areas of interest within a 1-mile buffer from the Project area boundary. The area of analysis totals 153,100 acres (239 square miles) that is approximately 56 percent (%) open water and 44% terrestrial habitats. Terrestrial biological habitats include those areas used by wildlife such as invertebrates, reptiles, amphibians, birds, and mammals and are defined primarily by land use and dominant vegetational community type. Specific habitats within the area of analysis and examples of the wildlife that use each habitat type are discussed further below.

The Project's area of analysis for fisheries and aquatic biological resources is defined as the Project area boundary and contributing flows and drainage basin associated with Utah Lake.

3.1.3 Method

The method used for analyzing the potential impacts to terrestrial and aquatic biological resources and their habitats included a literature review of available potential and known species' occurrences and a geographic information systems (GIS) desktop assessment of the area of analysis. GIS was used to overlay various land cover and other spatial datasets onto the area of analysis to gain an understanding of the general landscape features and ecology of the area.

3.1.4 Ecosystem and Habitat Types

3.1.4.1 Ecosystem

Ecoregions are mapped geographic delineations of landscapes containing ecosystems linked by similar climatic, geologic, soil, land use, potential natural vegetation, and landform characteristics (Omernik 1987). Omernik developed the most authoritative mapping of ecosystems in the continental United States on multiple regional scales with the Level III and Level IV being the more commonly used scales for ecoregion mapping. The ULRP area of analysis exists within the Utah Valley along the eastern edge of Omernik's Central Basin and Range (13) Level III Ecosystem (Figure 2).

3.1.4.2 Habitat Types

Eight representative habitat types were identified within the area of analysis around Utah Lake based on an analysis using the United States Department of Agriculture (USDA) and United States Department of the Interior joint Landscape Fire and Resource Management Planning Tool (LANDFIRE) 2016 Remap mapping system for Existing Vegetation Type (United States Geological Survey [USGS] 2016) (Figure 3). Vegetation communities were consolidated into selected habitat groups based on similar land use and dominant vegetation. Table 1 is a summary table of representative habitats.

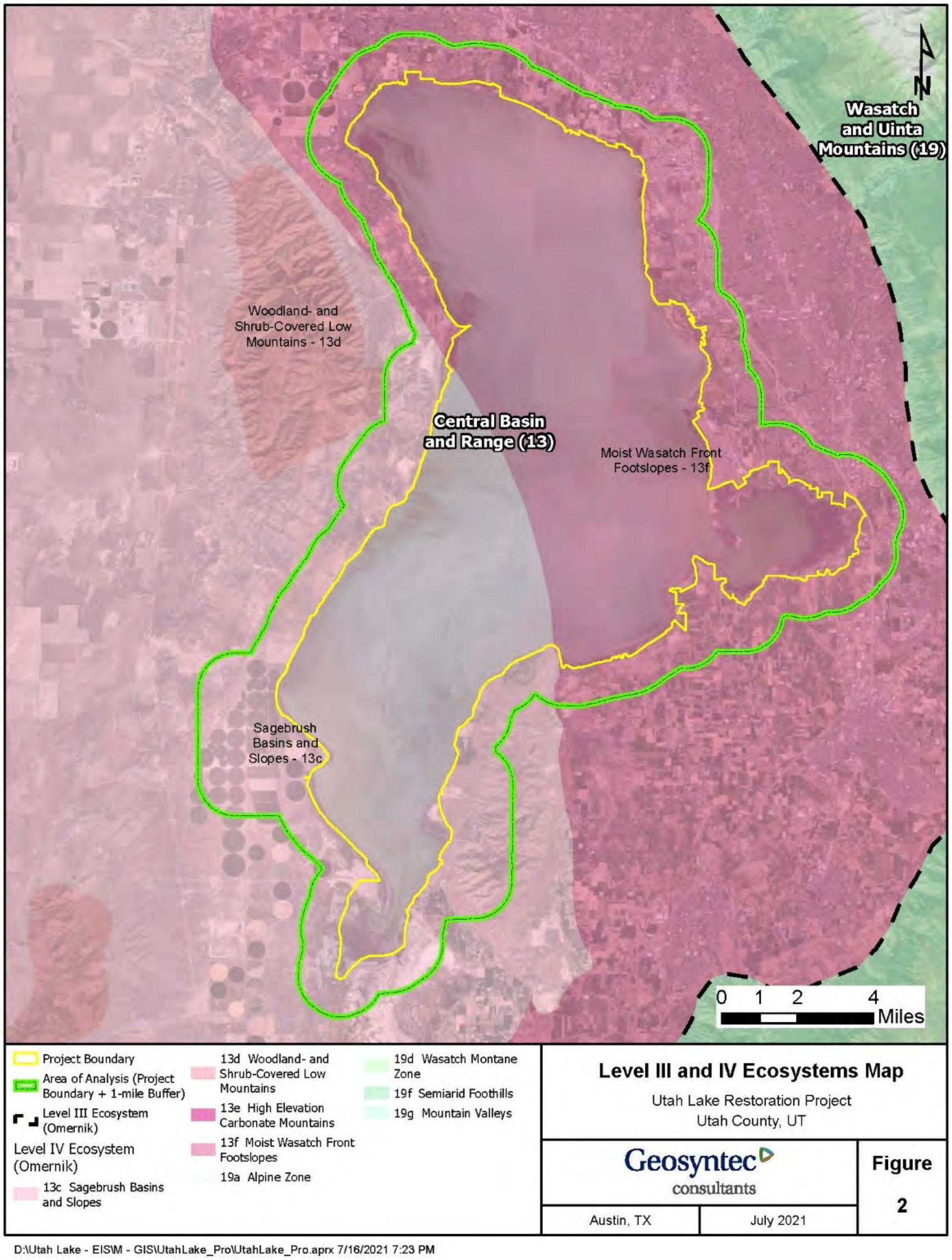

Figure 2. Ecosystems Map

Table 1. Summary of Habitat Types Within the Area of Analysis

Habitat Type	Acreage	Percentage
Open Water	85,602	55.9%
Wetland	9,526	6.2%
Upland Grassland	6,552	4.3%
Woodland	904	0.6%
Shrubland	15,697	10.2%
Developed/Urban	10,982	7.2%
Agriculture	23,727	15.5%
Sparsely vegetated	109	<0.1%
Total:	**153,100**	

3.1.4.2.1 Open Water

The largest area of habitat is open water that includes over 85,000 acres (56% of the area of analysis). The open water habitat includes Utah Lake and its multiple perennial waterways that feed into the lake. The Jordan River that flows north into the Great Salt Lake is the only outlet of Utah Lake. Utah Lake functions as a shallow, freshwater lake ecosystem with the potential for two alternative stable ecological conditions: a clear water state or a turbid water state. A clear water state is typically signified by a rich array of rooted aquatic plants (macrophytes), and a turbid water state is typically driven by single-celled algae (phytoplankton) production in the water column. Utah Lake is currently in a turbid water state with minimal macrophyte presence.

Historically, Utah Lake was dominated by rooted aquatic vegetation that protected the shorelines and shallow lake areas from wind-driven wave disturbance, thereby minimizing turbidity levels (United States Fish and Wildlife Service [USFWS] 2010). Studies conducted in the 1970s found seven major plant community types associated with Utah Lake that included pondweed, bulrush-cattail marshes, spikerush-bulrush meadows, lowland woody vegetation, saline terrestrial vegetation, and annual herbaceous vegetation (USFWS 2010). However, several ecological disturbances have led to a reduction of aquatic vegetation, thereby changing the lake from a complex clear water system to a simplified turbid system with poor water quality. Currently, the lake is dominated by microscopic, green algae known as phytoplankton. Phytoplankton are primary producers in the aquatic food web. When populations are in balance, phytoplankton provide a necessary energy resource for other aquatic species; however, when phytoplankton populations are overabundant, algae dominate the surface water, which blocks light from penetrating through the water column. If light cannot penetrate through the water column, photosynthesis in rooted aquatic plants is inhibited. As a result, the rooted aquatic vegetation community eventually collapses. Phytoplankton populations are stimulated by warm water and high-nutrient conditions. These conditions are often associated with surface water inputs and lake level fluctuations.

During the mid-1800s, settlers began modifying the Utah Lake Basin to accommodate water storage. Historically, water levels were higher than current conditions; the average lake level fluctuation was 2.1 feet annually. In the past 50 years, lake level fluctuations have increased to an average of 3.5 feet annually, leading to more frequent and longer periods of high and low water conditions (Braegger 2016). Though lake fluctuations are natural and expected in a shallow water system such as Utah Lake, prolonged periods of drought accentuate the effects of lake level changes over time. This was documented in the 1930s, 1960s, and 1990s when drought conditions created additional stresses to the system as observed through higher evaporation rates, decreased surface water inputs, and increased water demands. The increase in lake level fluctuations has eliminated much of the historically documented aquatic vegetation that helped decrease turbidity and provided necessary rearing habitat for juvenile fish species (USFWS 1999).

The introduction of non-native fishes, in particular common carp (*Cyprinus carpio*), has also led to a significant reduction in aquatic vegetation. Carp are a bottom-feeding species and are responsible for uprooting aquatic vegetation, thereby disturbing sediments and perpetuating the turbid water state (USFWS 2010). Aquatic vegetation also provides critical rearing habitat for juvenile fish; therefore, the absence of vegetation leaves juvenile native fishes susceptible to predators and in competition from non-native species. Phytoplankton, zooplankton, and macrophytic biota are also negatively affected by increased water turbidity. Low macrophyte densities, small-bodied zooplankton taxa, and decreased benthic macroinvertebrate biomass now characterize Utah Lake (Landom and Walsworth 2021). However, ongoing concerted carp removal efforts in Utah Lake have improved overall aquatic ecosystem health. Reduction of carp biomass in Utah Lake has resulted in increased abundance and biodiversity of phytoplankton and zooplankton (Landom and Walsworth 2021). In particular, the abundance of large-bodied zooplankton taxa has increased, providing an essential prey base for many Utah Lake fishes, including the June sucker (Landom and Walsworth 2021).

Utah Lake has at least 18 zooplankton taxa from several diverse groups, including rotifers, cladocerans, copepods, ostracods, and amphipods (Landom and Walsworth 2021). Future effects from climate change in turbid, shallow lakes such as Utah Lake may include higher summer chlorophyll *a* concentration with a stronger dominance of blue-green algae and reduced zooplankton abundance (reducing a primary food source of June suckers) (USFWS 2021a).

Benthic macroinvertebrates are essential taxon to the function of the Utah Lake ecosystem. They play a key role in the timing and intensity of harmful algal blooms (HABs) in Utah Lake (Richards and Miller 2017). Macroinvertebrates, such as midges and worms, are a principal prey base for most fish species in Utah Lake, including the June sucker, because they are easily digestible and protein rich (Landom and Walsworth 2021; Richards and Miller 2017). Unfortunately, Utah Lake benthic invertebrate fauna falls extremely short of natural development (i.e., depauperate). Three taxa account for almost 99% of the total benthic invertebrate biomass of Utah Lake. The three most dominant benthic macroinvertebrate taxa are *Chironomus* sp. (midge), *Tanypus* sp.(midge), and Oligochaeta (segmented worm) (Richards and Miller 2017). While the current taxa lack variability, their productivity is high (Richards and Miller 2017). Utah Lake contains an estimated 790 to 3,210 tons of chironomid midges in the sediments at any one time (Richards and Miller 2017). Increasing the diversity of shoreline macrophytes would increase macroinvertebrate abundance and diversity (Landom and Walsworth 2021). Provo Bay benthic assemblages differ from the rest of Utah Lake. This area has significantly greater benthic invertebrate biomass with Tanypodinae midges, rather than chironomid midges, dominating (Richards and Miller 2017).

The Utah Lake watershed historically supported one of the richest and most diverse freshwater mollusk assemblages in the western United States with some estimates suggesting more than 50 species of snails, mussels, and clams (Oliver and Bosworth 1999). Utah Lake alone supported 17 mollusk taxa before European settlement, including at least 2 major water quality regulator mussel taxa (Oliver and Bosworth 1999; Richards and Miller 2017). The Utah Lake food web was balanced by top-down predators, such as the Bonneville cutthroat trout (*Onchorynchus clarki Utah*), and bottom-up controllers, like mollusks (Richards and Miller 2017). Utah Lake has experienced severe mollusk decline with most of these species already extinct or facing population declines (Oliver and Bosworth 1999).

3.1.4.2.2 Wetlands

Wetlands are transitional areas between open water and uplands and can range from being narrow fringe habitat to broad extensive areas along numerous deltas that have formed along the eastern shoreline of the lake. Approximately 9,500 acres (6%) of wetland habitat exists within the area of analysis and includes meadows, marshes, forested and scrub-shrub wetlands, playas (mineral flats) and alkaline depressions. The extent of wetlands located along the lake’s shoreline vary with seasonal and long-term climatic variabilities. Additional details on the wetlands are provided in the Wetland Delineation Report (See Appendix B).

3.1.4.2.3 Upland Grasslands

Upland grassland occurs mostly on flat plains throughout the area of analysis but is more frequently found interspersed among other habitats. Pure stands of upland grasslands are rare due to accelerated changes to land uses and increased competition from non-native species.

3.1.4.2.4 Woodland

Woodland habitat is represented generally as an overstory of scattered tall trees with varying densities of lower canopy cover. The habitat type is the smallest area of vegetated land use with approximately 900 acres (< 1%) located within the area of analysis. This habitat type is primarily associated with riparian corridors along flowing streams into Utah Lake or pinyon-juniper-dominated areas found in higher elevations along the foothills of the Lake and West Mountain ranges.

3.1.4.2.5 Shrubland

Shrubland occurs extensively throughout most of the uplands in the area of analysis and accounts for over 15,500 acres (10%) of habitat. The vegetation within this habitat generally exhibits some level of disturbance from past or present land use.

3.1.4.2.6 Developed/Urban Landscape

The developed/urban landscape habitat is described as those areas that have been modified by man from its natural form. Species that occur within human-dominated ecosystems are described as urban wildlife and include both native and exotic species. Within the area of analysis, the developed/urban landscape habitat encompasses almost 11,000 acres (7%).

3.1.4.2.7 Agriculture

Historically, agriculture has been active since the settlement of the valley around Utah Lake by people of European ancestry. The primary use of Utah Lake and its associated streams has been for water for irrigation (Jackson and Stevens 1981). Agricultural lands account for the largest area of terrestrial habitat with almost 24,000 acres (15.5%) within the area of analysis.

3.1.4.2.8 Sparsely vegetated

Sparsely vegetated habitat is comprised of barren cliffs, canyons, and washes that exist within the Lake Mountains range and isolated outcrops within the area of analysis. Only 109 acres (< 1%) of the area of analysis make up this mostly sporadic habitat type.

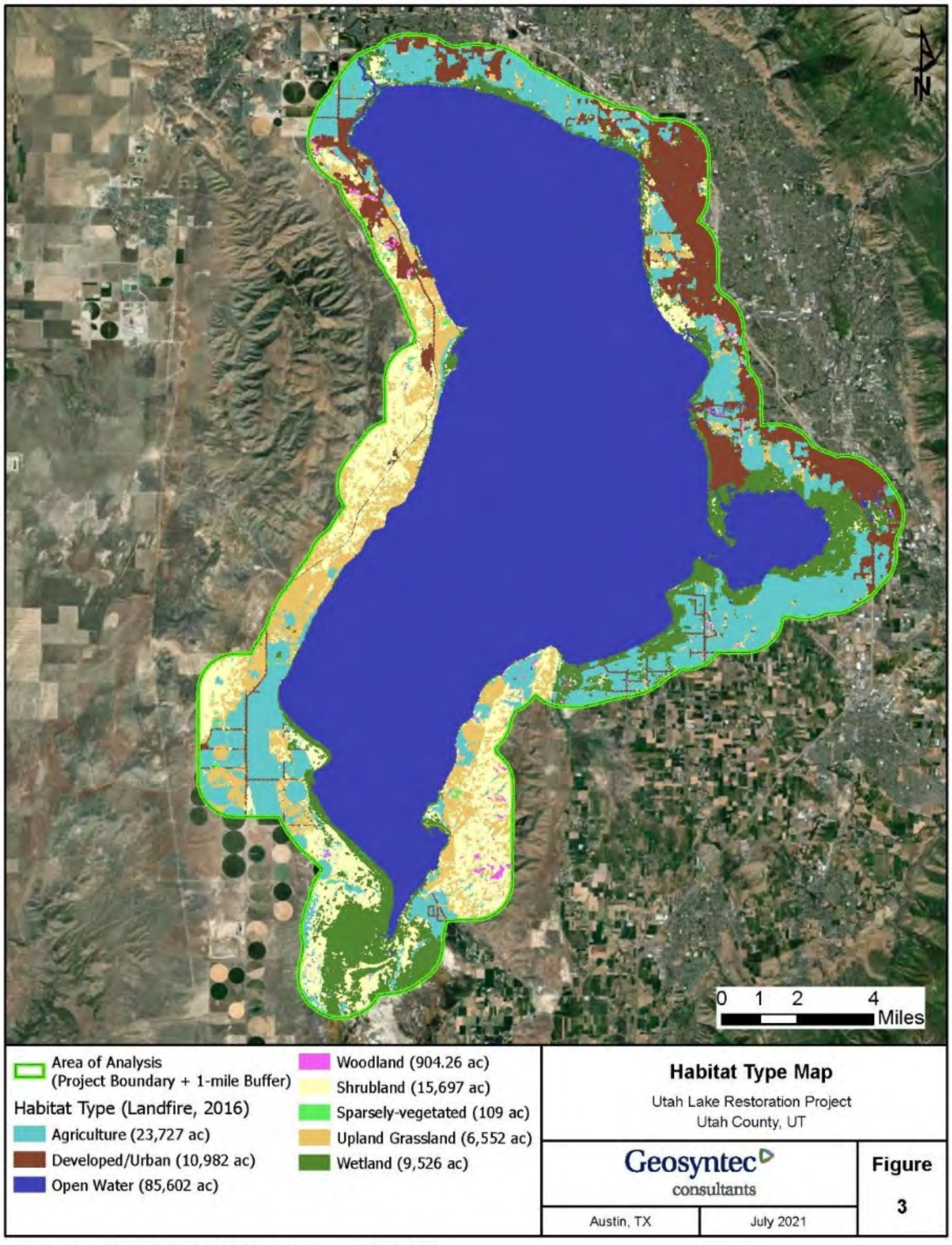

Figure 3. Habitat Types Map

3.1.5 Endangered Species

According to the USFWS Information for Planning and Consultation (IPaC) tool, two federally listed wildlife species and one plant species protected under the Endangered Species Act (ESA) have potential to occur in the area of analysis: western yellow-billed cuckoo (*Coccyzus americanus*), June sucker, and Ute ladies'-tresses (*Spiranthes diluvialis*) (USFWS 2021b). According to the Utah Natural Heritage Program Online Species Search tool, 12 Species of Greatest Conservation Need (SGCN) have been documented in or adjacent to the area of analysis in the last 30 years (Utah Division of Wildlife Resources [UDWR] 2021a). These SGCN species consist of nine sensitive avian species, one sensitive mammal species, one sensitive fish species, and one sensitive amphibian species.

Table 2 lists the special-status plant and wildlife species that are known to occur or have potential to occur in or adjacent to the area of analysis.

Table 2. Special-Status Plant and Wildlife Species with the Potential to Occur in or Adjacent to the Area of Analysis

Common Name	Scientific Name	Status	Associated Habitat Types in the Area of Analysis
Plant Species			
Ute ladies'-tresses	*Spiranthes diluvialis*	ESA threatened	Wetland
Avian Species			
American white pelican	*Pelecanus erythrorhynchos*	SGCN	Open water
Bald eagle	*Haliaeetus leucocephalus*	SGCN	Woodland and open water
Black swift	*Cypseloides niger*	SGCN	Woodland, upland grassland, and open water
Caspian tern	*Hydroprogne caspia*	SGCN	Wetland and open water
Ferruginous hawk	*Buteo regalis*	SGCN	Woodland, shrubland, upland grassland, and agriculture
Golden eagle	*Aquila chrysaetos*	SGCN	Shrubland, upland grassland, sparsely vegetated, and woodland
Greater sage-grouse	*Centrocercus urophasianus*	SGCN	Upland grassland and shrubland
Peregrine falcon	*Falco peregrinus*	SGCN	Woodland, sparsely vegetated, and open water
Snowy plover	*Charadrius nivosus*	SGCN	Wetland

Common Name	Scientific Name	Status	Associated Habitat Types in the Area of Analysis
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	ESA threatened	Woodland, open water, and wetland
Mammal Species			
Townsend's big-eared bat	*Corynorhinus townsendii*	SGCN	Woodland, developed/urban, and open water
Fish Species			
June sucker	*Chasmistes liorus*	ESA threatened	Open water
Bonneville cutthroat trout	*Oncorhynchus clarkii utah*	SGCN	Open water
Amphibian Species			
Northern leopard frog	*Lithobates pipiens*	SGCN	Wetland

ESA: Endangered Species Act
USFWS (2021b), UDWR (2021a)

3.1.5.1 Federally Listed Species

3.1.5.1.1 Ute Ladies'-Tresses

Distribution

Ute ladies'-tresses is found in the western states: southwestern Montana, Washington, Idaho, Wyoming, Utah, western Nebraska, Colorado, and southeastern Nevada. Primarily, it is found at the base of the eastern slope of the Rocky Mountains in Wyoming and Colorado, in the upper Colorado River basin, along the Wasatch Front, and in the eastern Great Basin (Fertig et al. 2005).

In Utah, populations of Ute ladies'-tresses occur in Cache, Daggett, Duchesne, Garfield, Juab, Tooele, Uintah, Utah, Wasatch, and Wayne Counties and is known historically from Salt Lake and Weber Counties (UDWR 2021b).

Ute ladies'-tresses occur in 13 Utah watersheds: Ashley-Brush, Duchesne, Escalante, Fremont, Jordan, Lower Green, Lower Weber, Provo, Southern Great Salt Lake Desert, Spanish Fork, Strawberry, Upper Green-Flaming Gorge Reservoir, and Utah Lake (Fertig et al. 2005).

Four populations are known to occur within the area of analysis along groundwater-fed springs or in sub-irrigated meadows.

Life History

Ute ladies'-tresses is a perennial forb that seems to reproduce exclusively from seed. Microscopic seeds are dropped in late August or September and dispersed by wind or water. Seedlings seem to require a symbiotic relationship with mycorrhizal fungi to survive, and the absence of appropriate fungi in the soil could be a major factor limiting the establishment of new Ute ladies'-tresses populations (Fertig et al. 2005). Seedlings develop into larger dormant roots. Although no data is available to show the number of years required for Ute ladies'-tresses roots to reach sufficient size to develop aboveground leafy shoots, related *Spiranthes* taxa may remain dormant for 8 to 11 years. Vegetative plants can revert to dormancy below ground for 1 to 4 or more growing seasons and then reemerge with new aboveground vegetation (Fertig et al. 2005).

New vegetative shoots are produced in October and persist through the winter as small rosettes. They resume growth in the spring and, depending on conditions, may develop inflorescences or remain in a vegetative state for the growing season. In the winter, vegetative plants may die back to dormant roots or persist as winter rosettes (Fertig et al. 2005). Plants often remain in the vegetative state for 2 or more years before reproducing. Flowering occurs from early July to late October.

Habitat

Ute ladies'-tresses is most often found in moist meadows such as those found along perennial stream terraces, floodplains, and oxbows. It is also found along sub-irrigated or spring-fed stream channels, lakeshores, and irrigated meadows.

Over one-third of known Ute ladies'-tresses populations are associated with perennial streams and can be found on alluvial banks, point bars, floodplains, or oxbows. Periodic flooding reworks alluvial bars and terraces along perennial streams, creating early successional conditions in which Ute ladies'-tresses thrive. These habitat sites also have a high-water table (Fertig et al. 2005). Along perennial streams, Ute ladies'-tresses typically occur on shallow sandy loam, silty loam, or clayey silt alluvial soils overlaying cobbles or gravel. Other vegetation commonly associated with streamside populations includes creeping bentgrass (*Agrostis stolonifera*), quackgrass (*Elymus repens*), arctic rush (*Juncus arcticus*), and smooth horsetail (*Equisetum laevigatum*). Ute ladies'-tresses thrive when vegetative cover is kept short due to periodic flooding, grazing, or mowing. River floodplain habitats occur primarily along unconfined and meandering reaches (Fertig et al. 2005). Lakeshore habitat generally occurs on low-lying gravel bars or flats where seasonal flooding and a high-water table maintain the vegetation in an early mid-seral state.

Several Ute ladies'-tresses populations along the Wasatch Front are associated with spring-fed or subirrigated, moist meadows. These wetlands are outside of active stream channels and are not directly impacted by seasonal flooding events. Their hydrology is driven by groundwater rather than surface flows. Commonly associated vegetation includes horsetail species (*Equisetum* spp.), fewflower spikerush (*Eleocharis quinqueflora*), Nebraska sedge (*Carex nebrascensis*), scratchgrass (*Muhlenbergia asperifolia*), arctic sedge (*Carex capitata*), and seaside arrowgrass (*Triglochin maritima*) (Fertig et al. 2005). Ute ladies'-tresses also occur at sites associated with human-developed dams, levees, reservoirs, irrigation ditches, borrow pits, and irrigated meadows.

Within the area of analysis, there is suitable habitat for Ute ladies'-tresses in the wetland habitat type outlined in Section 3.2.4.2 and shown in Figure 3. Specific conservation management areas are described in the next section.

Management and Threats

Ute ladies'-tresses was listed as threatened under the ESA in January 1992 (*Federal Register* 57:2048). As of 2004, 18 out of 52 extant populations occur on sites that are protected through land designation or legal mandates, and those protected sites contain nearly 78% of the total estimated population of Ute ladies'-tresses. Of those 18 populations, 5 are actively managed for orchid conservation, 3 of which are in Utah (Utah Lake Vineyard, American Fork Mill Pond, and the Middle Provo River). One of these locations (Utah Lake Vineyard) is within the area of analysis (Fertig et al. 2005).

Primary threats to Ute ladies'-tresses are habitat loss from urbanization and road/infrastructure construction; other threats consist of recreation, haying/mowing, livestock grazing, hydrology changes, invasive species, changes in vegetative succession stage, loss of pollinators, and drought (Fertig et al. 2005).

3.1.5.1.2 Western Yellow-Billed Cuckoo

Distribution

Historically, the western yellow-billed cuckoo range included all states west of the Rocky Mountains and extended into southern British Columbia and the northwestern states of Mexico. Currently, the species' breeding range is limited to riparian habitat from northwestern Mexico through Arizona and southern Nevada, with disjunct fragments of habitat occurring in Utah, western Colorado, southwestern Wyoming, and southeastern Idaho, as well as certain areas in California. The western yellow-billed cuckoo migrates to northern South America to winter (UDWR 2021c).

Western yellow-billed cuckoos were probably common summer residents in Utah, but currently appear to be an extremely rare breeder in lowland riparian habitats statewide (UDWR 2021c). Confirmed past breeding records occur on the Provo River between Deer Creek and Jordanelle Reservoir, in the Moab Scott Matheson Wetlands Preserve, and in the Ouray National Wildlife Refuge. Other sites where several records exist and breeding is possible are the northern Salt Lake Valley, Utah Lake near the mouth of the Provo River, Cedar City, and Beaver Dam Wash. One of the state's most extensive patches of riparian habitat occurs at the confluence of Duchesne River, White River, and Green River on the Uintah and Ouray Reservation. Although this area has not been surveyed, it likely contains breeding western yellow-billed cuckoos (Utah Partners in Flight 2002).

This species was documented in the area of analysis in 2005 (UDWR 2021a). Additionally, a confirmed sighting of yellow-billed cuckoo occurred in July 2018 at the River Lane birding location, southwest of Provo Bay along the edge of Utah Lake (eBird 2018).

Life History

Western yellow-billed cuckoo migrants are one of the latest migratory birds to arrive in Utah—in late May or early June. They generally start migrating south in late August or early September. Nesting behavior might be tied to food abundance; the species forgoes nesting in years when food is not abundant (UDWR 2021c).

The western yellow-billed cuckoo breeds late in the season, beginning in late June, but the time between laying eggs and chick maturation is notably quick. A breeding pair will build a loose stick nest on a horizontal branch or in the fork of a tree or large shrub. They will lay 1 to 5 eggs, with an incubation period of 9 to 11 days. The young leave the nest 7 to 8 days after hatching. The young will climb on branches for about 2 weeks after leaving the nest and are capable of flight at about 3 weeks of age (UDWR 2021c).

The western yellow-billed cuckoo gleans insects from tree and shrub foliage. The birds feed primarily on caterpillars, such as tent caterpillars, but also feed on grasshoppers, cicadas, beetles, and katydids, and occasionally lizards and frogs (UDWR 2021c).

Habitat

The western yellow-billed cuckoo breeds and nests in large stands of dense, multilayered riparian vegetation within 100 meters (m) of water, with canopy trees and at least one layer of shrubby understory with a preference for willows with a cottonwood overstory. Other vegetation that supports suitable cuckoo habitat consists of alder (*Alnus* spp.), walnut (*Juglans* spp.), boxelder (*Acer* spp.), sycamore (*Plantanus* spp.), ash (*Fraxinus* spp.), mesquite (*Prosopis* spp.), tamarisk, and Russian olive (USFWS 2017).

For suitable habitat in Utah, areas of vegetation need to be at least 12 acres in extent and separated from other patches of suitable habitat by at least 200 m. Additionally, narrow patches of riparian habitat are not suitable; somewhere within a patch, the multilayered riparian vegetation should be at least 100 m wide by 100 m long. Open areas within a patch should be less than 300 m (USFWS 2017).

Designated critical habitat for the western yellow-billed cuckoo was recently revised. In Utah, the designated critical habitat is located along the Green River and can be found in Uintah, Duchesne, Emery, and Grand Counties. No critical habitat occurs in the area of analysis.

Within the area of analysis, suitable nesting and foraging habitat for western yellow-billed cuckoo is present in the woodland, wetland, and open water habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

The western yellow-billed cuckoo is a federally listed threatened species as well as a Utah state sensitive species. Designated critical habitat has been identified to provide special management considerations or protection.

Primary threats include loss of riparian habitat due to stream channelization, dams and river flow management, conversion to agriculture and other uses, and invasive species such as tamarisk. Special management considerations to critical habitat meant to reduce threats may include regulating stream flows to mimic natural flooding to maintain habitat, establishing conservation easements or land acquisition to protect habitat, and minimizing habitat disturbance, fragmentation, and destruction (Federal Register 86:20798).

As much as 80% to 95% of Utah's riparian habitat has been lost or altered in the last 150 years. Additionally, dense shrub layers (riparian shrubs and regenerating trees) are absent in most of the existing riparian zones in the state. The causes of riparian loss and alteration include agriculture encroachment, urban encroachment, overgrazing, water development (reservoirs and in-stream flow depletions), channelization, road construction, and recreational impacts (Utah Partners in Flight 2002). Management objectives include maintaining and increasing multilayered riparian habitats with mainly native plant species and increasing western yellow-billed cuckoo populations throughout suitable watersheds in Utah.

3.1.5.1.3 June Sucker

Distribution

The June sucker is a highly mobile fish species that exhibits lake-wide distribution in Utah Lake throughout the year (USFWS 2021a). During April and May, adult June suckers congregate near the mouths of the Provo River, Hobble Creek, Spanish Fork River, and American Fork River before moving upstream to spawn in these Utah Lake tributaries (USFWS 1999). The Provo River is the largest tributary to the lake in terms of annual flow, width, and watershed area and provides critical habitat for spawning adult suckers (USFWS 2021a). Post-spawning suckers congregate near the mouth of Provo Bay on the east side of Utah Lake, which could be a response to the high food productivity that remains in the bay until the fall (USFWS 1999). Zooplankton densities are greater in Provo Bay than in other lake areas and provide abundant food to meet the energy demands of post-spawn suckers, as well as an ideal location for the growth and survival of young-of-year (YOY) June suckers recently emerged from the spawning tributaries (USFWS 1999). June suckers congregate along the western lakeshore in the fall and move back to the eastern shore in the winter. One hypothesis for this seasonal distribution is that they are attracted to the warm water springs on the eastern shore of Utah Lake (USFWS 2021a). Throughout the rest of the year, adult June suckers are highly mobile and are found within the entire lake.

Life History

From late April to late June, increased water flow and changing water temperatures initiate a spawning cue to June suckers to begin their spawning migration into Utah Lake tributaries. The primary tributary is Provo River, but Hobble Creek, Spanish Fork River, and American Fork River are also used to a lesser extent (USFWS 2021a). Prior to the European settlement of Utah Valley, spawning (and larval rearing) regularly occurred at large deltas of the Provo River, Spanish Fork River, American Fork River, Hobble Creek, and Battle Creek tributaries. Each one offered redundant options for braided, slow, meandering channels and aquatic vegetation (USFWS 2021a). Spawning habitat consists of moderately deep runs in slow to moderate currents with 4-to-8–inch coarse gravel or small cobble substrate free of silt and algae. Deeper pools adjacent to spawning areas provide resting or staging areas (USFWS 2021a). June suckers broadcast on the substrate, and eggs develop while clinging to the substrate. A few days after spawning, June sucker larvae hatch and passively drift toward Utah Lake over 2 to 3 weeks (Kreitzer et al. 2010, Modde and Muirhead 1994). Since European colonization of Utah Valley, detrimental tributary alterations have occurred, decreasing June sucker spawning and rearing habitat. Recently, Hobble Creek and the Provo River deltas have been restored, or are in the process of being restored, to a condition that supports June sucker spawning. Because the Provo River is the largest tributary to Utah Lake (in terms of annual flow, width, and watershed area), the majority of spawning June suckers use the Provo River rather than other Utah Lake tributaries. The annual flow, width, and watershed of Provo River support the timing of the June sucker's spawning period (USFWS 2021a). Additionally, modifications to the Fort Field diversion structure on the Provo River now allow an additional 1.2 miles of spawning habitat upstream for the June sucker (USFWS 2021a). In the Spanish Fork River, adult spawning is limited to the lower 2.7 miles, but this area is of poor quality (e.g., low water clarity, diversion structures, and miles of levees along the channel) (USFWS 2021a). After the 5-to-8–day spawning period, June suckers are likely to congregate at the mouth of Provo Bay potentially because of the heightened food concentrations that remain suspended after the spawning event (USFWS 2021a).

After June sucker larvae emerge from spawning tributaries, they drift downstream and rear in shallow vegetated habitats near tributary mouths (USFWS 2021a). Predation from non-native fish during larval drift has been shown to have a negative effect for the June sucker but is not the only contributing factor to their recruitment failure (Andersen et al. 2007, Modde and Muirhead 1994). Provo Bay is the most used larval settlement and rearing area because it has higher zooplankton densities and forage availability than other areas of Utah Lake (USFWS 2021a). The current Provo River channel lacks the vegetative cover and habitat complexity necessary to substantially sustain larval fishes rearing in the lower Provo River because of this region's long history of altering, dredging, and channelizing the river. This likely contributes to decreased survival of YOY June sucker as most June sucker larvae do not survive more than 20 days after hatching (USFWS 2021a). The trapezoidal shape of the Provo River channel contributes to a backwater effect on the lower 2 miles of the Provo River, where the velocity stalls during low-flow scenarios and a high seasonal lake level causes the water to back up from the lake into the Provo River (USFWS 2021a).

The number of larvae drifting into Utah Lake is substantially reduced in this lower stretch of the river because the larvae cannot adequately control their position in the water column to feed or avoid predation. The Provo River Delta Restoration Project (PRDRP) will increase larvae survival by restoring additional rearing habitat along the Provo River, thereby enhancing larvae population viability and resiliency (USFWS 2021a). A similar restoration effort took place in 2008 at a Hobble Creek delta (and the subsequent East Hobble Creek Restoration Project), which successfully re-established numerous seasonally inundated off-channel ponds, boosting larval production (USFWS 2021a). As the Provo River delta is restored to historical delta conditions, larval development and growth will increase and improve in this area.

Similar to larval June suckers, YOY also rely on shallow, warm, and complex vegetated aquatic habitat at the tributary mouths and Utah Lake interface. Therefore, they encounter the same obstacles in this life stage of reduced rearing habitat from altered tributary flows, lake water level management, nutrient loading, poor water quality, and river channelization. Therefore, the PRDRP improvements will also increase survivorship of YOY June suckers. This life history stage presents a significant threat of falling prey to seven non-native self-sustaining populations of piscivores in Utah Lake (i.e., white bass (*Moronidae chrysops*), walleye (*Sander vitreus)*, largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), black bullhead (*Ameiurus melas*), northern pike (*Esox lucius*), and channel catfish (*Ictalurus punctatus*). White bass and northern pike present the largest threat because both species become piscivorous and feed on YOY and juvenile fish at an early age (USFWS 2021a). YOY June suckers aggregate in shoals with hundreds of individuals near the surface but under the cover of aquatic vegetation (USFWS 2021a). Provo Bay remains a sufficient settlement and rearing area compared to other areas of Utah Lake because of its high zooplankton densities and proximity to the well-established Provo River spawning tributary (USFWS 2021a). YOY prey on both zooplankton and macroinvertebrates (Landom and Walsworth 2021, Richards and Miller 2017).

Once juvenile June suckers complete their migration into Utah Lake, they use littoral (i.e., nearshore or coastal) aquatic vegetation as cover and refuge, similar to the life stages previously mentioned (USFWS 2021a). Juveniles continue to form schools near the water surface in shallow areas in response to the zooplankton predation opportunities in that area of the water column (USFWS 2021a). Juveniles continue to remain vulnerable to non-native predators, particularly white bass and northern pike (USFWS 2021a). Juveniles eat both zooplankton and macroinvertebrates. The two most abundant zooplankton diet items are a rotifer, *Brachionus* sp., and a copepod (*Microcyclops rubellus*) (Kreitzer et al. 2010). Chironomids are the most common macroinvertebrate prey item in diets of many Utah Lake fish species (including carp and June suckers, particularly young June suckers) (Landom and Walsworth 2021, Richards and Miller 2017). As juveniles grow into subadults, they begin to move offshore (USFWS 2021a).

Low recruitment remains an issue with June sucker recovery and recruitment goals set for recovery of the species that are not being met (USFWS 2021a). Spawning populations of June suckers are increasing, but natural levels of recruitment are low and, as a result, difficult to quantify. Annual stocking efforts are needed to maintain the June sucker population in Utah Lake. Larval and adult June suckers occur in the Spanish Fork River, but this area is of poor quality and has obstacles to recruitment (e.g., seasonally inadequate flows, poor June sucker rearing habitat at the Utah Lake interface, low water clarity, diversion structures, and miles of levees along the channel) (USFWS 2021a). As the Provo River delta is restored to historical delta conditions, recruitment of young fish into the adult population should increase and improve (USFWS 2021a).

Adult June suckers are highly mobile. Most of the year they are distributed throughout Utah Lake, covering large areas in short periods of time. However, algal blooms can demonstrably decrease their movements (USFWS 2021a). June suckers congregate on the western lakeshore in the fall and move to the eastern lakeshore in the winter, possibly due to relatively warm freshwater springs in the area (USFWS 2021a). In April and May, large numbers of June suckers congregate at the mouths of Provo River, Hobble Creek, Spanish Fork River, American Fork River, and likely Provo Bay for pre-spawn staging (USFWS 2021a). Despite being a member of the sucker family Catostomidae, June suckers are mid-water, not benthic, feeders. Adult June suckers maintain the diet of plankton and macroinvertebrates into adulthood. Zooplankton are an essential prey base of the June sucker (Landom and Walsworth 2021). The zooplankton prey base of June suckers includes *Bosmina* sp., *Ceriodaphnia* sp., *Microcyclops rubellus, Acanthocyclops vernalis, Brachionus* sp., *Keratella* sp., and Nematoda. A study by Kreitzer et al. (2010) identified *Brachionus* sp. and *Microcyclops rubellus* as the most abundant types of zooplankton, but *Acanthocyclops vernalis* and *Ceriodaphnia* sp. as the highest diet composition by volume. Macroinvertebrates, such as nonbiting midges and worms, are also common prey items. They are easily digestible and rich in protein (Richards and Miller 2017). Adult June suckers can live 40 years or more. During the first 3 to 5 years, they experience rapid growth. Reproductive maturing is reached around year 5 to 10 (Andersen et al. 2007). Years 8 to 10 are characterized by intermediate growth. June suckers year 10 and beyond experience reduced growth. Both sexes have similar growth rates in the first 10 years (USFWS 2021a).

Survivorship is more extensively studied from June suckers reared in captivity and then released live. Ultimately, survivorship depends on the length of fish at stock (which correlates to age) and the time of year the lake was stocked (USFWS 2021a). The youngest June suckers experienced a survival rate of 2% into the next year. Year 1 June suckers had a survival rate of 0% to 67%. Year 2 June suckers had a survival rate of 83% if the stock was released in early summer (USFWS 2021a). Therefore, the June Sucker Recovery Implementation Program (JSRIP) stocking program focuses on stocking 2-year-old fish to increase survival. There is evidence that June suckers are successfully reproducing and recruiting after being stocked, but the exact location and conditions that are contributing to this success are unknown. Year-to-year survival rates for spawning June suckers range from 65% to 95% depending on the tributary and year (USFWS 2021a). Additional research is needed to understand the level of natural June sucker recruitment occurring in Utah

Lake. Long-term survival of stocked fish has been observed with individuals stocked more than 10 years before being detected during spawning (USFWS 2021a).

Habitat

Historically, suitable riverine habitat was more abundant for spawning adults, but water management decisions have led to inconsistent water flows to the historical range of spawning habitat. Adult June suckers prefer streams with slow, meandering channels and large, braided, deltas that provide shelter for juvenile rearing. The availability of nearby slow water pools and aquatic vegetation are also essential for protection from predators and rearing habitat for juvenile fish (USFWS 2021a).

Management and Threats

The existing June sucker population is currently managed by UDWR. When the species was listed in 1986, it was estimated that there were fewer than 1,000 fish left in the wild (USFWS 1999). Following the ESA listing in 1986, two refuge populations were established for the conservation of the species' population and to maintain the remaining population's genetic diversity (USFWS 1999). The first population was established as part of the JSRIP stocking program at the Fisheries Experiment Station (FES) hatchery in Logan, Utah. To the greatest extent possible, an effort was taken to preserve the genetic diversity of the wild Utah Lake population. Brood stock provided by the FES was then used to establish a second refuge population in 2004 at Red Butte Reservoir in Salt Lake City, Utah. These populations have been successful at not only retaining the genetic diversity of the species but also establishing self-sustaining populations. With consistent effort to reduce predator interactions and restore habitat, June sucker populations are expected to grow.

In 1991, UDWR (formally known as Utah Department of Fish and Game) built a fish culture facility as part of the FES in Logan, Utah, to develop brood stock and document successful rearing techniques for the June sucker (UDWR 2021d). Stocking efforts increased in the early 2000s with the expansion of the June sucker rearing facility at the FES, which delivered fish to Utah Lake, Red Butte Reservoir, Mona Reservoir, and the Rosebud grow pond in Box Elder County. The FES currently stocks 25,000 juvenile June suckers at Utah Lake annually (JSRIP 2020a). Augmenting the wild June sucker population with stocked, juvenile June suckers has proven to be a viable contribution to the species' recovery.

A recovery plan for June sucker that was finalized in 1999 by the USFWS included several criteria required for downlisting or delisting the species status. Recently, the USFWS determined that the requirements to downlist the species from endangered to threatened had been met (USFWS 2021a).

3.1.5.2 State Listed Wildlife Species

3.1.5.2.1 American White Pelican

Distribution

The breeding range for American white pelican (*Pelecanus erythrorhynchos*) occurs west of the Great Lakes, extending from Canada into the mountain states, to the Gulf Coast of Texas and Mexico (Utah Wildlife Action Plan Joint Team 2015). Populations breeding west of the Rocky Mountains migrate south and southwest into California and the western coast and central states of Mexico (UDWR 2021e).

In Utah, American white pelicans are a common resident at Great Salt Lake and surrounding wetlands, and they are found at freshwater bodies throughout the state. The only known breeding colonies of the American white pelican are in the northern portions of the state, within the Great Salt Lake/Utah Lake complex; the Gunnison Island colony in the northern part of the Great Salt Lake is the most important nesting colony of the species range-wide, consisting of approximately 12,000 breeding adults, which is about 20% of the population (Utah Wildlife Action Plan Joint Team 2015). Although there were historic records of a breeding colony on Rock Island in Utah Lake, that information is from the early 1900s (Goodwin 1904). Nonbreeding and early spring and late summer/early fall American white pelicans of breeding age are widely dispersed through Utah in small numbers (Utah Partners in Flight 2002).

This species was documented in the area of analysis in 2005 (UDWR 2021a).

Life History

American white pelicans migrating in the spring arrive in Utah in early March. Winter migration happens anytime from October through December (Utah Partners in Flight 2002).

American white pelicans are highly social, often observed sleeping, roosting, and sunbathing together. They nest in colonies and use cooperative flight and foraging strategies. Groups of pelicans ranging from a few to hundreds can be observed driving fish to shallow areas, often encircling and concentrating their prey (UDWR 2021e, Utah Wildlife Action Plan Joint Team 2015). The primary food of American white pelican is small schooling fish that occur in shallow wetlands, such as minnows, carp, and suckers (Cornell Lab of Ornithology 2019).

American white pelicans are monogamous, pairing after arrival in Utah, and will produce a 2-egg clutch with an incubation period of 30 days. Parents attend to nestlings to 3 weeks of age, then young congregate into pods (UDWR 2021e).

Habitat

American white pelicans prefer to nest on islands associated with freshwater lakes and prefer foraging in shallow lakes, marshlands, and rivers (UDWR 2021e). Colonial nest sites are usually islands with flat or low-gradient slopes so adults can access the nest by flying in. Gravel or sandy, unconsolidated substrates are preferred for nesting (Utah Partners in Flight 2002).

In Utah, the primary breeding habitat is found at Great Salt Lake, as this is the only known location of nesting American white pelican colonies. The Gunnison Island breeding population is somewhat unique in that the lake surrounding the nest colony is hypersaline and does not support a fishery; therefore, adults must make flights of at least 30 miles, one way, to fisheries (Utah Partners in Flight 2002). Traditional foraging areas for Gunnison Island adults have occurred to the east of the colony at Bear River Bay, including the Bear River Migratory Bird Refuge, and east and southeast at state waterfowl management areas and privately managed wetlands. Pelicans have also flown to foraging areas north of Gunnison Island to American Falls Reservoir in southern Idaho and south to Utah Lake (Utah Partners in Flight 2002).

Within the area of analysis, suitable foraging habitat is present on Utah Lake, but nesting habitat is insufficient to draw nesting colonies.

Management and Threats

American white pelican is designated by the state of Utah as a SGCN and is protected under the Migratory Bird Treaty Act (MBTA) of 1918 (Utah Wildlife Action Plan Joint Team 2015). They are highly sensitive to human disturbances at their breeding colonies and readily abandon nests. Their primary threats are human disturbance and destruction of foraging and breeding habitat and water use and management that affects the shallow wetlands they depend on (Cornell Lab of Ornithology 2019, Pacific Flyway Council 2012).

According to Utah Partners in Flight (2002), management objectives for American white pelican in Utah include protecting breeding grounds at Gunnison and Bird Islands (assumed to also mean Hat Island in the Great Salt Lake), identifying foraging areas, managing for sustainable fisheries, and maintaining breeding and foraging habitat for the species.

3.1.5.2.2 Bald Eagle

Distribution

The breeding range of the bald eagle (*Haliaeetus leucocephalus*) found throughout North America consists of Alaska, Canada, and the coastal and northern portions of the United States. Bald eagles migrate into the United States in the winter, are most widespread during that time, and can be found throughout the United States (Cornell Lab of Ornithology 2019; UDWR 2021f). Bald eagles can be found throughout Utah. In northern Utah, winter population numbers are in the hundreds; a small nesting population occurs there as well (Utah Wildlife Action Plan Joint Team 2015).

This species was documented in the area of analysis in 2006 (UDWR 2021a).

Life History

Bald eagles prefer to roost in tall trees that offer a wide view. For nesting, they use tall conifers that protrude above the forest canopy, mature or old-growth trees, snags, cliffs, and rock promontories (USFWS 2020). Bald eagles can take up to 3 months to build their large nests (5–6 feet in diameter) but may reuse them year after year (Cornell Lab of Ornithology 2019). They will usually lay 2 eggs, and both parents share in incubating them, which lasts about 5 weeks (UDWR 2021f). The young fledge after 10 to 12 weeks but may remain around the nest for several more weeks.

Bald eagles generally do not breed until they are 5 or 6 years old. Immature eagles will spend those years exploring throughout their range; they are capable of flying hundreds of miles per day (Cornell Lab of Ornithology 2019). Adult bald eagles migrate south in late fall when lakes and rivers freeze. They return north to breeding grounds when weather and food availability permit, usually January through March (Cornell Lab of Ornithology 2019).

Habitat

Bald eagles require a good food base, typically nesting in forested areas near estuaries, large lakes, reservoirs, rivers, and coastlines, where there is an adequate food supply (USFWS 2020). During nonbreeding periods, bald eagles will congregate near open water in tall trees for spotting prey and night roosts for sheltering (USFWS 2020). Wintering areas are usually associated with open water, although other habitats may be used if food resources are readily available (UDWR 2021f).

Within the area of analysis, suitable nesting, foraging, and winter roosting habitat for bald eagles is present in the woodland and open water habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

Bald eagles became rare in the mid- to late 1900s due to trapping, shooting, and use of the pesticide DDT (dichloro-diphenyl-trichloroethane), which caused reproductive failure. In 1978 the bald eagle was federally listed as endangered. Protection and the banning of the pesticide DDT have led to a dramatic resurgence in the species, and in 2007 it was removed from the endangered species list. The bald eagle is designated by the state of Utah as a SGCN and is protected under the Bald and Golden Eagle Protection Act and the MBTA of 1918 (Utah Wildlife Action Plan Joint Team 2015). Primary threats include lead poisoning through ingestion of hunter-shot prey, collisions with motor vehicles and stationary structures, and destruction of shoreline nesting, perching, roosting, and foraging habitats (Cornell Lab of Ornithology 2019).

3.1.5.2.3 Black Swift

Distribution

The black swift (*Cypseloides niger)* can be found in mountainous regions of the western United States and Canada in three separate areas: central Colorado through central Utah, central and southwestern coastal California, and southern Alaska to northern Washington, extending east to Alberta, northern Idaho, and western Montana (UDWR 2021g). In the northern subpopulation, black swifts are common, while in Colorado black swifts are uncommon. In Utah, they are extremely rare (UDWR 2021g). The black swift is thought to overwinter in Central America into South America.

Only two confirmed breeding locations are known in Utah: the Bridal Veil Falls area in Provo Canyon and the Aspen Grove area near Mt. Timpanogos. Birds have been spotted in Zion National Park, Big Cottonwood Canyon, the Manti-La Sal National Forest, the Salt Lake City area, Red Creek near Fruitland, and Upper Provo Falls near Mirror Lake. Other potential breeding sites are possible, such as in the Uinta and Wasatch Mountains, where suitable habitat exists.

This species was documented in the area of analysis in 1996 (UDWR 2021a).

Life History

Black swifts nest in small colonies, often behind waterfalls. Nesting sites are often reused year after year. The species' nesting period is extremely long for a bird of its size. Typically, only 1 egg is laid in July, and both adults incubate for 24 to 27 days. Nestlings develop over a period of 45 to 49 days (UDWR 2021g).

Black swifts are one of the latest migrants and breeders in Utah. They arrive late in May and may still be tending nests in early September. Swifts migrate south from mid-September through October (Utah Partners in Flight 2002).

Black swifts feed exclusively on flying insects caught midair, usually thousands of meters above the ground. They usually forage in flocks, often with other species (Utah Partners in Flight 2002).

Habitat

Black swift nesting habitat is classified as mountain riparian. Nesting sites typically exhibit six characteristics: waterfalls, cliffs, inaccessibility to humans and predators, darkness, unobstructed flight paths, and ledges or cracks (for nest placement) (Utah Partners in Flight 2002). Nests are on ledges, cracks, or crevices, often behind or in the spray of waterfalls.

Nesting sites are typically surrounded by coniferous forests, often mixed conifer or spruce-fir, but this varies depending on elevation and aspect and may include mountain shrub, aspen, or even alpine components. Streams that create the waterfalls are typically mountain riparian habitats but may also occur at lower elevations in canyon country (Utah Partners in Flight 2002).

Nesting habitat for black swifts is not present in the area of analysis, although suitable foraging habitat is present in the area of analysis.

Management and Threats

This species is designated by the state of Utah as a SGCN and is protected under the MBTA of 1918. Black swift populations declined by 94% between 1970 and 2014, although the causes of the decline are unknown due to a lack of information (Cornell Lab of Ornithology 2019). Management issues in Utah, according to Utah Partners in Flight (2002), consist of habitat loss and modification, lack of habitat, pesticide use, and human disturbance.

3.1.5.2.4 Caspian Tern

Distribution

Caspian tern (*Hydroprogne caspia*) breeds in widely scattered locations throughout the world and winters in other scattered locations (UDWR 2021h). Breeding locations in North America occur in Canada and the northwestern United States in very localized areas around large bodies of water. Winter migration occurs along the coasts of Mexico and inland in the southern portion of the country, Florida, and the Caribbean islands.

Caspian tern has been known to occasionally breed in northern Utah, although it is uncommon. Colonies have been documented on islands and dikes associated with Great Salt Lake wetlands as well as at Utah Lake (Utah Wildlife Action Plan Joint Team 2015).

This species was documented in the area of analysis in 2002 (UDWR 2021a).

Life History

Caspian tern nest on the ground in open, sparsely vegetated areas, often in colonies or in association with other ground-nesting shorebirds. Both parents incubate 2 or 3 eggs for 25 to 28 days. The young leave the nest after a few days and are able to fly after 25 to 30 days (UDWR 2021h). Young may remain with parents for as long as 8 months, with the adults providing food to the young (National Audubon Society 2021).

Caspian terns are fierce defenders of their territories, threatening neighbors within the colony that come too close. They will chase predatory birds and other predators (Cornell Lab of Ornithology 2019). Caspian terns feed primarily on fish. The birds fly above the water and rapidly diving to catch their prey.

Habitat

Caspian terns breed along large lakes, marshes, islands, beaches, bays, and coastal waters. They nest in colonies on flat, open areas with little vegetation, often sandy or pebbly with short plants. They readily nest on artificial habitats such as dredge-spoil islands (Cornell Lab of Ornithology 2019). They favor protected waters, not usually foraging over open sea (National Audubon Society

2021). In Utah they are typically found on islands and dikes associated with Great Salt Lake wetlands.

Within the area of analysis, suitable nesting and foraging habitats for Caspian tern are present in the wetland and open water habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

This species is designated by the state of Utah as a SGCN and is protected under the MBTA. Overall populations have remained stable, although in many regional and local areas it is considered sensitive. Threats to the survival of Caspian tern consist of hunting, pesticides and other pollutants, disturbance of colonies, and loss of breeding areas to sea level rise (Cornell Lab of Ornithology 2019).

3.1.5.2.5 Ferruginous Hawk

Distribution

Ferruginous hawks (*Buteo regalis*) breed in western North America, from south-central Canada to northern Utah and New Mexico. They primarily winter in grasslands and shrub steppes in the southwestern and central United States, into Mexico (UDWR 2021i) (Utah Partners in Flight 2002).

In Utah, ferruginous hawks are found statewide in grassland and shrub-steppe habitats. They primarily nest in juniper trees but will also nest on the ground or on power line structures (Utah Wildlife Action Plan Joint Team 2015).

This species was documented near the area of analysis in 2008 (UDWR 2021a).

Life History

The primary food for ferruginous hawks is small mammals, especially rabbits, prairie dogs, and pocket gophers. Prey is caught during flights from perches, short-distance strikes from the ground, or via aerial hunting (Utah Partners in Flight 2002).

Nesting starts in March or April. Nest locations can vary from trees and shrubs to cliffs, utility structures, and ground outcrops. Ferruginous hawks will also use artificial nesting platforms (Utah Partners in Flight 2002). Fall migration occurs from August to early October.

Habitat

Ferruginous hawks occur in grasslands, agricultural lands, shrub steppe habitat, and at the edges of pinyon-juniper forests and avoid high elevations, forest, and narrow canyons (Utah Partners in Flight 2002). During winter, they will use open farmlands, grasslands, deserts, and other arid regions where prey are found.

Within the area of analysis, suitable nesting and foraging habitats for ferruginous hawks are present in the woodland, shrubland, upland grassland, and agriculture habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

Ferruginous hawks are protected under the MBTA and are designated by the state of Utah as a SGCN. Threats to ferruginous hawk populations include prey base loss, removal of nesting trees, and excessive human intrusion during breeding. Management recommendations from Utah Partners in Flight (2002) consist of reducing habitat conversion by encouraging native grasslands instead of converting juniper and sagebrush lands to exotic grasses for livestock grazing.

3.1.5.2.6 Golden Eagle

Distribution

The golden eagle (*Aquila chrysaetos*) breeds across western North America, from Alaska south to northern Mexico. Populations in the northern parts of its breeding range migrate south for the winter, but most populations in the western United States are year-round residents of the same area. This species is rarely seen in the eastern United States. It is quite common in Utah (UDWR 2021j). Utah is home to year-round resident breeding golden eagles and also hosts winter migrants from farther north (Utah Wildlife Action Plan Joint Team 2015).

This species was documented near the area of analysis in 2012 (UDWR 2021a).

Life History

Golden eagles usually nest on cliffs. They may also build nests in trees or on human-made structures, including nesting platforms and electrical transmission towers. Golden eagles defend large territories and are generally wary of human disturbance (Utah Wildlife Action Plan Joint Team 2015). Golden eagle pairs are monogamous and often use the same nest in consecutive years, although sometimes they may use an alternate nest (UDWR 2021j). A pair will build a large nest of sticks and vegetation that averages 5 to 6 feet wide, approximately 1 to 3 months before egg laying (Cornell Lab of Ornithology 2019).

Eggs are laid from late February to early March in Utah. Most often 2 eggs are laid, but clutches may contain 1, 3, or, rarely, 4 eggs. The eggs are incubated mostly by the female and hatch after 43 to 45 days. Young can fly after 60 to 77 days and are cared for by the parents for at least 30 days after fledging. The young may remain with the parents for several months (UDWR 2021j).

Golden eagles feed primarily on small to medium-sized mammals, especially rabbits, marmots, prairie dogs, and ground squirrels, but they will also eat insects, snakes, birds, juvenile ungulates, and carrion (UDWR 2021j).

Habitat

Golden eagles live in open country, especially in mountainous regions, featuring native vegetation. They avoid developed areas and uninterrupted stretches of forest. They are found primarily in mountains up to 12,000 feet, canyonlands, rimrock terrain, and riverside cliffs and bluffs. Golden eagles nest on cliffs and steep escarpments in grassland, chapparal, shrubland, forest, and other vegetated areas (Cornell Lab of Ornithology 2019).

Within the area of analysis, there is no suitable nesting habitat for golden eagles, although suitable foraging habitat is present in the shrubland, upland grassland, sparsely vegetated, and woodland habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

The golden eagle is designated by the state of Utah as a SGCN and is protected under the Bald and Golden Eagle Protection Act and the MBTA of 1918 (Utah Wildlife Action Plan Joint Team 2015). The Bald and Golden Eagle Protection Act outlaws harming golden eagles, their eggs, and their nests. However, impacts from humans remain a threat. Most recorded golden eagle deaths are from collisions with vehicles, wind turbines, and other structures or by electrocution at power poles (newer designs greatly reduce this risk). Urbanization, agricultural development, and changes in wildfire regimes have disturbed or reduced nesting and hunting habitats for the species (Cornell Lab of Ornithology 2019).

3.1.5.2.7 Greater Sage-Grouse

Distribution

Greater sage-grouse (*Centrocercus urophasianus*) occur only in western North America. They were historically found in virtually all areas with sagebrush in parts of 15 states: Arizona, California, Colorado, Idaho, Nebraska, Montana, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming. They were also found in three Canadian provinces: Alberta, British Columbia, and Saskatchewan (Utah Partners in Flight 2002). Greater sage-grouse have been extirpated from Arizona, Nebraska, New Mexico, Oklahoma, and British Columbia, and remaining populations have declined in all states and provinces (Utah Partners in Flight 2002).

In Utah, greater sage-grouse inhabit sagebrush habitat in the Colorado Plateau and Great Basin geographic regions. It is estimated that greater sage-grouse in Utah only occupy 41% of the habitat they once did, due to habitat loss, fragmentation, and degradation (Utah Partners in Flight 2002, Utah Wildlife Action Plan Joint Team 2015).

This species was documented near the area of analysis in 1993 (UDWR 2021a).

Life History

Greater sage-grouse are a sagebrush-obligate species dependent on sagebrush ecosystems for breeding, brood rearing, and winter survival.

Breeding activities occur from mid-March to early July depending on the elevation. Male greater sage-grouse display on leks in early morning and late evening to attract females. Leks are generally close to or within large expanses of sagebrush and have good visibility and acoustical qualities (Utah Partners in Flight 2002). The same lek locations are used year after year. After breeding in late March to early April, females disperse from the lek site and choose nest sites often within 1.75 to 2.5 miles of the lek. Nest sites are usually located in taller, more dense sagebrush with an abundance of forbs and grasses (Utah Partners in Flight 2002).

Nests are typically placed at the base of a live plant. Clutch size ranges from 6 to 10 eggs, and incubation occurs for 27 to 28 days. Greater sage-grouse will commonly abandon a nest if the hen is disturbed during nesting. Hatching of eggs in Utah can start by early May but mostly occurs in June (Utah Partners in Flight 2002).

Upon hatching, hens with chicks remain in sagebrush uplands, feeding on succulent forbs and insects. As chicks mature later in the season, hens with broods move toward wet meadow areas, which are a highly important part of greater sage-grouse habitat (Utah Partners in Flight 2002). Greater sage-grouse move to and from areas with succulent green vegetation throughout the summer, while the intermixing of broods and flocks is common and becomes pronounced by mid-September (Utah Partners in Flight 2002). These flocks typically include unsuccessful and successful hens and chicks from several broods. Males are usually found in separate flocks on benches and along ridges some distance from wet meadows. Greater sage-grouse prefer denser sagebrush and some green forbs from mid-September into November (Utah Partners in Flight 2002).

Areas used in early winter are extensive stands of sagebrush, the leaves of which are the species' primary winter food (Utah Partners in Flight 2002). By mid-March, flocks of greater sage-grouse are usually within 2 to 3 miles of leks used the previous year.

Habitat

Sage-grouse occur only in the sagebrush and sagebrush steppe ecosystems of western North America. Important areas of sagebrush rangeland that provide optimal habitat for greater sage-grouse include strutting grounds, water sources (springs, seeps, creeks, and livestock water developments), wet meadows, forb-dominated meadows, and south- and west-facing ridges and slopes where the species is known to winter (Utah Partners in Flight 2002).

Leks are considered to be the center of greater sage-grouse activities. The species prefers open areas surrounded by sagebrush to strut on. The majority of nesting and brood-rearing activities occur within 2 miles of a lek.

The Utah Conservation Plan for Greater Sage-Grouse does not identify any greater sage-grouse habitat in the area of analysis (State of Utah 2019). According to available spatial data from the UDWR, there are no Sage-grouse management areas in the area of analysis, and the closest occupied lek is located approximately 13 miles from the area of analysis (UDWR 2019, 2020b). In the area of analysis, suitable habitats for greater sage-grouse are present in the shrubland and upland grassland habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

Greater sage-grouse are considered a sensitive species but have been removed from the candidate species list for consideration to be listed on the threatened and endangered species list (USFWS 2015a). In the Great Basin, the primary threats are the expansion of invasive grasses, such as cheatgrass (which results in more frequent and intense wildfires), and conifer encroachment. Both eliminate the sagebrush that greater sage-grouse need. Additional stressors, such as improper grazing, predation, mining, and infrastructure development, can contribute to localized population declines (USFWS 2015a).

The Utah Conservation Plan for Greater Sage-Grouse (State of Utah 2019) aims to protect, maintain, and increase greater sage-grouse populations and habitats within sage-grouse management areas by maintaining and increasing populations statewide and by maintaining, protecting, and increasing greater sage-grouse seasonal habitats within those management areas (State of Utah 2019).

3.1.5.2.8 Peregrine Falcon

Distribution

Peregrine falcons (*Falco peregrinus*) are distributed widely and breed in a variety of habitats on every continent except Antarctica. In North America, the species is a permanent resident along the Pacific Northwest coast; through large portions of Utah, Colorado, and Arizona; and south into Mexico. Some breeding populations occur in the northern tundra and areas in the northern United States. These northern breeders are long-distance migrants, many of which go to South America. Winter nonbreeding populations in North America occur along the southern Atlantic and Gulf coasts, in eastern Mexico, and in the Caribbean islands (Cornell Lab of Ornithology 2019).

This species was documented in the area of analysis in 2006 (UDWR 2021a).

Life History

Peregrine falcons nest on cliff ledges, on transmission line towers, in quarries, and on skyscrapers. In places without cliffs, peregrine falcons may use abandoned raven (*Corvus corax*), bald eagle, osprey (*Pandion haliaetus*), or red-tailed hawk (*Buteo jamaicensis*) nests. The birds do not build a nest with sticks but rather scrape the nest ledge to create a depression in the sand, gravel, or other substate (Cornell Lab of Ornithology 2019). They will lay 2 to 5 eggs, which the female primarily incubates for 32 to 35 days while the male brings her food. The female stays with the young after nestlings hatch, while the male brings food to them. Nestlings fledge after 39 to 49 days (National Audubon Society 2021).

Peregrine falcons are reported to be the fastest birds in the world, capable of achieving speeds of over 200 miles per hour. They hunt by flying above their prey and diving down to either grab or strike prey hard enough to stun or kill it. Typical prey includes shorebirds, ducks, grebes, gulls, pigeons, and songbirds. They also eat substantial numbers of bats (Cornell Lab of Ornithology 2019).

Habitat

Cliffs and tall, human-made structures surrounded by open landscapes with nearby riparian areas provide desirable habitat for peregrine falcons in North America. They nest in a multitude of habitat types, from 12,000 feet in elevation down to rivers and coastlines and show little preference for specific ecological communities. Peregrine falcons are most adapted to open or partially wooded habitats. In cities, they may nest on skyscrapers, and pigeon populations offer a reliable source of food (Cornell Lab of Ornithology 2019). In Utah, breeding sites occur in the Utah Mountain, Basin and Range, Mojave, and Colorado Plateau ecoregions (Messmer et al. 1998).

In the area of analysis, suitable foraging habitats for the peregrine falcon are present in the woodland, sparsely vegetated, and open water habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

This species is designated by the state of Utah as a SGCN and is protected under the MBTA of 1918. The peregrine falcon was greatly affected by the use of DDT, which causes the raptors to lay thin-shelled eggs that would often break. Since DDT was banned, populations have recovered to the point the peregrine falcon was removed from the endangered species list (UDWR 2021k).

3.1.5.2.9 Snowy Plover

Distribution

Snowy plover (*Charadrius nivosus*) occurs in much of the world. The species is common in Utah, with the largest known concentration in interior North America found on Great Salt Lake. Inland populations are migratory, Utah populations migrate to the California coast and Mexico for winter (UDWR 2021l). Year-round populations are found in California, central Mexico, and some Caribbean islands. Winter migrants can be found along the Pacific coast of Mexico and along the Gulf Coast (Cornell Lab of Ornithology 2019).

This species was documented in the area of analysis in 1990 (UDWR 2021a).

Life History

Nests are built on the ground, usually in open or sparsely vegetated areas near water. With an average of 3 eggs, both parents incubate the eggs for 24 to 27 days. After the first clutch hatches, the female may leave the nest and lay a second brood with a different mate, leaving the male to tend the young alone (Cornell Lab of Ornithology 2019; UDWR 2021l). Young snowy plovers leave the nest within 3 hours of hatching and are able to forage unassisted (Cornell Lab of Ornithology 2019).

The snowy plover eats insects and other small invertebrates that are captured in sand, mud, or shallow water. On Great Salt Lake, brine shrimp provide a good source of food (UDWR 2021l).

Habitat

Beaches, ponds, and shorelines are the preferred habitat of this species, which is found in open sandy areas adjacent to water (UDWR 2021l). They nest on coastal beaches and inland at salt flats, playas, river sandbars, alkaline lakes, and agricultural ponds (Utah Wildlife Action Plan Joint Team 2015).

In the area of analysis, suitable nesting and foraging habitats for snowy plover are present in the wetland habitat type outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

The snowy plover is designated by the state of Utah as a SGCN and is protected under the MBTA of 1918. Pacific coastal populations are federally listed as threatened. The primary conservation concern for the snowy plover is habitat alteration and degradation from beachfront development and recreation. Nests can be destroyed by being stepped on by people or domestic animals or driven on by vehicles.

3.1.5.2.10 Townsend's Big-Eared Bat

Distribution

Townsend's big-eared bat (*Corynorhinus townsendii*) occurs in western North America, from southwestern Canada to Mexico. The species occurs statewide in Utah below 9,000 feet in elevation, although populations are thought to be declining (UDWR 2021m). Townsend's big-eared bat is found throughout the state in a wide variety of habitats but is closely tied to caves and abandoned mines for both hibernation and maternity roosts (Utah Wildlife Action Plan Joint Team 2015). Because of its narrow roosting preferences, local distribution of Townsend's big-eared bat tends to be restricted by the presence of suitable roosting habitat.

This species was documented near the area of analysis in 2012 (UDWR 2021a).

Life History

Townsend's big-eared bats use caves and mines year-round both for maternity colonies and hibernacula. Females congregate into nursery colonies and typically give birth to one young each year.

The species is nocturnal, and individuals typically do not leave their roosts until well after sunset (UDWR 2021m). Townsend's big-eared bats prefer to forage in close proximity to roost complexes. They eat flying insects, particularly moths. Townsend's big-eared bat is a slow-flying and highly maneuverable bat, which probably feeds by gleaning vegetation as well as by capturing prey on the wing (UDWR 2020c).

Bats are active in the summer months when insect prey is available. Bats avoid winter food scarcity by hibernating. Hibernation occurs from early fall through early spring. Movements toward hibernacula begin in late summer, after the dissolution of maternity colonies, and Townsend's big-eared bats typically begin to arrive at hibernacula in October (United States Forest Service [USFS] 2006).

Mating occurs in late summer or early autumn. Females store sperm during the winter hibernation period and do not ovulate until arousing from hibernation in the spring (USFS 2006). The gestation period varies from 40 to 60 days, and the duration apparently depends on ambient temperature and levels of precipitation. Births occur midsummer, coinciding with periods of high prey availability (USFS 2006).

Habitat

Townsend's big-eared bat can occur in many types of habitat but is often found near forested areas. Caves, mines, and buildings are used for day roosting and winter hibernation. They favor larger, more complex caves, which provide more variable conditions (UDWR 2020a). Throughout its western range, Townsend's big-eared bat roosts in a variety of vegetative communities, and at a range of elevations, and there appears to be little or no association between local surface vegetative characteristics and the selection of particular subsurface roosts (USFS 2006). This suggests that the bats select roosts based on the internal characteristics of the structure rather than the surrounding vegetative community.

This bat uses a variety of habitats for foraging but appears to prefer forests, forest edges, and riparian zones, especially in association with cave and mine resources (UDWR 2020a).

In the area of analysis, suitable roosting and foraging habitats for Townsend's big-eared bat are present in the woodland, developed/urban, and open water habitat types outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

The Townsend's big-eared bad is designated by the state of Utah as a SGCN and is managed under the Utah Bat Conservation Plan. The primary threats to Townsend's big-eared bat are loss of cave and mine roosting sites and human disturbance at roosts. Mine closures throughout the west have resulted in the closure of thousands of mines. Additional reactivation of thousands of mines throughout the range also results in the loss of that resource to bats.

3.1.5.2.11 Northern Leopard Frog

Distribution

The northern leopard frog (*Lithobates pipiens*) is found throughout southern Canada and in the northern Rocky Mountains and intermountain areas of the United States. It is fairly common in Utah (UDWR 2021n).

This species was documented in the area of analysis in 1992 (UDWR 2021a).

Life History

Females lay eggs in the spring, typically on vegetation just below the surface of the water. Adult frogs eat a variety of small invertebrates while tadpoles eat algae, organic debris, and small invertebrates. During cold months, they are inactive, taking cover underwater or in damp burrows.

Habitat

The northern leopard frog occurs in a variety of aquatic habitats, particularly near cattails and other aquatic vegetation. The species requires a mosaic of habitats to meet the requirements of all its life stages and breeds in a variety of aquatic habitats that include slow-moving or still water along streams and rivers, wetlands, permanent or temporary pools, beaver ponds, and human-constructed habitats such as earthen stock tanks and borrow pits. Subadult northern leopard frogs typically migrate to feeding sites along the borders of larger, more permanent bodies of water, and recently metamorphosed frogs will move up and down drainages and across land to locate new breeding areas (USFWS 2015b).

In the area of analysis, suitable habitat for the northern leopard frog is present in the wetland habitat type outlined in Section 3.2.4.2 and shown in Figure 3.

Management and Threats

The northern leopard frog is designated by the state of Utah as a SGCN. The northern leopard frog is experiencing threats from habitat loss, disease, non-native species, pollution, and climate change (USFWS 2015b). The USFWS was petitioned to add the western United States population of the northern leopard frog to the list of threatened species protected under the ESA. While the species has experienced reductions in its historical range, particularly in the western United States and western Canada, it is still considered to be widespread and relatively common in the eastern United States and eastern Canada. Threats at the species level do not indicate that the northern leopard frog is in danger of extinction or likely to become so within the foreseeable future, throughout all or a significant portion of its range. Listing is not warranted at this time (USFWS 2011).

3.1.6 Flora and Fauna

3.1.6.1 Migratory Birds

The area of analysis includes several species of birds protected under the MBTA, which includes species that use Utah Lake and surrounding area as stopover habitat during migration, as well as species that migrate into the area of analysis to breed or overwinter. Both Goshen Bay at the southern end of the lake and Provo Bay on the east are recognized by the Audubon Society as State-level Important Bird Areas for migratory birds within the Great Basin Bird Conservation Region (National Audubon Society 2013).

A species report of the area of analysis requested through the Avian Knowledge Network (AKN) online phenology tool (AKN 2021) returned 288 species. The AKN compiles data derived from survey, banding, and community science datasets. However, when cross-referenced with species lists from birding hotspots monitored by the Cornell Lab of Ornithology eBird online community science database (Utah Lake Parkway Trail [North Shore] on the north side of Utah Lake, Utah Lake State Park to the east, and Lincoln Beach – Lincoln Point to LeBarron Point on the south; eBird 2021), many of the species identified as occurring within the area of analysis have not been observed for years or are observed infrequently and may be assumed to have been a rarity for the area or a transient individual. To provide the most relevant avian information for analysis of potential Project impacts, this section will highlight species identified by the eBird database as having occurred multiple times within the last 3 years, as well as those species identified by the USFWS as Birds of Conservation Concern (USFWS 2008) or species that may warrant special attention by the USFWS IPaC tool (USFWS 2021b). Table 3 provides an alphabetical list of 223 migratory avian species commonly occurring within the open water and wetland habitats of Utah Lake, as well as the immediately adjacent woodland, brushland, upland grassland, and sparsely vegetated habitats within the area of analysis.

Table 3. Common Migratory Birds with the Potential to Occur in the Project Area

Common Name	Scientific Name	Habitat
American Avocet	*Recurvirostra americana*	Wetland
American Coot	*Fulica americana*	Wetland and open water
American Crow	*Corvus brachyrhynchos*	Wetland, woodland, and sparsely vegetated
American Dipper	*Cinclus mexicanus*	Wetland
American Goldfinch	*Spinus tristis*	Woodland
American Kestrel	*Falco sparverius*	Wetland, upland grassland, and shrubland
American Pipit	*Anthus rubescens*	Wetland, upland grassland

Common Name	Scientific Name	Habitat
American Redstart	*Setophaga ruticilla*	Woodland, wetland
American Robin	*Turdus migratorius*	Woodland, wetland, and upland grassland
American Tree Sparrow	*Spizella arborea*	Woodland and wetland
American White Pelican	*Pelecanus erythrorhynchos*	Open water
American Wigeon	*Anas americana*	Open water and wetland
Baird's Sandpiper	*Calidris bairdii*	Wetland
Bald eagle	*Haliaeetus leucocephalus*	Open water and sparsely vegetated
Bank Swallow	*Riparia*	Wetland
Barn Owl	*Tyto alba*	Upland grassland
Barn Swallow	*Hirundo rustica*	Upland grassland, shrubland, and wetland
Barrow's Goldeneye	*Bucephala islandica*	Open water and wetland
Belted Kingfisher	*Megaceryle alcyon*	Wetland and woodland
Bewick's Wren	*Thryomanes bewickii*	Woodland and wetland
Black Phoebe	*Sayornis nigricans*	Wetland and woodland
Black Scoter	*Melanitta americana*	Open water
Black swift	*Cypseloides niger*	Open water and upland grassland
Black Tern	*Chlidonias niger*	Open water
Black-bellied Plover	*Pluvialis squatarola*	Wetland
Black-billed Magpie	*Pica hudsonia*	Upland grassland
Black-capped Chickadee	*Poecile atricapillus*	Woodland and wetland
Black-chinned Hummingbird	*Archilochus alexandri*	Woodland
Black-crowned Night-Heron	*Nycticorax*	Wetland and woodland
Black-headed Grosbeak	*Pheucticus melanocephalus*	Woodland
Black-necked Stilt	*Himantopus mexicanus*	Wetland
Black-throated Gray Warbler	*Setophaga nigrescens*	Woodland and wetland
Black-throated Sparrow	*Amphispiza blineata*	Upland grassland and shrubland
Blue Grosbeak	*Passerina caerulea*	Upland grassland, woodland, and wetland
Blue-gray Gnatcatcher	*Polioptila caerulea*	Woodland
Blue-winged Teal	*Anas discors*	Open water and wetland
Bonaparte's Gull	*Chroicocephalus philadelphia*	Open water
Brewer's Blackbird	*Euphagus cyanocephalus*	Wetland and woodland
Brewer's Sparrow	*Spizella breweri*	Upland grassland
Broad-tailed Hummingbird	*Selasphorus platycercus*	Woodland
Broad-winged Hawk	*Buteo platypterus*	Upland grassland and sparsely vegetated
Brown Creeper	*Certhia americana*	Woodland and wetland
Brown-headed Cowbird	*Molothrus ater*	Woodland, upland grassland, and shrubland
Bufflehead	*Bucephala albeola*	Open water

Common Name	Scientific Name	Habitat
Bullock's Oriole	*Icterus bullockii*	Wetland and woodland
Bushtit	*Psaltriparus minimus*	Woodland
California Gull	*Larus californicus*	Open water
Canada Goose	*Branta canadensis*	Open water and wetland
Canvasback	*Aythya valisineria*	Open water and wetland
Caspian tern	*Hydroprogne caspia*	Open water
Cassin's Finch	*Haemorhous cassinii*	Woodland
Cassin's Vireo	*Vireo cassinii*	Woodland and upland grassland
Cattle Egret	*Bubulcus ibis*	Upland grassland and wetland
Cedar Waxwing	*Bombycilla cedrorum*	Woodland
Chipping Sparrow	*Spizella passerina*	Woodland, upland grassland, shrubland, and wetland
Cinnamon Teal	*Anas cyanoptera*	Open water and wetland
Clark's Grebe	*Aechmophorus clarkii*	Open water and wetland
Clark's Nutcracker	*Nucifraga columbiana*	Woodland
Clay-colored Sparrow	*Spizella pallida*	Upland grassland, shrubland, Woodland
Cliff Swallow	*Petochelidon pyrrhonota*	Wetland and sparsely vegetated
Common Goldeneye	*Bucephala clangula*	Open water and wetland
Common Loon	*Gavia immer*	Open water
Common Merganser	*Mergus merganser*	Open water
Common Nighthawk	*Chordeiles minor*	Upland grassland, shrubland, and sparsely vegetated
Common Raven	*Corvus corax*	Upland grassland, shrubland, and sparsely vegetated
Common Tern	*Sterna hirundo*	Open water
Common Yellowthroat	*Geothlypis trichas*	Wetland
Cooper's Hawk	*Accipiter cooperii*	Woodland
Cordilleran Flycatcher	*Empidonax occidentalis*	Woodland
Dark-eyed Junco	*Junco hyemalis*	Woodland and upland grassland
Double-crested Cormorant	*Phalacrocorax auritus*	Open water
Downy Woodpecker	*Picoides pubescens*	Woodland and wetland
Dunlin	*Calidris alpina*	Wetland
Dusky Flycatcher	*Empidonax oberholseri*	Woodland
Eared Grebe	*Podiceps nigricollis*	Open water and wetland
Eastern Kingbird	*Tyrannus*	Upland grassland, shrubland, and woodland
Eastern Phoebe	*Sayornis phoebe*	Upland grassland, shrubland, and woodland
Evening Grosbeak	*Coccothraustes vespertinus*	Woodland
Ferruginous Hawk	*Buteo regalis*	Sparsely vegetated and upland grassland
Forster's Tern	*Sterna forsteri*	Open water
Fox Sparrow	*Passerella iliaca*	Woodland and wetland

Common Name	Scientific Name	Habitat
Franklin's Gull	*Leucophaeus pipixcan*	Open water, upland grassland, and shrubland
Gadwall	*Anas strepera*	Open water and wetland
Golden Eagle	*Aquila chrysaetos*	Upland grassland and sparsely vegetated
Golden-crowned Kinglet	*Regulus satrapa*	Woodland and wetland
Golden-crowned Sparrow	*Zonotrichia atricopilla*	Woodland and wetland
Grasshopper Sparrow	*Ammodramus savannarum*	Upland grassland
Gray Catbird	*Dumetella carolinensis*	Woodland and wetland
Gray Flycatcher	*Empidonax wrightii*	Upland grassland and shrubland
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	Upland grassland and woodland
Great Blue Heron	*Ardea herodias*	Wetland
Great Egret	*Ardea alba*	Wetland
Great Horned Owl	*Bubo virginianus*	Woodland
Greater Scaup	*Aythya marila*	Open water and wetland
Greater Yellowlegs	*Tringa melanoleuca*	Wetland
Great-tailed Grackle	*Quiscalus mexicanus*	Upland grassland, woodland, and sparsely vegetated
Green-tailed Towhee	*Pipilo chlorurus*	Woodland, shrubland, and upland grassland
Green-winged Teal	*Anas crecca*	Open water and wetland
Hairy Woodpecker	*Picoides villosus*	Woodland
Hammond's Flycatcher	*Empidonax hammondii*	Woodland and upland grassland
Hermit Thrush	*Catharus guttatus*	Woodland and wetland
Herring Gull	*Larus argentatus*	Open water
Hooded Merganser	*Lophodytes cucullatus*	Open water
Horned Grebe	*Podiceps auritus*	Open water and wetland
Horned Lark	*Eremophila alpestris*	Upland grassland and shrubland
House Finch	*Haemorhous mexicanus*	Upland grassland, woodland, and sparsely vegetated
House Wren	*Troglodytes aedon*	Woodland, shrubland, and sparsely vegetated
Juniper Titmouse	*Baeolophus ridgwayi*	Woodland
Killdeer	*Charadrius vociferus*	Wetland and upland grassland
Lark Sparrow	*Chondestes grammacus*	Woodland, shrubland, and upland grassland
Lazuli Bunting	*Passerina amoena*	Woodland, shrubland, and upland grassland
Least Sandpiper	*Calidris minutilla*	Wetland
Lesser Black-backed Gull	*Larus fuscus*	Open water
Lesser Goldfinch	*Spinus psaltria*	Woodland
Lesser Scaup	*Aythya affinis*	Open water
Lesser Yellowlegs	*Tringa flavipes*	Wetland
Lewis's Woodpecker	*Melanerpes lewis*	Woodland

Common Name	Scientific Name	Habitat
Lincoln's Sparrow	*Melospiza lincolnii*	Wetland and woodland
Loggerhead Shrike	*Lanius ludovicianus*	Upland grassland and shrubland
Long-billed Curlew	*Numenius americanus*	Wetland
Long-billed Dowitcher	*Limnodramus scolopaceus*	Wetland
MacGillivray's Warbler	*Geothlypis tolmiei*	Woodland
Mallard	*Anas platyrhynchos*	Wetland and open water
Marbled Godwit	*Limosa fedoa*	Wetland
Marsh Wren	*Cistothorus palustris*	Wetland
Merlin	*Falco columbarius*	Upland grassland and wetland
Mew Gull	*Larus canus*	Open water
Mountain Bluebird	*Sialia currucoides*	Upland grassland
Mountain Chickadee	*Poecile gambeli*	Woodland
Mourning Dove	*Zenaida macroura*	Woodland, upland grassland, shrubland, and sparsely vegetated
Mute Swan	*Cygnus olor*	Open water
Nashville Warbler	*Oreothlypis ruficapilla*	Woodland
Neotropic Cormorant	*Phalacrocorax brasilianus*	Open water
Northern Flicker	*Colaptes auratus*	Woodland
Northern Harrier	*Circus cyaneus*	Upland grassland and shrubland
Northern Mockingbird	*Mimus polyglottos*	Woodland, upland grassland, and sparsely vegetated
Northern Pintail	*Anas acuta*	Open water
Northern Pygmy-Owl	*Glaucidium gnoma*	Woodland
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Open water, woodland, and sparsely vegetated
Northern Shoveler	*Anas clypeata*	Open water
Northern Shrike	*Lanius excubitor*	Upland grassland and shrubland
Olive-sided Flycatcher	*Contopus cooperi*	Woodland and shrubland
Orange-crowned Warbler	*Oreothlypis celata*	Woodland
Osprey	*Pandion haliaetus*	Open water
Palm Warbler	*Setophaga palmarum*	Woodland
Pectoral Sandpiper	*Calidris melanotos*	Wetland
Peregrine falcon	*Falco peregrinus*	Sparsely vegetated and open water
Pied-billed Grebe	*Podilymbus podiceps*	Open water and wetland
Pine Siskin	*Spinus pinus*	Woodland
Pinyon Jay	*Gymnorhinus cyanocephalus*	Woodland
Plumbeous Vireo	*Vireo plumbeus*	Woodland
Prairie Falcon	*Falco mexicanus*	Upland grassland, shrubland, and sparsely vegetated
Purple Martin	*Progne subis*	Upland grassland and open water
Red Knot	*Calidris canutus*	Wetland

Common Name	Scientific Name	Habitat
Red-breasted Merganser	*Mergus serrator*	Open water
Red-breasted Nuthatch	*Sitta canadensis*	Woodland
Red-eyed Vireo	*Vireo olivaceus*	Woodland
Redhead	*Aythya americana*	Open water
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Woodland
Red-necked Phalarope	*Phalaropus lobatus*	Wetland
Red-tailed Hawk	*Buteo jamaicensis*	Upland grassland
Red-winged Blackbird	*Agelaius phoeniceus*	Wetland
Ring-billed Gull	*Larus delawarensis*	Open water
Ring-necked Duck	*Aythya collaris*	Open water
Rock Wren	*Salpinctes obsoletus*	Upland grassland and sparsely vegetated
Ross's Goose	*Chen rossii*	Wetland and open water
Rough-legged Hawk	*Buteo lagopus*	Upland grassland and sparsely vegetated
Ruby-crowned Kinglet	*Regulus calendula*	Woodland
Ruddy Duck	*Oxyura jamaicensis*	Open water and wetland
Rufous Hummingbird	*Selasphorus rufus*	Woodland and wetland
Sage Thrasher	*Oreoscoptes montanus*	Shrubland
Sagebrush Sparrow	*Artemisiospiza nevadensis*	Shrubland
Sanderling	*Calidris alba*	Wetland
Sandhill Crane	*Antigone canadensis*	Wetland and upland grassland
Savannah Sparrow	*Passerculus sandwichensis*	Upland grassland, shrubland, and wetland
Say's Phoebe	*Sayornis saya*	Upland grassland and shrubland
Semipalmated Plover	*Charadrius semipalmatus*	Wetland
Semipalmated Sandpiper	*Calidris pusilla*	Wetland
Sharp-shinned Hawk	*Accipiter striatus*	Woodland
Snow Bunting	*Plectrophenax nivalis*	Woodland and upland grassland
Snow Goose	*Chen caerulescens*	Wetland, upland grassland, and open water
Snowy Egret	*Egretta thula*	Wetland
Snowy plover	*Charadrius nivosus*	Wetland
Solitary Sandpiper	*Tringa solitaria*	Wetland
Song Sparrow	*Melospiza melodia*	Wetland and woodland
Sora	*Porzana carolina*	Wetland
Spotted Sandpiper	*Actitis macularius*	Wetland
Spotted Towhee	*Pipilo maculatus*	Woodland and upland grassland
Stilt Sandpiper	*Calidris himantopus*	Wetland
Summer Tanager	*Piranga rubra*	Woodland
Swainson's Hawk	*Buteo swainsoni*	Upland grassland and sparsely vegetated
Tennessee Warbler	*Oreothlypis peregrina*	Woodland
Townsend's Solitaire	*Myadestes townsendi*	Woodland

Common Name	Scientific Name	Habitat
Townsend's Warbler	*Setophaga townsendi*	Woodland
Tree Swallow	*Tachycineta bicolor*	Woodland, wetland, and open water
Trumpeter Swan	*Cygnus buccinator*	Open water
Tundra Swan	*Cygnus columbianus*	Open water
Turkey Vulture	*Cathartes aura*	Upland grassland, shrubland, woodland, and sparsely vegetated
Vesper Sparrow	*Pooecetes gramineus*	Upland grassland and shrubland
Violet-green Swallow	*Tachycineta thalassina*	Woodland and wetland
Virginia Rail	*Rallus limicola*	Wetland
Virginia's Warbler	*Oreothlypis virginiae*	Woodland
Western Grebe	*Aechmophorus occidentalis*	Open water
Western Meadowlark	*Sturnella neglecta*	Upland grassland
Western Sandpiper	*Calidris mauri*	Wetland
Western Wood-Pewee	*Cotopus sordidulus*	Woodland
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	Woodland
Whimbrel	*Numenius phaeopus*	Wetland
White-breasted Nuthatch	*Sitta carolinensis*	Woodland
White-crowned Sparrow	*Zonotrichia leucophrys*	Woodland and upland grassland
White-faced Ibis	*Plegadis chihi*	Wetland
White-winged Scoter	*Melanitta fusca*	Open water
Wild Turkey	*Meleagris gallopavo*	Woodland
Willet	*Tringa semipalmata*	Wetland
Willow Flycatcher	*Empidonax traillii*	Wetland and woodland
Wilson's Phalarope	*Phalaropus tricolor*	Wetland
Wilson's Snipe	*Gallinago delicata*	Wetland
Wilson's Warbler	*Cardellina pusilla*	Woodland and wetland
Wood Duck	*Aix sponsa*	Wetland
Woodhouse's Scrub-Jay	*Aphelocoma woodhouseii*	Woodland
Yellow Warbler	*Setophaga petechia*	Wetland and woodland
Yellow-breasted Chat	*Icteria virens*	Wetland and woodland
Yellow-headed Blackbird	*Xanthocephalus*	Wetland

Source: eBird (2021); AKN (2021)

3.1.6.2 Reptiles and Amphibians

Reptiles can inhabit a wide variety of habitats within the area of analysis such as agricultural, developed/urban, open water, sparsely vegetated, upland grassland, wetland, woodland, and shrubland. Most amphibians typically prefer open water, wetland, or portions of other terrestrial habitats that have access to moist conditions for majority of their life cycle (Pritchett et al. 1981). There have been 10 amphibians and 27 reptiles identified by the iNaturalist website as observed within the area of analysis (iNaturalist 2021a). Habitat requirements were assessed from available species information on the Utah Conservation Data Center website (Biological and Conservation Database 2021). Table 4 identifies the observations and provides the corresponding habitat type for each.

Table 4. Common Amphibian and Reptiles with the Potential to Occur in the Area of Analysis

Common Name	Scientific Name	Habitat
Amphibians		
American Bullfrog	*Lithobates catesbeianus*	Open Water, Wetlands
Boreal Chorus Frog	*Pseudacris maculata*	Open Water, Wetlands, Upland Grassland, Shrubland, Woodland
Columbia Spotted Frog	*Rana luteiventris*	Open Water, Wetlands
Great Basin Spadefoot	*Spea intermontana*	Upland Grassland, Shrubland, Woodland
Great Plains Toad	*Anaxyrus cognatus*	Upland Grassland, Agriculture
Green Frog	*Lithobates clamitans*	Open Water
Northern Leopard Frog	*Lithobates pipiens*	Wetlands
Western Tiger Salamander	*Ambystoma mavortium*	Upland Grassland, Shrubland, Woodland, Developed/Urban, Agriculture
Western Toad	*Anaxyrus boreas*	Open Water, Wetlands, Woodland
Woodhouse's Toad	*Anaxyrus woodhousii*	Open Water, Wetlands, Upland Grassland, Shrubland, Woodland, Developed/Urban, Agriculture
Reptiles		
Black-necked Gartersnake	*Thamnophis cyrtopsis*	Open Water, Wetlands
Common Garter Snake	*Thamnophis sirtalis*	Wetlands
Common Sagebrush Lizard	*Sceloporus graciosus*	Woodland, Sparsely Vegetated
Common Side-blotched Lizard	*Uta stansburiana*	Shrubland, Woodland, Sparsely Vegetated
Common Slider	*Trachemys scripta*	Open Water, Wetlands
Desert Collared Lizard	*Crotaphytus bicinctores*	Sparsely Vegetated
Desert Horned Lizard	*Phrynosoma platyrhinos*	Shrubland, Sparsely Vegetated
Desert Nightsnake	*Hypsiglena chlorophaea*	Wetlands, Upland Grassland, Shrubland, Woodland, Developed/Urban, Agriculture
Gopher Snake	*Pituophis catenifer*	Upland Grassland, Shrubland, Woodland
Greater Short-horned Lizard	*Phrynosoma hernandesi*	Upland Grassland, Woodland, Sparsely Vegetated
Long-nosed Leopard Lizard	*Gambelia wislizenii*	Shrubland, Sparsely Vegetated
Long-nosed Snake	*Rhinocheilus lecontei*	Shrubland, Sparsely Vegetated
New Mexico Whiptail	*Aspidoscelis neomexicanus*	Upland Grassland, Shrubland, Woodland
North American Racer	*Coluber constrictor*	Wetlands, Upland Grassland, Shrubland, Woodland

Common Name	Scientific Name	Habitat
Northern Rubber Boa	*Charina bottae*	Open Water, Wetlands, Upland Grassland, Woodland
Ornate Tree Lizard	*Urosaurus ornatus*	Shrubland, Woodland, Developed/Urban, Agriculture, Sparsely Vegetated
Painted Turtle	*Chrysemys picta*	Open Water, Wetlands
Prairie Rattlesnake	*Crotalus viridis*	Upland Grassland, Shrubland, Woodland, Agriculture, Sparsely Vegetated
Ring-necked Snake	*Diadophis punctatus*	Upland Grassland, Woodland, Sparsely Vegetated
Smooth Greensnake	*Opheodrys vernalis*	Wetlands, Upland Grassland
Striped Whipsnake	*Masticophis taeniatus*	Open Water, Wetlands
Western Fence Lizard	*Sceloporus occidentalis*	Upland Grassland, Shrubland, Sparsely Vegetated
Western Milksnake	*Lampropeltis gentilis*	Upland Grassland, Shrubland, Woodland, Sparsely Vegetated
Western Rattlesnake	*Crotalus oreganus*	Upland Grassland, Shrubland, Woodland, Sparsely Vegetated
Western Skink	*Plestiodon skiltonianus*	Woodland, Sparsely Vegetated
Western Terrestrial Garter Snake	*Thamnophis elegans*	Open Water, Wetlands, Upland Grassland, Shrubland, Woodland, Developed/Urban, Agriculture, Sparsely Vegetated
Western Whiptail	*Aspidoscelis tigris*	Shrubland, Sparsely Vegetated

Source: iNaturalist (2021a); Utah Division of Wildlife Resources Utah Conservation Data Center (2021a)

3.1.6.3 Mammals

3.1.6.3.1 Mule Deer

Mule deer (*Odocoileus hemionus*) typically migrate from high-elevation summer ranges to lower elevation winter ranges. However, some deer will spend their entire year at lower elevations when forage is available and pressure from development and predators is relatively low. Areas adjacent to Utah Lake provide a variety of habitat that is suitable for mule deer. Some habitat types in the area of analysis, such as agricultural, upland grassland, and shrubland, are used as winter range while others, such as woodland, are used as year-round habitat.

Approximately 594 acres of crucial year-round mule deer habitat also intersects the area of analysis along the eastern edge of the Lake Mountains on the west side of the area of analysis. Mule deer habitat in the Lake Mountains consists of upland grasslands, shrublands, and woodlands. This habitat is somewhat separated from the area of analysis by State Route (SR) 68, a two-lane paved highway.

Mule deer also use habitats directly adjacent to Utah Lake. Many areas along the lake contain cottonwood (*Populus* spp.) galleries, Russian olive (*Elaeagnus angustifolia*) thickets, and marshlands that provide suitable habitat for year-round occupancy by mule deer. This habitat is not considered crucial by the UDWR and therefore is not mapped.

3.1.6.3.2 Pronghorn

Pronghorn (*Antilocapra americana*) habitat is characterized by relatively mild topography and vegetation cover typically consisting of semi-desert shrub species with an understory of perennial and annual grasses and a variety of forb species. Pronghorn can also inhabit pinyon-juniper and juniper woodlands. In the area of analysis, pronghorn habitat types mainly consist of shrublands and upland grasslands. Vegetation within pronghorn habitat is dominated by sagebrush species (*Artemisia* spp.), grasses, and forbs. Approximately 1,955 acres of crucial year-round habitat intersects the area of analysis south of the Lake Mountains on the west side of the area of analysis. SR 68, a two-lane paved highway, separates this habitat from Utah Lake (UDWR 2020b).

3.1.6.3.3 Bats

There are 19 bat species that exist within the state of Utah. Most, if not all, of these species have the potential to occur statewide and, therefore, within the area of analysis. The two habitat factors limiting the presence of bats in a given environment are roost sites and foraging habitat. With the exception of some extreme environments (remote salt flats, exposed alpine, etc.), all habitats in Utah are at least suitable foraging habitat for bats. Open water sources offer a higher quality foraging habitat, as insects are often more abundant over open water and surface water is typically bordered by vegetation that is preferred by insects. In addition, bats require open water for drinking. In a dry state such as Utah, drinking water is often a limiting factor for bat distribution. Bats can use small sources of open water, such as cattle tanks, but larger bodies of water provide easier and more stable access to water (Oliver et al. 2013).

The area of analysis offers several aspects of prime bat habitat. Utah Lake provides abundant open water, which is used as a drinking source, provides abundant forage, and supplies some roost sites in the form of large trees that grow along the shoreline and buildings in developed portions of the area of analysis. Table 5 provides a list of bat species that are known to exist in the state of Utah.

Table 5. Bat Species Known to Occur in Utah

Common Name	Scientific Name	Utah Distribution	Utah Abundance
Allen’s big-eared bat	*Idionycteris phyllotis*	South and southeast	Rare
Arizona myotis	*Myotis occultus*	Southern Utah	Uncommon
Big brown bat	*Eptesicus fuscus*	Statewide	Abundant
Big free-tailed bat	*Nyctinomops macrotis*	Southern half of state	Rare
Brazilian free-tailed bat	*Tadarida brasiliensis*	Statewide*	Abundant

Common Name	Scientific Name	Utah Distribution	Utah Abundance
California myotis	*Myotis californicus*	Statewide, except Uinta Mountains	Common
Fringed myotis	*Myotis thysanodes*	Statewide*	Uncommon
Hoary bat	*Lasiurus cinereus*	Statewide	Uncommon
Little brown myotis	*Myotis lucifugus*	Statewide*	Common
Long-eared myotis	*Myotis evotis*	Statewide	Common
Long-legged myotis	*Myotis volans*	Statewide	Abundant
Pallid bat	*Antrozous pallidus*	Statewide*	Common
Silver-haired bat	*Lasionycteris noctivagans*	Statewide	Common
Spotted bat	*Euderma maculatum*	Statewide*	Rare
Townsend's big-eared bat	*Corynorhinus townsendii*	Statewide	Common
Western pipistrelle	*Parastrellus hesperus*	Statewide*	Extremely abundant
Western red bat	*Lasiurus blossevillii*	North–south band from extreme north-central to extreme southwest	Very rare
Western small-footed myotis	*Myotis ciliolabrum*	Statewide	Uncommon
Yuma myotis	*Myotis yumanensis*	Statewide*	Uncommon

* Likely found statewide; however, it is unreported in parts of Utah.

3.1.6.3.4 Other Mammal Species

Habitat types within the area of analysis provide food and cover for many species of mammals. Table 6 provides a list of common mammal species, derived from the iNaturalist website, with the potential to occur in or adjacent to the area of analysis as well as their associated habitat types found in the area of analysis (iNaturalist 2021b).

Table 6. Common Mammal Species with the Potential to Occur in the Area of Analysis

Common Name	Scientific Name	Associated Habitat Types in the Area of Analysis
American beaver	*Castor canadensis*	Wetland and open water
American mink	*Neovison vison*	Wetland
American red squirrel	*Tamiasciurus hudsonicus*	Woodland
Black-tailed jack rabbit	*Lepus californicus*	Shrubland, upland grassland, and agriculture
Bobcat	*Lynx rufus*	Woodland
Bushy-tailed woodrat	*Neotoma cinerea*	Woodland, shrubland, upland grassland, wetland, developed/urban, and agriculture
Common raccoon	*Procyon lotor*	Woodland, wetland, agriculture, and developed/urban

Common Name	Scientific Name	Associated Habitat Types in the Area of Analysis
Coyote	*Canis latrans*	Woodland, shrubland, upland grassland, agriculture, and developed/urban
Deer mouse	*Peromyscus maniculatus*	Woodland, shrubland, upland grassland, wetland, developed/urban, and agriculture
European rabbit	*Oryctolagus cuniculus*	Upland grassland, shrubland, and agriculture
Fox squirrel	*Sciurus niger*	Woodland and developed/urban
House mouse	*Mus musculus*	Woodland, shrubland, upland grassland, wetland, developed/urban, and agriculture
Long-tailed vole	*Microtus longicaudus*	Woodland, shrubland, upland grassland, wetland, developed/urban, and agriculture
Long-tailed weasel	*Mustela frenata*	Woodland, shrubland, upland grassland, wetland, developed/urban, and agriculture
North American porcupine	*Erethizon dorsatum*	Woodland
Northern pocket gopher	*Thomomys talpoides*	Shrubland and upland grassland
Rock squirrel	*Otospermophilus variegatus*	Woodland, upland grassland, and shrubland
Striped skunk	*Mephitis*	Woodland, shrubland, upland grassland, wetland, developed/urban, and agriculture
Western harvest mouse	*Reithrodontomys megalotis*	Woodland, shrubland, upland grassland, wetland, developed/urban, and agriculture
White-tailed jackrabbit	*Lepus townsendii*	Shrubland, upland grassland, and agriculture

Source: iNaturalist (2021b)

3.1.6.4 Fishes

3.1.6.4.1 Native

Historically, several native fish occupied Utah Lake including, the Bonneville cutthroat trout, June sucker (*Chasmistes liorus*), Utah sucker (*Catostomus ardens*), Utah chub (*Gila atraria*), mountain whitefish (*Prosopium williamsoni*), mountain sucker (*Catostomus platyrhunchus*), Bonneville redside shiner (*Richardsonius balteatus hydroflox*), speckled dace (*Rhinichthys osculus*), longnose dace (*Rhinichthys cataractae*), leatherside chub (*Lepidomeda aliciae*), least chub (*Iotichtys phlegethontis*), Utah Lake sculpin (*Cottus echinatus*), and mottled sculpin (*Cottus bairdi*). The June sucker, Utah sucker, and Utah chub still occur in Utah Lake (USFWS 2010).

3.1.6.4.2 Non-native

Non-native fish species were first introduced to Utah Lake in the late 1800s to support the fishing industry. The common carp (1886), black bullhead (1893), and largemouth bass (1890) were added to Utah Lake before the twentieth century. The introduction of the channel catfish (1919), walleye (1952), and white bass (1956) followed in the early to mid-1900s (USFWS 1999). By the mid-1900s, the abundance of non-native fish species began to dominate the lake ecosystem (Heckmann et al. 1981).

A survey was conducted by the Utah Division of Natural Resources in 1970 to assess the fish species composition of Utah Lake. White bass (70%), carp (16%), and black bullhead (8%) made up the majority of the fish biomass with less dominant species such as bluegill (*Lepomis macrochirus*), channel catfish, golden shiner (*Notemigonus crysoleucas*), yellow shiner (*Notropis calientis*), largemouth bass, walleye, and fathead minnows (*Pimephales promelas*) completing the remaining 6% (Heckmann et al. 1981). The carp, walleye, white bass, black bullhead, and channel catfish populations were successful at adapting to the shallow waters and are currently the most abundant species in Utah Lake. In the early 2000s, carp made up approximately 91% of the total fish biomass in the lake. To date, it is estimated that 29 million pounds of carp have been removed from Utah Lake, and efforts have reduced the population by 78% since 2010 (JSRIP 2020a). Though these efforts have been successful in reducing non-native species, continued effort is needed to manage the carp population.

The recent, illegal introduction of the northern pike to Utah Lake is an increasing and immediate threat to June sucker populations. Pike are large, predatory fish that are capable of preying on adult June suckers, potentially leading to a decline in the number of spawning sucker adults. Pike also prefer to spawn in shallow waters at the mouth of tributaries, where spawning June suckers congregate before heading upstream and where aquatic vegetation provides habitat and protection for juvenile suckers. The overlap in habitat and aggressive behavior of pike makes the species a threat to sucker populations and the conservation efforts of the JSRIP (JSRIP 2020b).

3.1.6.5 Plants

This section discusses the native and non-native plants that occur within the area of analysis. According to iNaturalist website, there are over 681 different plant species that have been observed within the various habitat types discussed in Section 3.2.4.2 of this document (iNaturalist 2021c). Of the total documented species, 166 plants are classified as introduced or non-native species.

3.1.6.5.1 Native

Native plants have been identified during numerous botanical studies conducted by Brotherson, Coombs, Cottam, and others within or adjacent to the area of analysis (Brotherson 1981). Absent significant natural or human-made disturbance or land use conversion most habitats are dominated by native plant species. For example, in terrestrial wetland habitats, native cattails (*Typha latifolia*), softstem bulrush (*Scirpus validus*), and American bulrush or tule (*Scirpus acutus*) occupy freshwater marshes, whereas spikerush (*Eleocharis macrostachya*) require drier land (Coombs 1970). In more saline aquatic environments, inland saltgrass (*Distichlis spicata*), Baltic rush (*Juncus balticus*), and other halophytes such as kochia (*Kochia americana*), red saltwort (*Salicornia rubra*) and bush seepweed (*Suaeda nigra*) persist. Conversely, in the well-drained uplands, big sagebrush, rabbitbushes, greasewood, and snakeweed are dominant in the shrubland canopy (Coombs 1970). Riparian habitats have cottonwoods and several species of willows that make up a majority of overstory tree cover.

3.1.6.5.2 Non-native

Where past and present disturbance has occurred, non-native or exotic plant species typically invade a disturbed habitat and can quickly become established. These non-native plant species can outcompete native species, thereby limiting diversity and reducing habitat and food for native wildlife. Many areas in the area of analysis have experienced some form of disturbance through land use changes or extreme droughts and have caused the habitats to be significantly impacted by the presence of several non-native invasive species.

Many of these non-native plants are regulated in the state of Utah as noxious weeds. Under Utah Administrative Code Rule R68-9 of the Utah Noxious Weed Act, the Commissioner of Agriculture and Food, with the aid of each county's weed board, maintains a list of noxious weeds and implement appropriate treatments to control the spread of such designated weeds. As of 2020, Utah County's weed control division lists 54 weeds on the noxious weed list (Table 7).

Table 7. 2020 Noxious Weed List for Utah County

Common Name	Scientific Name	Class*
African Rue	*Peganum harmala*	1A
Malta Starthistle	*Centaurea melitensis*	1A
Common Crupina	*Crupina vulgaris*	1A
Mediterranean Sage	*Salvia aethiopis*	1A
Plumless Thistle	*Carduus acanthoides*	1A
Small Bugloss	*Anchusa officinalis*	1A
Spring Milletgrass	*Milium vernale*	1A
Syrian Beancaper	*Zygophyllum fabago*	1A
Ventenata	*Ventenata dubia*	1A
Camelthorn	*Alhagi maurorum*	1B
Common St. Johnswort	*Hypericum perforatum*	1B
Cutleaf Vipergrass	*Scorzonera laciniata*	1B
Elongated Mustard	*Brassica elongata*	1B
Garlic Mustard	*Alliaria petiolata*	1B
Giant Reed	*Arundo donax*	1B
Goatsrue	*Galega officinalis*	1B
Japanese Knotweed	*Reynoutria japonica*	1B

Common Name	Scientific Name	Class*
Oxeye Daisy	*Leucanthemum vulgare*	1B
Purple Starthistle	*Centaurea calcitrapa*	1B
Sahara or African Mustard	*Brassica tournefortii*	1B
Viper Bugloss (Blueweed)	*Echium vulgare*	1B
Black Henbane	*Hyoscyamus niger*	2
Dalmation Toadflax	*Linaria dalmatica*	2
Diffuse Knapweed	*Centaurea diffusa*	2
Dyers Woad	*Isatis tinctoria*	2
Leafy Spurge	*Euphorbia esula*	2
Medusahead	*Taeniatherum caput-medusae*	2
Purple Loosestrife	*Lythrum salicaria*	2
Rush Skeletonweed	*Chondrilla juncea*	2
Spotted Knapweed	*Centaurea stoebe*	2
Squarrose Knapweed	*Centaurea virgata*	2
Yellow Starthistle	*Centaurea solstitialis*	2
Yellow Toadflax	*Linaria vulgaris*	2
Bermudagrass	*Cynodon dactylon*	3
Canada Thistle	*Urophora cardui*	3
Field Bindweed	*Convolvulus arvensis*	3
Hoary Cress	*Lepidium draba*	3
Houndstongue	*Cynoglossum officinale*	3
Jointed Goatgrass	*Aegilops cylindrica*	3
Musk Thistle	*Carduus nutans*	3
Perennial Pepperweed	*Lepidium latifolium*	3
Perennial Sorghum species	*Sorghum halepense and Sorghum almum*	3
Phragmites (Common reed)	*Phragmites australis ssp.*	3
Poison Hemlock	*Conium maculatum*	3
Puncturevine	*Tribulus terrestris*	3
Quackgrass	*Elymus repens*	3
Russian Knapweed	*Acroptilon repens*	3
Scotch Thistle (Cotton thistle)	*Onopordum acanthium*	3
Tamerisk (Saltcedar)	*Tamarix ramosissima*	3
Cogongrass	*Imperata cylindrica*	4
Damesrocket	*Hesperis matronalis*	4
Myrtle Spurge	*Euphorbia myrsinites*	4
Russian Olive	*Elaeagnus angustifolia*	4
Scotch Broom	*Cytisus scoparius*	4

* - Class 1A (Early Detection Rapid Response [EDRR] Watch List), Class 1 (EDRR), Class 2 (Control), Class 3 (Containment), and Class 4 (Prohibited for sale or propagation)

These noxious plants have been categorized into the following five classes:

- **Class 1A:** Early Detection Rapid Response (EDRR) Watch List. Declared noxious and invasive weeds. Not known to exist in Utah but a significant risk of invasion.
- **Class 1B:** EDRR. Declared noxious and invasive weeds with a limited distribution in Utah. Pose a serious threat to the state and should be considered as a very high priority.
- **Class 2:** Control. Declared noxious and invasive weeds that pose a threat to the state and should be considered a high priority for control. Widely distributed in Utah in varying populations. The concentration of these weeds is at a level where control or eradication may be possible
- **Class 3:** Containment. Declared noxious and invasive weeds that are widely spread throughout the state and considered beyond control. Weed control efforts should be directed at reducing or eliminating new or expanding weed populations. Known and established weed populations, as determined by the Utah County weed control authority, may be managed by any approved weed control method. These weeds pose a threat to the agricultural industry and agricultural products.
- **Class 4:** Prohibited. Declared noxious and invasive weeds that pose a threat to the state through the retail sale or propagation in the nursery and greenhouse industry.

One of the most prevalent invasive plants in the area of analysis is *Phragmites*. *Phragmites*, a non-native, highly invasive plant species that currently dominates much of the shoreline and wetland habitats. Starting in 2008, The Utah Lake Commission has coordinated a long-term shoreline restoration program with local municipal governments, Utah County, and applicable state and federal agencies, as well as private landowners to remove *Phragmites* and other invasive plant species such as tamarisk and Russian olive from the shoreline of Utah Lake. Over 9,000 acres of shoreline and seasonally submerged parts of Utah Lake are targeted for active treatment and removal of *Phragmites*.

3.1.7 Regulatory Framework

This section provides an overview of notable federal and state environmental laws, policies, plans, regulations, and/or executive orders relevant to terrestrial biological resources. A brief summary of each is provided.

3.1.7.1 Federal Regulations

- Federal ESA
- MBTA of 1918
- Bald and Golden Eagle Protection Act
- Executive Order 13112: Prevention and Control of Invasive Species

3.1.7.2 State Regulations

- Wildlife Resources Code 23-14-1-2a
- Utah Administrative Rule R657-48
- Utah Noxious Weed Act

3.2 Cultural Resources

Cultural resources are any prehistoric or historic district, site, building, structure, or object considered important to a culture, subculture, or community for scientific, traditional, religious, or other purposes. Archaeological resources are areas where prehistoric or historic activity altered the earth or where deposits of physical remains are discovered. Prehistoric cultural resources are those materials deposited or left behind prior to the entry of non-Native Americans into an area. Historic cultural resources are those materials deposited or left behind after the European presence was established. Architectural resources include standing structures of historic value. Traditional resources can include archaeological resources, structures, topographic features, habitats, plants, wildlife, and minerals that Native Americans or other groups consider essential for the preservation of traditional culture. Traditional values can be manifested at locations called traditional cultural properties.

3.2.1 Resource Indicators and Measures

The primary indicator for impacts to cultural resources is whether there is a potential loss of or impact to characteristics that qualify the property for listing on the National Register of Historic Places (NRHP) or would diminish the cultural value of areas important to Native American or other traditional communities. This indicator is measured by current site condition and departures from this condition.

3.2.2 Area of Analysis

For the purposes of describing the affected environment for cultural resources and the analysis of environmental consequences for management alternatives, the area of analysis for direct and indirect impacts is considered here at two scales. The first is the preliminary Project area boundary plus a 500-foot buffer from Project boundary, hereafter referred to as the "preliminary Project area boundary". The second includes a buffer 2 miles from the limits of disturbance. This much broader area is referred to as the "extended area of analysis" and is described in an effort to characterize cultural resources that may be subject to indirect or cumulative effects from the Project.

3.2.3 Cultural Resource Surveys

Archaeological survey data maintained by the Utah Division of State History indicates that 50 previous cultural resource assessments have been completed within or intersect the preliminary Project area boundary. The majority of these assessments were conducted along the lake's eastern margin.

3.2.4 Documented Archaeological Sites

Available documents provide records of 73 archaeological sites within the preliminary Project area boundary. These sites are potentially the most susceptible to impacts from development. Of these 73 sites, 57 are prehistoric and 16 are historic in age. There are 17 prehistoric sites eligible for or listed in the NRHP; 3 are not eligible; and 37 have not been evaluated for NRHP eligibility.

A total of 16 historic archaeological sites were identified. Out of the 16 historical archeological sites identified, 10 are eligible for the NRHP and 6 are not eligible.

Within the extended area of analysis, 182 previously documented archaeological sites were identified by referenced cultural resource assessments. Of these 182 sites, there are 111 prehistoric sites, 67 historic sites, 2 multicomponent sites, and 2 sites with insufficient documentation to determine class. Prehistoric sites are represented by 9 different site types. There are 40 prehistoric sites eligible for or are listed on the NRHP, and 9 are not eligible. The remaining prehistoric sites have not been evaluated for NRHP eligibility.

The 67 identified historic sites include 18 different site types. Of these 67 sites, 22 are eligible for or listed on the NRHP, and 45 are not eligible.

3.2.5 Historic Architectural Sites

There are 19 historic architectural sites documented within the preliminary Project area boundary, and their proximity to Project activities makes them potentially more susceptible to adverse effects as a result of the Project. Of the 19 architectural sites documented, 16 are eligible for the NRHP.

There are 689 historic architectural localities within the extended area of analysis. Historic residential structures comprise 602 of these locations and are the most common historic architectural site. Of these historic architectural resources, 455 are eligible for or listed in the NRHP; 213 are not eligible; NRHP eligibility has not been determined for 4 sites; 12 locations have been demolished; and there is no information available on NRHP eligibility for 5 locations.

3.2.6 Tribal Trust

Due to Section 106 requirements, coordination with the Tribes will be completed during the Individual Permit application review.

3.2.7 Regulatory Framework

3.2.7.1 Federal Regulations

- National Historic Preservation Act
- Archaeological Resources Protection Act
- Native American Graves Protection and Repatriation Act

3.2.7.2 State Regulations

- Utah Antiquities Act (Utah Code Annotated 9-9-404)
- Native American Graves Protection and Repatriation Act (Utah Code Annotated 9-9-401)

3.3 Aesthetics

The aesthetic quality of a community or area depends upon its visual resources and the physical features that make up the landscape, including land, water, vegetation, and human-made features such as buildings, roads, and structures.

3.3.1 Resource Indicators and Measures

3.3.1.1 NEPA Requirements

NEPA does not dictate “how” to conduct an environmental analysis for visual and aesthetic resources; thus, the agencies have flexibility in how they assess the specific resource impacts and a few agencies have developed their own methods and procedures.

3.3.1.2 Visual Impact Assessment Systems

The visual impact analysis process evaluates an area based on impacts to the landscape character and impacts on sensitive views and viewers. The system selected to evaluate the visual impact considers the regulatory agencies and the community concerns as it seeks to provide compliance. The Project is under the jurisdiction of USACE, and the information provided follows the USACE Visual Resource Assessment Procedure (VRAP).

3.3.1.2.1 USACE VRAP

The VRAP was developed to inventory existing scenic values, assess potential impacts on visual resources, and to recommend changes or mitigation to reduce those visual impacts for projects involving the USACE (USACE 1988). The VRAP is made up of two parts: Management Classification System (MCS) and Visual Impact Assessment (VIA).

The MCS focuses on identifying existing scenic values associated with the landscapes potentially impacted by a project (landscape similarity zones), establishing visual quality ratings for those landscapes, and forecasting trends and changes to visual resources with and without the project. The final step of the inventory is to assign an MCS class (or management class) to serve as a guideline for the degree and nature of acceptable visual change (contrast) in a particular landscape.

The VIA uses the inventory information from the MCS to evaluate project impacts from discrete viewpoints or key observation points (KOPs). Viewpoints are selected that are representative of the project area and are chosen because they represent typical viewer locations, typical viewer activities or expectations, and potential project visibility

3.3.1.3 Visual Impact Receptors

Both humans and the landscape may be impacted by a proposed project. The VRAP considers both the impacts to the landscape as well as to views and viewers within the viewshed. This element of the analysis also considers the impact the project may have on designated areas with specific visual management objectives or protections, such as wilderness areas, national parks, monuments, wild and scenic areas, areas of critical environmental concern, and scenic byways and highways. There are no such designated areas within the Project boundary.

3.3.1.3.1 Landscape (Management Classifications and Visual Quality Ratings)

Landscape character is defined as a continuous unit of land comprising harmonizing features that result in and exhibit a particular visual character. The Bureau of Land Management (BLM), USFS, and other land management agencies typically delineate units representing landscape character to form the baseline for their respective visual inventories. The VRAP system uses Landscape Similarity Zones (LSZs), as the basis for inventorying the landscape's quality and visual quality objectives.

3.3.1.3.2 Human (Sensitive Viewers)

Sensitive views represent places from where the project can be seen by viewers with an awareness of the visual and aesthetic character of the setting. These are commonly referred to as KOPs and establish locations from where impacts on views are assessed. The identification of KOP locations includes a review of residences, recreation areas, and transportation corridors within the area of analysis to represent critical viewpoints, typical views in representative landscapes, and special project features.

3.3.1.5 Visual Resource Indicators

Potential positive or negative impacts on landscape character occur where proposed changes to the existing landscape's landform, water, vegetation, and/or structures is modified in such a way that improves or degrades the character of the setting. Similarly, positive or negative impacts to views from KOPs occur where the introduction of a project into the viewshed reduces or introduces contrasting elements in the landscape that are noticeable, attract attention, or dominate views compared with the existing condition of the landscape. The level of change introduced by a project, or visual contrast, is the metric to assess impacts on views from KOP locations. This is done by comparing the design features of the existing setting (e.g., form, line, color, and texture) with those proposed by the project. As part of this assessment, several additional factors are considered, including the following:

- **Distance:** contrast introduced generally decreases as distance increases.
- **Angle of observation:** superior (above), normal (level), or inferior (below); the apparent size of a project is directly related to the angle between the viewer's line-of-sight and the slope upon which the project is to take place, as this angle nears 90 degrees (vertical and horizontal), the maximum area is viewable.
- **Length of time in view:** longer duration views increase visual contrast.
- **Relative size or scale:** the project compared to other elements in the landscape.

3.3.2 Area of Analysis

The Project's visual resource area of analysis is defined as groups of properties, roads, public rights-of-way, and public open space that lie within the visual envelope (viewshed) or zone of visual influence of the Project. This viewshed extends outside of the Project boundary with a range that does not exceed 12 miles.

The area of analysis is further differentiated by landscapes within a +/-1-mile buffer of the Project boundary. This buffer was chosen as representing similar landscapes adjacent to the Project.

3.3.3 Method

The evaluation for the ULRP includes an assessment of the existing condition and potential effects on landscape and human receptors in accordance with NEPA to "assure for all Americans' safe, healthful, productive, and aesthetically and culturally pleasing surroundings" (Sullivan et al. 2017). The process used for conducting this VIA includes a description of surroundings, methods of analysis, potential environmental impacts, and mitigation and minimization measures.

The visual analysis for the ULRP follows the VIA method of the USACE VRAP (Smardon et al. 1988). Specifically, the method was used to evaluate visual resources affecting the Project area following the VRAP flow chart generally depicted in Figure 4.

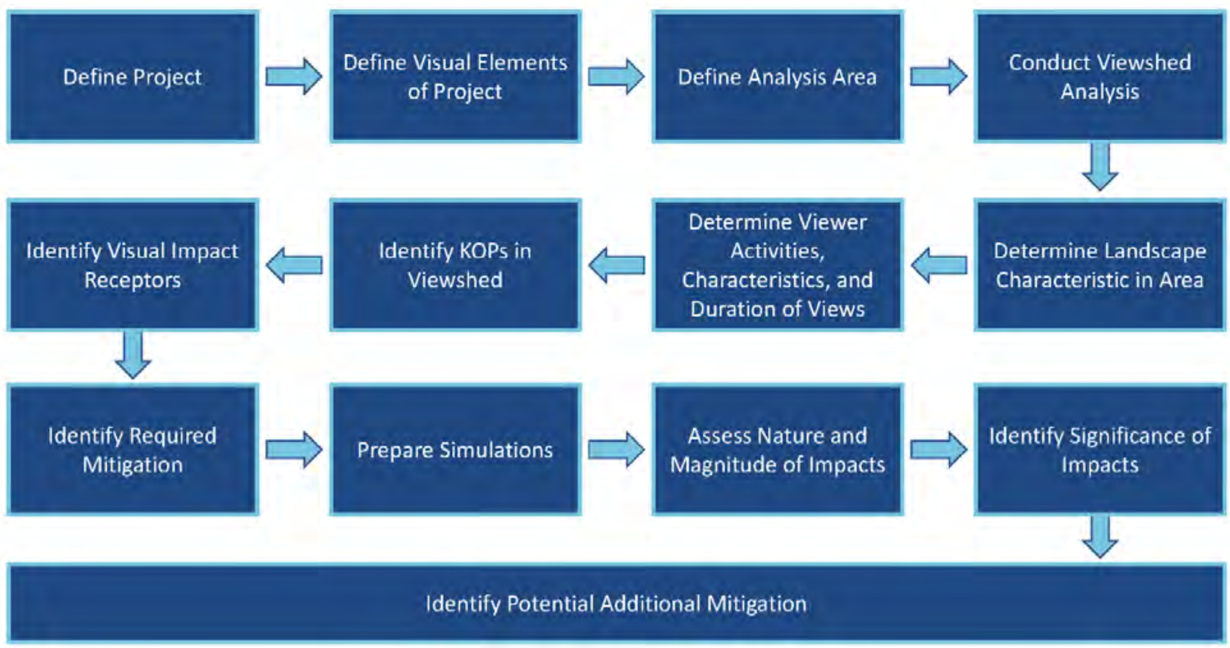

Figure 4. VRAP Method

The specific approach used to evaluate the visual resources current conditions used the VRAP MCS and LSZs as the baseline condition and establishes an assessment framework to evaluate the effects of the alternatives within the area of analysis (Table 8).

Table 8. Visual Resources Approach

<table>
<tr><th colspan="3">1-Identify Problems and Opportunities</th><th>2-Conduct viewshed analysis</th></tr>
<tr><td>1a

Define Study Area</td><td>1b

Identify Regional Landscape- Define Area of Analysis</td><td>1c

Determine MCS Class-General</td><td rowspan="2">2a

Inventory existing visual resources

Forecast without-plan conditions to assess any changes from existing visual resource conditions

Forecast with-plan conditions</td></tr>
<tr><td colspan="3">1d

- Identify visual impact receptors
- Establish similarity zones
- Identify KOPs in viewshed
- Determine viewer activities, characteristics, and duration of views
- Determine landscape character in area</td></tr>
<tr><th colspan="4">3- Formulate Alternative Plans/Evaluate Alternative Plans</th></tr>
<tr><td colspan="2">3a

Use simulations to show design alternatives

Assess nature and magnitude of impacts

Identify significance of impacts</td><td>3b

Assess visual impacts by calculating the difference between future with and without plan conditions for each landscape component, for each viewpoint</td><td>3c

Combine viewpoint assessments from multiple evaluators / calculate a VIA value.</td></tr>
<tr><td>3d

Identify required mitigation

Identify potential additional mitigation</td><td>3e

Combine public/ professional VIA values to calculate total VIA</td><td>3f

Compare VIA values with MCS criteria</td><td>3g

Finalize Report</td></tr>
</table>

3.3.4 Landscape Character Units

Landscape character is defined as a contiguous unit of land comprised of harmonizing features that result in and exhibit a particular character. These differentiators are identified, described, and mapped and include ecoregions, vegetation, water, and land use. They are further defined through the use of visual quality ratings and grouping within similarity zones.

3.3.4.1 BLM Scenic Quality Rating Units

The BLM inventoried, delineated, and rated Scenic Quality Rating Units for all lands within the area of analysis. Scenic Quality Rating Units in the BLM Visual Resource Management (VRM) system are similar to LSZs in the USACE system. The visual mapping polygons within the area of analysis have all been rated by the BLM as Class C landscapes, (Figure 5). Class C landscapes are considered to have a moderate sensitivity, which corresponds to landscapes with the lowest value in the VRM system. This baseline condition description of the landscape is useful in identifying LSZs within the USACE system, rating the LSZs, and assigning MCS Classes.

3.3.4.2 Landscape Similarity Zones

Within the 1-mile buffer area of the Project boundary, 10 LSZs have been identified that represent areas that share common characteristics of landform, water resources, vegetation, land use, and land use intensity (Table 9). The LSZs were further characterized by their ecoregion, dissimilar features (unique to a few areas), and similar features (shared by most or all locations).

Since the Project boundary is within the Lake itself, the LSZ delineation was made 1 mile outside of the Lake boundary and extended to 1-mile inside of the Lake boundary.

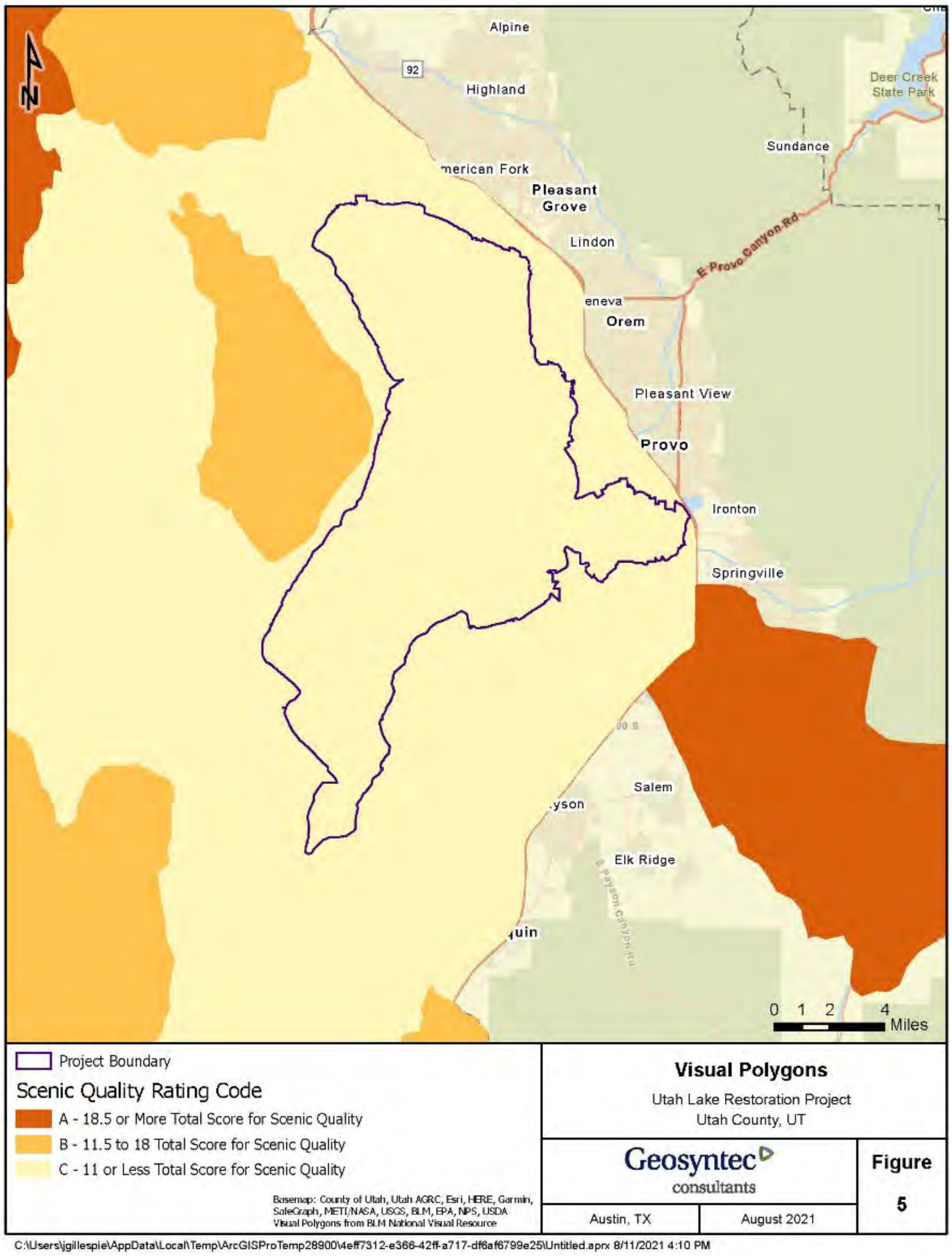

Figure 5. Visual Polygons

Table 9. LSZ Designations

Landscape Similarity Zones	Location Name	Dissimilar Features	Ecoregion	LSZ Similarities
LSZ-1	American Fork	Rail	Ecoregion III- 13 Ecoregion IV- 13 (f) moist Wasatch	LSZ 1-5 and 9 have residential and commercial development areas, therefore, no areas are identified as specifically rural or suburban. All LSZs are in the valley land. All LSZs have Lake exposure and contain wetlands. All LSZs have some type of recreational facilities. All LSZs have some agricultural lands. All LSZs have some type of developed transportation and Lake access. Industrial / light industrial is evident in every LSZ, except 6. Invasive species are a concern in all LSZs. All LSZs have residential homes; 1-5 and 9 have residential communities.
LSZ-2	Vineyard	Rail, beach, wastewater treatment plant, marina		
LSZ-3	Utah Lake State Park	Wildlife natural area / preserve, rail, wastewater treatment plant, beach, marina		
LSZ-4	Provo Airport	Airport		
LSZ-5	Provo Bay	Rail, wastewater treatment plant, wildlife management area, golf course, boat ramps		
LSZ-6	Rock Island Waterfowl Area	Barren lands, waterfowl management area, beaches, marina	Ecoregion III- 13 Ecoregion IV- 13 (c) sagebrush	
LSZ-7	Lincoln Point-Goshen Bay	Beach, wetland preserve, barren lands, boat ramp, near mountains		
LSZ-8	Mosida/ Knolls	Barren lands; shrub/scrub sagebrush; near mountains,		
LSZ-9	Saratoga Springs	Golf course; near mountains	Ecoregion III- 13 Ecoregion IV- 13 (f) moist Wasatch	
LSZ-10	Water	Aquatic environment	Ecoregion III- 13 Ecoregion III- Split (13-c, 13-f)	

3.3.5 LSZ Visual Quality MCS Ratings

Following the VRAP MCS process, professional aesthetic judgments were used to assess the visual quality of the LSZs and to categorize those assessments in an overall Assessment Framework for the Regional Landscape. Sensitivity is measured by the level of concern expected for an area's scenic quality. Visual quality MCS ratings were determined for each of the identified

LSZs by completing a visual resource inventory process based on seven key factors: water resources, landform, vegetation, diversity, seasonal change, land water use, intensity, access, user type, and degree of use. Visual quality levels were defined as Distinct, Average, or Minimal as follows:

- Distinct: unique or an asset to the area, a visual asset with many positive attributes. Diversity and variety are characteristics.
- Average: something that is common in the area and not considered unique and is representative of the typical landscape of the area.
- Minimal: a potential liability in the area, lacking positive attributes and diminishes the visual quality of the surrounding area.

For each LSZ location, the water resources, landform, vegetation, land use, user activities and special conditions were rated, where Distinct = 3, Average = 2, and Minimal = 1. A summary of the MCS rating for each LSZ is presented in Table 10.

MCS classes (Preservation, Retention, Partial Retention, Modification, or Rehabilitation) are assigned to each LSZ based on the zone's total assessment value, or MCS Rating.

The rating scale for each class is as follows:

- Preservation class: Similarity Zones having a total assessment value of 17 or more. Projects in this zone have a VIA value of 0.
- Retention class: Similarity Zones having a total assessment value of 14–16. Projects VIA values no lower than -2.
- Partial retention class: Similarity Zone having a total assessed value of 11–13. Projects should have a VIA value no lower than -5.
- Modification class: Similarity Zones having a total assessed value of 9–10; Projects should have VIA values no lower than -6.
- Rehabilitation class: Similarity Zones having a total assessed value of less than 8. Projects in these zones should have VIA values above 0 or visual impact value of less than or equal to -8 should be reformulated and reassessed, prior to implementation.

Table 10. MCS Rating & Class

Landscape Similarity Zones	Location Name	MCS Rating	MCS Class
LSZ-1	American Fork	10	Modification
LSZ-2	Vineyard	10	Modification
LSZ-3	Utah Lake State Park	13	Partial Retention
LSZ-4	Provo Airport	7	Rehabilitation
LSZ-5	Provo Bay	7	Rehabilitation
LSZ-6	Rock Island Waterfowl Management Area	11	Partial Retention
LSZ-7	Lincoln Point- Goshen Bay	13	Partial Retention
LSZ-8	Mosida/Knolls	8	Rehabilitation
LSZ-9	Saratoga Springs	10	Modification
LSZ-10	Water	9	Modification

3.3.6 Sensitive Viewers

Sensitive viewers can be categorized into three core groups: Recreation, Residential, and Transportation. While there are no designated scenic highways or designated areas with specific visual management objectives or protections within the Project boundary and immediately around the lake, the Project area can be seen from various roadways and recreational areas, including beaches, parks, wildlife management areas, marina/fishing areas, and mountain trails. There are also several residential communities surrounding the Project area from which the proposed Project could be seen.

3.3.6.1 Recreation

Recreation includes activities that take place in the water and at beaches, marinas, water access points, parks, and trails.

Utah Lake currently has 6 beaches located in 4 of the LSZs. Beach viewers typically have a moderate to high degree of exposure frequency and a long viewing duration.

There are 6 marinas on the lake. Additionally, there are 18 water access points located in 8 of the LSZs. Viewer exposure frequency to the Project area from these locations is typically moderate with a long viewing duration.

There are 11 parks and recreation management areas in 5 of the LSZs. The focused viewers within the parks and recreation management areas have low to high exposure frequency with short to moderate viewing durations.

The Utah Lake Commission is working to complete a “round the Lake” multiuse path called the Utah Lake Trail. Sections of the Utah Lake Trail are existing, while others are planned or only conceptualized. Additionally, there are 7 trailheads that are directly connected to the Utah Lake Trail and over 50 separate trail heads and connected trails within the area of analysis. The exposure frequency for these viewers is typically low to moderate with brief viewing durations of the Project area.

Several wildlife management areas are adjacent to Utah Lake. With views that are partially screened and panoramic, view exposure frequency is typically high with short viewing durations.

3.3.6.2 Residential

Residences exist alone and in residential communities around the lake. Views from these locations are typically panoramic or partially screened from backyards and community parks and trails that are open to the lake.

3.3.6.3 Transportation

Primary transportation routes running north, and south are located on both sides of the lake. These include trails, rails, and roadways. Due to the normal viewing position, views of the lake from most roadways and rails in the project area are screened by vegetation, landforms, and structures. Opportunities for viewing the Project area from these routes are frequent with short to moderate viewing durations.

3.3.7 KOP Summary Rating

Fifteen KOPs were selected to represent each type of sensitive viewer and landscapes critical to existing, current, and planned land uses. The KOPs were also selected to represent and consider views from the Utah Lake Trail that exists in part and is being developed to encircle the lake as shown in the Utah Lake Trail Plan (Utah Lake Commission 2021a). The Utah Lake Trail is a key feature of the lake from which the Project area can be seen. A summary of KOP viewer use, duration of views, concerns for aesthetic changes, angle of observation, and visual quality rating sensitivity level are presented in Table 11.

Table 11. KOP Locations and Viewpoint Criteria

KOP #	Description	GIS Location	Amount of Use	Duration of View	Aesthetic Concern (changes)	Angle of Observation	Sensitivity Level
1	Utah Lake Trail (north side of Lake)	40°21'40.74"N 111°52'16.52"W	Moderate	Long	High	Normal	High
2	Vineyard Beach	40°18'58.02"N 111°45'54.04"W	High	Long	Moderate	Normal	Moderate
3	Utah Lake State Park	40°14'29.52"N 111°44'5.00"W	Moderate	Moderate	Moderate	Normal	High
4	Utah Lake Trail (airport)	40°13'5.17"N 111°43'41.97"W	Moderate	Moderate	Moderate	Normal	High
5	Lakeview Parkway	40°12'23.63"N 111°40'7.08"W	High	Short	Moderate	Normal	Moderate
6	Lincoln Beach / Lincoln Park	40° 8'25.07"N 111°48'10.32"W	Moderate	Moderate	Moderate	Normal	Moderate
7	Mulberry Beach	40° 7'11.47"N 111°50'45.17"W	Low	Long	High	Normal	High
8	Mosida Handcart Trail Site	40° 4'34.49"N 111°55'14.72"W	Moderate	Moderate	Moderate	Normal	Moderate
9	Knolls	40°11'54.87"N 111°53'11.67"W	Moderate	Moderate	Moderate	Normal	Moderate
10	Redwood Road (Route 68)	40°16'21.91"N 111°52'1.19"W	High	Short	Moderate	Superior	Moderate

KOP #	Description	GIS Location	Amount of Use	Duration of View	Aesthetic Concern (changes)	Angle of Observation	Sensitivity Level
11	Eagle Park	40°20'6.46"N 111°54'25.60"W	High	Long	Moderate	Normal	Moderate
12	Utah Lake (Water Location)	40°19'2.60"N 111°49'56.77"W	Low	Moderate	Moderate	Normal	Moderate
13	Eagle Crest Trailhead	40°28'19.30"N 111°50'9.45"W	High	Moderate	Moderate	Superior	Moderate
14	Mt. Timpanogos Peak	40°23'26.88"N 111°38'45.75"W	Low	Moderate	High	Superior	High
15	Squaw Peak Mountain Trail	40°16'19.63"N 111°36'59.91"W	Moderate	Short	Moderate	Superior	Moderate

3.3.8 Regulatory Framework

3.3.8.1 Federal Regulations

- Federal Land Policy and Management Act of 1976 (FLPMA)
- NEPA
- Rivers and Harbors Act of 1894, as Amended
- USACE VRAP

Agency Management: Federal and state regulating agencies are stakeholders that have vested interest in the management of visual resources. Permitting will require communication and coordination of project details which may also result in development of focused memorandums.

3.3.8.2 State Regulations

There are no specific Utah State regulations regarding visual impacts.

3.4 Land Use

A large variety of land uses occur on and around Utah Lake. On Utah Lake, the land uses include recreation, such as fishing, hunting, boating, paddle boarding, and other activities. Recreational activities also occur along the lake's shoreline, including camping, bird watching, bicycling, picnicking, hiking, and other activities. Other land uses that occur along the shorelines and adjacent lands include residential, agricultural, mining, industrial, and commercial, as well as others. Land ownership on and around Utah Lake is also varied, including land owned or administered by the state of Utah, the BLM, the United States Bureau of Reclamation (BOR), and privately owned lands.

3.4.1 Resource Indicators and Measures

Resource indicators used in the analysis of land use include different land ownership types, land uses, and different zoning classifications within the area of analysis. Measures used to analyze potential impacts to land use include acres of disturbance in different land ownership types and acres of disturbance in different zoning classifications.

3.4.2 Area of Analysis

The area of analysis for land use is the Utah Lake settlement boundary with a 1-mile buffer. This area of analysis was chosen because it encompasses the land uses on and around Utah Lake that are most likely to be directly affected by the Project.

3.4.3 Method

The method for analyzing potential impacts to land use on and around Utah Lake will focus on how the Project will affect land ownership patterns in the area of analysis, the consistency of the Project with applicable zoning classifications in the area of analysis, the consistency of the Project with applicable general plans and resource management plans in the area of analysis, and a qualitative analysis of how the Project would affect existing land uses in the area of analysis.

3.4.4 Public Land Use

The state of Utah owns the bed of Utah Lake (approximately 95,500 acres), which is sovereign lands administered by the FFSL. Public land in the area of analysis includes the following:

- 2,992.0 acres of state land administered by the state of Utah School and Institutional Trust Lands Administration
- 9,747.0 acres of federal land administered by the BLM
- 647.6 acres of federal land administered by the BOR
- 34.3 acres of state land administered by the UDWR
- 0.6 acres of state land administered by the Utah Department of Transportation (UDOT) on the west side of the lake that is used for an administrative office for the Drivers License Division.

The remaining 44,067.1 acres of land in the area of analysis is privately owned land. Figure 6 depicts land ownership boundaries in the area of analysis.

3.4.5 Access Points

According to the Utah Lake Commission and the UDWR, there are approximately 27 main access points around the lake (Utah Lake Commission 2021b, UDWR 2021o).

3.4.6 Recreational Use

Recreational activities on and around Utah Lake include activities such as boating, fishing, hunting, camping, bird watching, bicycling, photography, picnicking, jet skiing, paddle boarding, hiking, jogging, water skiing, swimming, ice skating, kite boarding, and paragliding. Recreation is identified as an important land use in the Utah County General Plan, as well as in all of the general plans of the cities overlapping the area of analysis.

3.4.7 Private Use

Private lands are regulated by land use ordinances and zoning districts, as approved by local and county governments. Zoning districts and the regulations established within the zoning districts are authorized by Utah Code § 17-27a-505 and 10-9a-505. Land use ordinance and zoning maps are legislative decisions and are established through planning processes open to public discussion and adopted by county and city councils. There are also water rights associated with Utah Lake, which are under the jurisdiction of the Utah Division of Water Rights (Utah Code 73-2-1).

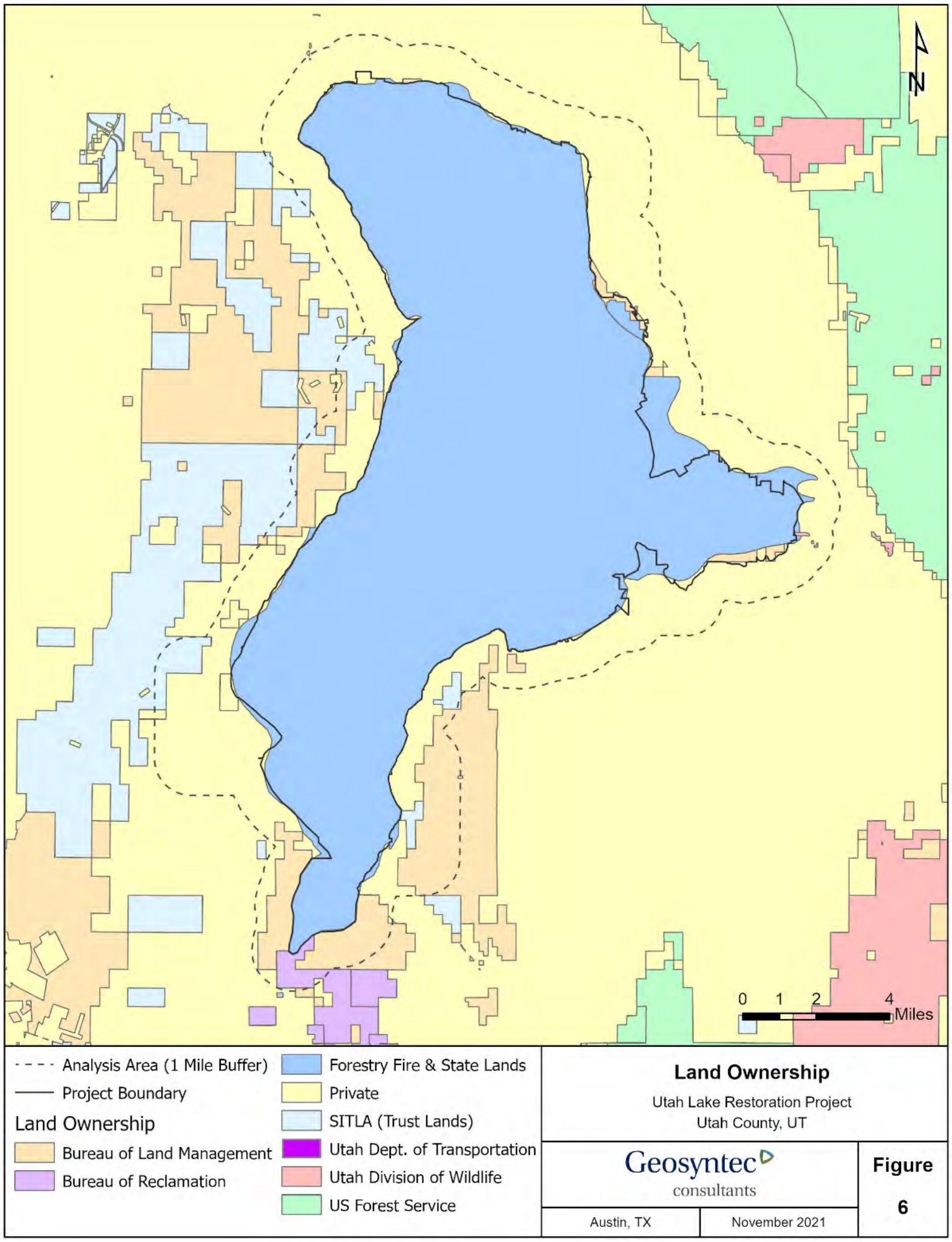

Figure 6. Land Ownership

3.4.7.1 Residential

There are approximately 6,495.6 acres in the area of analysis that are zoned for various types of residential uses. Planned community zoning classifications comprise 4,731.5 acres in the area of analysis. The most prevalent residential developments along the shoreline of the lake generally occur in Saratoga Springs, Lehi, and Vineyard. The potential for residential development in much of the area of analysis along the western side of the lake is limited by the Lake Mountains.

3.4.7.2 Agriculture

There are approximately 31,012.8 acres in the area of analysis that are zoned for various types of agricultural uses.

3.4.7.3 Water Rights

Utah Lake and the area of analysis are overlapped by four different water rights areas:

- Area 51 – Utah and Indianola Valleys
- Area 53 – Goshen and Northern Juab Valleys
- Area 54 – Cedar Valley
- Area 55 – Northern Utah Valley and Provo River

The water rights for water in Utah Lake include water rights held by irrigation companies, the BOR, local municipalities, the State of Utah Board of Water Resources, private individuals, local water districts, private companies, and religious organizations (Utah Division of Water Rights 2019).

3.4.8 Commercial and Industrial

There are approximately 2,013.0 acres in the area of analysis that are zoned for various types of commercial and industrial uses.

3.4.8.1 Facilities

Public facilities within the area of analysis are primarily recreation related, such as the parks and marinas. There are also three wastewater treatment plants (WWTPs) within the area of analysis. The Timpanogos Special Service District WWTP is located on the northern shoreline of the lake between Vineyard and Lehi and provides wastewater collection and treatment service to northern Utah County. The Orem WWTP is located east of the Powell Slough Waterfowl Management Area, and the Provo City WWTP is located east of Provo Bay.

3.4.8.2 Airports

There are two airports in the vicinity of Utah Lake. The Provo Airport is located on the eastern shoreline of Utah Lake, north of Provo Bay. The Provo Airport has two runways and provides commercial service as well as being a general aviation airfield. The Spanish Fork Airport is approximately 2 miles southeast of Provo Bay. The Spanish Fork Airport is a municipal airport with one runway.

3.4.9 Zoning Classifications

The zoning classifications of Utah County and all of the cities that are overlapped by the area of analysis have been grouped into general zoning types and summarized below. The locations of the zoning classifications in the area of analysis are shown in Figure 7.

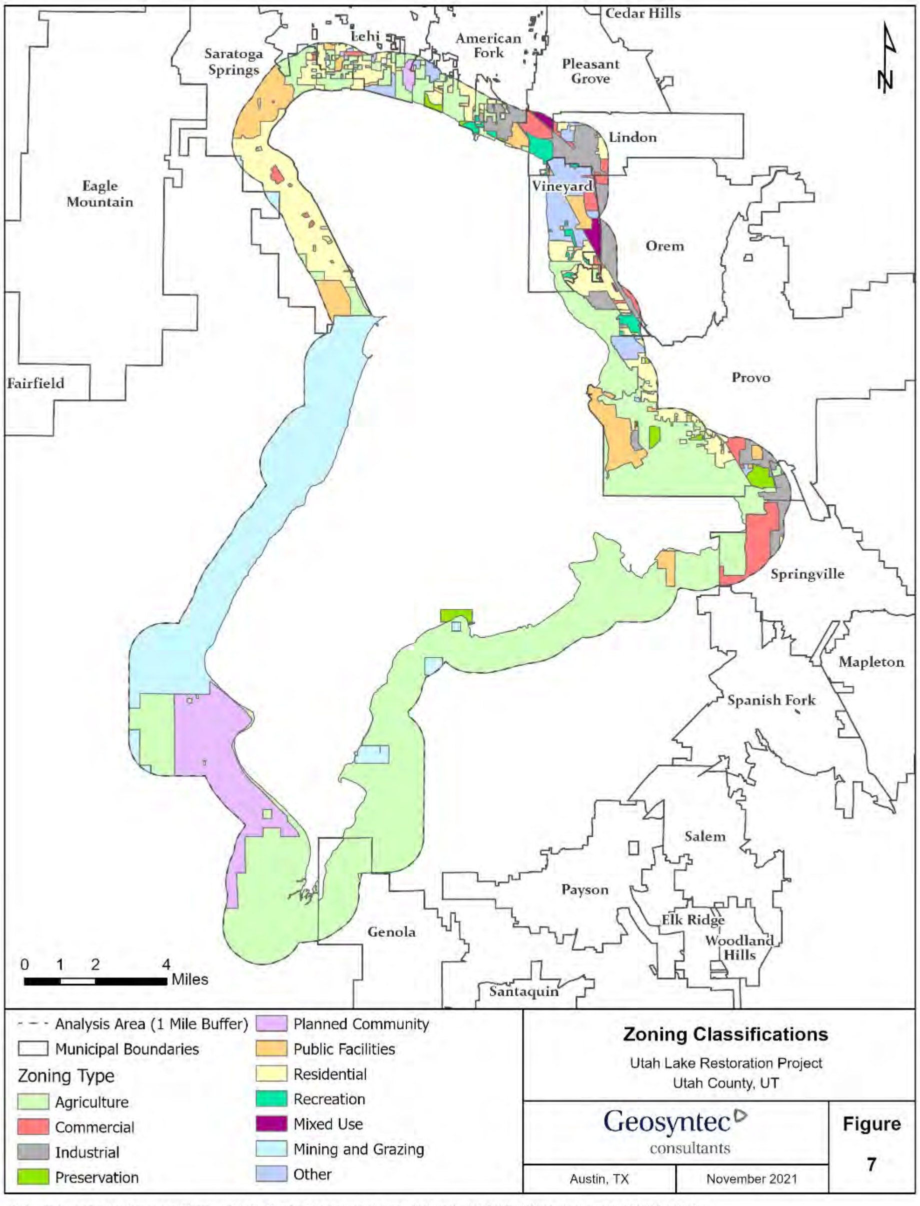

Figure 7. Zoning Classifications

3.4.10 Regulatory Framework

3.4.10.1 Federal Regulations

- NEPA (43 USC 4321 et seq.), 40 Code of Federal Regulations (CFR) 1500-1508
- FLPMA (43 USC 1701 et seq.) 43 USC Chapter 22 – Rights-of-Way and other Easements in Public Lands
- 43 CFR Part 2200 (Exchanges: general Procedures)
- 43 CFR 2800 (Rights-of-Way Under the FLPMA)

3.4.10.2 State Regulations

3.4.10.2.1 Utah Code

- Utah Code Title 63L Lands
  - Chapter 6 Transfer of Public Lands Act
  - Chapter 8 Utah Public Land Management Act
- Utah Code Title 65A FFSL
  - Chapter 2 Administration and Management of State Lands, Section 1 Administration of state lands – Multiple-use sustained yield management
  - Chapter 7 Sale, Exchange, and Lease of State Lands
  - Chapter 10 Management of Sovereign Lands
  - Chapter 15 Utah Lake Restoration Act (same as House Bill 272 Utah Lake Amendments 2018 General Session)
- House Bill 272 Utah Lake Amendments 2018 General Session

3.4.10.2.2 Utah Lake Master Plan

While it does not have the force of law, the Utah Lake Master Plan is used by the FFSL to guide its management of Utah Lake. The Utah Lake Master Plan includes land use vision statements, goals, objectives, and policies that focus on protection of the shoreline, protection of natural and cultural features, and enhancement and protection of public ownership and access (Utah Lake Commission 2009). The Utah Lake Master Plan also supports mixed uses around the lake, including agriculture, residential, commercial, industrial, and recreational uses.

3.4.10.3 County Code and Plans

3.4.10.3.1 Utah County Code

- Utah County Code Chapter 15. Planning
  - Article 155-1. In General, 15-1-1. Zoning Ordinance

3.4.10.3.2 County Land Use Plans

While they do not have the force of law, Utah County also has a general plan and resource management plan that includes goals, objectives, and policies that apply to lands within the area of analysis.

3.4.10.4 City Code and Plans

Land use in the four cities within the area of analysis is guided by the various cities' land development codes, zoning codes, and general plans. The applicable land development codes and zoning codes are listed below. The applicable general plans are discussed in the following section.

- Provo City Code Title 14 Zoning
- Provo City Code Title 15 Land Use and Development
- Lehi City Municipal Code Title 11 Land Use, Development Code
- Lehi City Development Code Chapter 5 Zoning Districts
- Saratoga Springs Code Title 19 Land Development Code
- Vineyard Municipal Code Title 15 Land Use and Development
- Zoning Ordinance of Genola, Utah

3.4.10.4.1 City General Plans

While they do not have the force of law, several cities within the area of analysis have enacted general plans that help guide land use, transportation, and recreation decisions in these cities. The Provo City General Plan, Lehi City General Plan, Saratoga Springs General Plan, Vineyard General Plan, Genola General Plan, American Fork General Plan, Lindon General Plan, and Springville General Plan all include applicable goals, objectives, and policies that apply to lands within the area of analysis.

3.5 Special Management Areas

A special management area is defined as land set aside for specific management purposes, often for resource protection and preservation or for wildlife habitat where special management attention is needed to protect important historical, cultural, and scenic values, or fish and wildlife or other natural resources. There are several types of special management areas in the area of analysis, including a wetland preserve, wetland mitigation sites and banks, conservation easements, a wildlife management area, and a cooperative wildlife management unit (CWMU).

3.5.1 Resource Indicators and Measures

Resource indicators used in the analysis of special management areas include descriptions of the different types of special management areas, including the size, location, and purpose of each. Potential impacts to special management areas are measured quantitatively by acres of surface disturbance that would result from the proposed Project in each special management area. In addition, the impacts of the proposed Project are analyzed qualitatively by examining whether the proposed surface disturbance is consistent with the special management area's management direction. Indirect impacts to special management areas may also be evaluated such as impacts from changes in water flow, aesthetics, adjacent land use, or important resource values.

3.5.2 Area of Analysis

The proposed Project's area of analysis for special management areas is defined as the Project boundary plus a 1-mile buffer, with several adjustments to accommodate federal and state ownership of adjacent parcels. Any special management area partly within the 1-mile buffer was included in its entirety in the analysis. The area of analysis was chosen because it encompasses the special management areas adjacent to Utah Lake that may be directly or indirectly affected by the proposed Project. Special management areas within the area of analysis are shown in Figure 8.

3.5.3 Method

Potential impacts to special management areas at Utah Lake are analyzed quantitatively as discussed in Section 3.5.4. If no surface disturbance is proposed in a special management area, a qualitative analysis examines whether adjacent or nearby indirect impacts from the proposed Project would affect the special management area's resource protection and preservation values, wildlife and wildlife habitat values, or other important values.

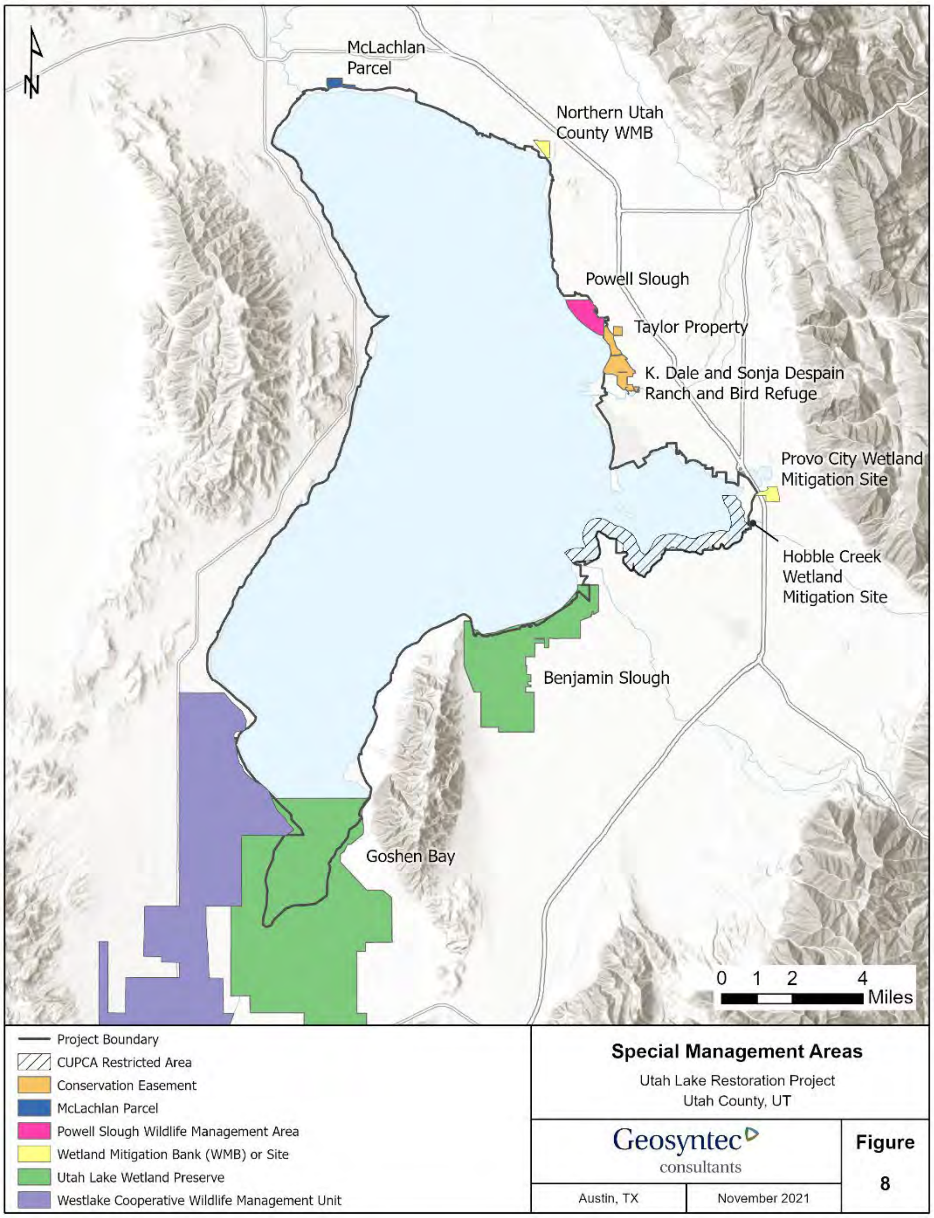

Figure 8. Special Management Areas

3.5.4 Affected Resources

3.5.4.1 Utah Lake Wetland Preserve

The Utah Lake Wetland Preserve (ULWP) is a network of wetland and interspersed upland habitats on the southern portion of Utah Lake. ULWP encompasses approximately 21,750 acres and consists of two units: Goshen Bay and Benjamin Slough (Utah Reclamation Mitigation and Conservation Commission [URMCC] 2021). Section 306(c) of the Central Utah Project Completion Act (CUPCA) of 1992 (Public Law 102-575. 1992) authorized the acquisition of private land, water rights, and conservation easements to establish the ULWP adjacent to or near the Goshen Bay and Benjamin Slough areas of Utah Lake.

3.5.4.2 Wetland Mitigation Sites and Banks

USACE requires compensatory mitigation for activities where impacts to aquatic resources have been avoided and minimized to the maximum extent practicable but still result in unavoidable adverse effects. A mitigation bank is a site or suite of sites where wetlands, streams, and riparian areas are restored, established, enhanced, and/or preserved for the purpose of providing compensatory mitigation.

3.5.4.2.1 Hobble Creek Wetland Mitigation Site

The JSRIP is a multiagency cooperative effort to coordinate and implement recovery actions for the endangered June sucker. In 2008, the JSRIP completed habitat restoration work along Hobble Creek on the east edge of Utah Lake's Provo Bay. The 21-acre parcel has been designated as a wetland mitigation site and is managed by the UDWR as a wildlife management area.

3.5.4.2.2 Provo City Wetland Mitigation Site

A runway expansion at the Provo Municipal Airport in the late 1990s caused the loss of approximately 30 acres of wetlands associated with Utah Lake. Compensatory mitigation was required as part of the project approval. The Provo Municipal Airport agreed to create a wetland area a minimum of 100 acres in size on the east side of Utah Lake, south of the now-Timpanogos Golf Club and east of Interstate 15 (Romboy 1993). The wetland area, at a final size of 146 acres, officially opened on May 1, 1996 (Romboy 1996).

A conservation easement was signed in 2000 by Provo City (the site owner) and the Provo City Redevelopment Agency for 86 acres of the wetland mitigation site to preserve and conserve the natural and scenic beauty of the property and its resources (City of Provo and the Provo City Redevelopment Agency 2000).

3.5.4.2.3 Northern Utah County Wetland Mitigation Bank

The Northern Utah County Wetland Mitigation Bank was established in 2009 and consists of 112 acres of land adjacent to Utah Lake wetlands in Lindon, Utah, on the northeast lakeshore. Through planning, design, and construction, 2.8 acres of open water, 1.2 acres of palustrine forested wetland, 85.1 acres of emergent marsh wetland, and 23.1 acres of upland habitat will eventually be established (UDOT 2018).

3.5.4.3 Conservation Easements

A conservation easement is a voluntary, legally binding agreement for a parcel of land that permanently protects its ecological or open-space values. Conservation easements are usually implemented between a landowner and a land trust or government agency; many of the private property rights are retained by the landowner. Most conservation easements remain with the property, even if the property is sold.

3.5.4.3.1 Utah Lake Easements (Taylor Property)

The Utah Lake Easements consist of two conservation easements for the Taylor Property located on the east side of Utah Lake just south of Powell Slough, both of which were established in 2000. The first easement covers 113 acres; the second easement covers 39 acres. The easement holder in each case is The Nature Conservancy (National Conservation Easement Database 2021).

3.5.4.3.2 K. Dale and Sonja Despain Ranch and Bird Refuge

The K. Dale and Sonja Despain Ranch and Bird Refuge conservation easement was established in 2000 and consists of 332 acres located on the east side of Utah Lake just south of Powell Slough. The easement holder is the City of Provo. The purpose of the easement is to protect the Despain Ranch and its associated open space (National Conservation Easement Database 2021).

3.5.4.4 Wildlife Management Areas

3.5.4.4.1 Powell Slough Wildlife Management Area

Powell Slough is a small, slow-moving stream that enters the east side of Utah Lake just south of the former Geneva Steel location. The slough flows through the Powell Slough Waterfowl Management Area, a large wetland system on approximately 373 acres that provides habitat for shorebirds and other waterfowl (PSOMAS and SWCA Environmental Consultants [SWCA] 2007).

3.5.4.4.2 Westlake Cooperative Wildlife Management Unit

The Westlake CWMU consists of approximately 23,637 acres of private land west and south of Utah Lake in Goshen Valley. Part of the northeast border of the Westlake CWMU is along the southwest shoreline of Utah Lake (UDWR 2021). Approximately 60% of the Westlake CWMU is agricultural land.

3.5.4.5 Scott McLachlan Parcel

This property was obtained by the Utah Division of FFSL as part of boundary settlement proceedings to create a wildlife preserve. It is located on the north shore of the lake and is approximately 80 acres in size (Utah Lake Commission 2009).

3.5.4.6 Provo Bay Central Utah Project Completion Act Restricted Area

To protect wetland habitat, Section 306(d) of the CUPCA prohibits any federal permits allowing commercial, industrial, or residential development on the southern portion of Provo Bay in Utah Lake. Recreational development consistent with wildlife habitat values is permitted. The southern portion of Provo Bay is defined as the "*area extending two thousand feet out into the Bay from the ordinary high water line on the south shore of Provo Bay, beginning at a point at the mouth of the Spanish Fork River and extending generally eastward along the ordinary high water line to the intersection of such line with the Provo City limit, as it existed as of October 10, 1990, on the east shore of the Bay*" (Public Law 102-575. 1992).

3.5.4.7 Other Special Management Areas

The following special management areas are discussed in other sections, as indicated:

- Important Bird Areas (e.g., Goshen Bay, Provo Bay): Biology
- June sucker habitats (e.g., lower Provo River critical habitat): Biology

3.5.5 Regulatory Framework

3.5.5.1 Federal Regulations

- CUPCA of 1992 (Public Law 102-575. 1992): ULWP
- CUPCA of 1992 (Public Law 102-575. 1992): Provo Bay Central Utah Completion Act Restricted Area
- National Wildlife Refuge System Administration Act of 1966 (Public Law 89-669) (16 United States Code [U.S.C] 668dd et seq.): ULWP
- Compensatory Mitigation for Losses of Aquatic Resources Final Rule (33 CFR Part 332): Hobble Creek Wetland Mitigation Site, Provo City Wetland Mitigation Site, and Northern Utah County Wetland Mitigation Bank

3.5.5.2 State Regulations

- Land Conservation Easement Act (Utah Code Title 57, Chapter 18): Utah Lake Easements (Taylor Property) and K. Dale and Sonja Despain Ranch and Bird Refuge
- Powell Slough Wildlife Management Area: No state rules were identified specifically for wildlife management areas, which are often owned by UDWR and managed to protect wildlife habitat and public access.
- Cooperative Wildlife Management Units for Big Game or Turkey (Utah Administrative Code R657-37): Westlake CWMU
- Acquisition and Disposition of Land by State Agencies (Utah Code 65A-4-1), Land Exchanges (Utah Administrative Code R652-80), and Adjudicative Proceedings (Utah Administrative Code R652-8-100): Scott McLachlan Parcel

3.6 Social and Economic

Social and economic considerations are described in this section with information provided within the area of analysis regarding demographics and population and transportation.

3.6.1 Resource Indicators and Measures

Resource indicators used in the analysis of socioeconomics include an evaluation of the current population, economy, community services, and the transportation networks in Utah County. Measures used to analyze socioeconomic impacts include the temporary impacts, which include cumulative impacts to the communities (e.g., housing availability, housing costs, food sources, and traffic) from the construction workforce's presence and more long term, and permanent economic and demographic changes resulting from the creation of the developed islands.

3.6.2 Area of Analysis

For the purposes of this socioeconomic analysis, the Project's area of analysis is Utah County and Census designated places within 1 mile of the project boundary. The Census designated places are shown on Figure 9.

3.6.3 Method

The method for analyzing potential impacts to socioeconomics in the area of analysis is a qualitative assessment of the Project impacts on population, employment, housing, public services, and transportation. Existing socioeconomic data will be compared to estimates and projections in future years.

3.6.4 Demographics and Population

The Project is located in Utah County which has an estimated population of 636,235 according to the 2019 U.S. Census Bureau Quick Facts (U.S. Census Bureau V2019) and 2015–2019 American Community Survey Estimates (Gardner Policy Institute [GPI] 2021). The areas surrounding Utah Lake consist of population centers dispersed throughout smaller communities and rural areas, rather than a concentration of residents in a single urban area. The US Census defines an urbanized area as an area with a population of 50,000 or more (U.S. Census 2010). Based on 2019 estimates, there are three urbanized areas around Utah Lake; the cities of Provo, Orem, and Lehi. Table 12 is a summary of the population characteristics of cities near Utah Lake up through 2019.

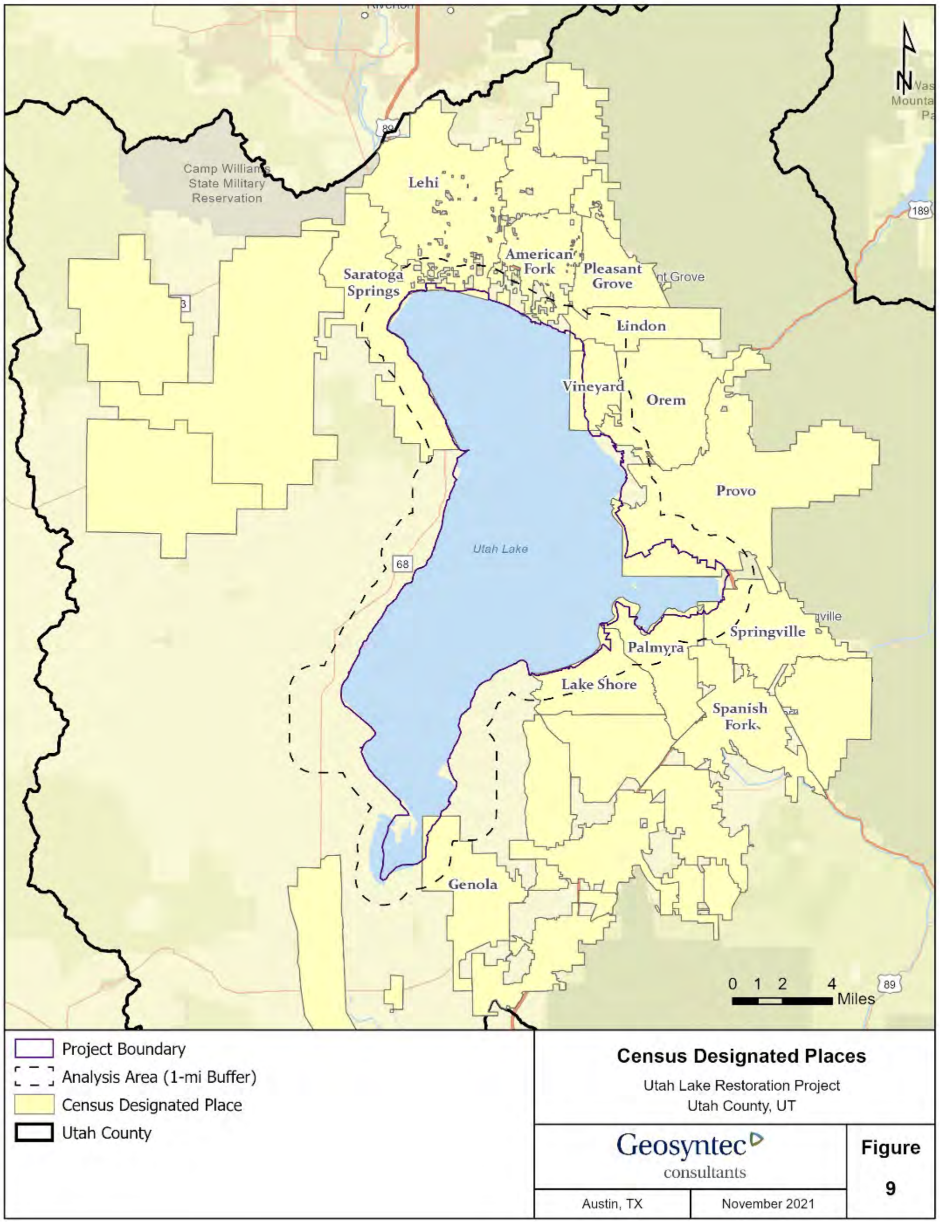

Figure 9. Census Designated Places

Table 12. Summary of Utah County and Selected City Population Characteristics

Population Characteristics	Utah County	Cities						
		Saratoga Springs	Lehi	American Fork	Pleasant Grove	Provo	Vineyard (town)	Orem
Estimates, July 1 2019	636,235	33,282	69,724	33,161	38,258	116,618	11,866	97,828
Estimates base, April 1, 2010	516,639	17,842	47,769	26,547	33,550	112,487	110	88,328
Percent change – April 1, 2010 (estimates base) to July 1, 2019	23.1%	86.5%	46.0%	24.0%	14.0%	3.7%	10,687.3%	10.8%
Census, April 1, 2010*	516,564	17,842	47,407	26,263	33,509	112,488	139	88,328

Source: U.S. Census Bureau. V2019. Quick Facts (https://www.census.gov/quickfacts/fact/table/utahcountyutah/PST045219)
* 2020 Population Census totals are not yet available.

Population projections for the state of Utah, Utah County, and the two other key counties that form the populated Wasatch Front are presented in Table 13.

Table 13. Wasatch Front Population Projections by County

Year	State of Utah	Utah County	Salt Lake County	Davis County	Weber County
2010 Census	2,772,373	518,872	1,031,697	307,625	231,833
2020	3,325,425	679,188	1,181,471	364,813	266,440
2030	3,889,310	861,852	1,306,414	406,046	302,764
2040	4,463,950	1,080,082	1,414,842	451,924	330,732
2050	5,017,232	1,297,515	1,531,282	493,263	356,812
2060	5,555,423	1,504,433	1,648,280	527,545	379,350
2065	5,827,810	1,620,246	1,693,513	544,958	389,334
2010-2065 Change	3,055,437	1,101,374	661,816	237,333	157,501
2010-2065 % Change	110.2%	212.3%	64.1%	77.1%	67.9%
Annual % Change	1.4%	2.1%	0.9%	1.0%	0.9%

Source: GPI (2017).

3.6.5 Economy and Employment

Key employment indicators for Utah County are presented in Table 14. Retail trade, health services, and education services are the dominant industries in Utah County, accounting for close to one-third of the workforce.

Table 14. Employment Statistics for Utah County in 2019

Employment Status	Estimate	Percent (%)	Percent Margin of Error
Population 16 years and over	422,172	--	--
In labor force	292,024	69.2	±0.4
Civilian labor force	291,506	69.0	±0.4
Employed	280,920	66.5	±0.4
Unemployed	10,586	2.5	±0.1
Armed Forces	518	0.1	±0.1
Not in labor force	130,148	30.8	±0.4
Median Household Income	$74,562	--	±0.01($868)
Income and Benefits (in 2019 inflation adjusted)			
Median household income (dollars)	$74,665	--	--
Mean household income (dollars)	$93,627	--	--
Occupation			
Management, business, scient, and arts	118,890	42.3	±0.5
Service occupation	41,979	14.9	±0.5
Sales and office	69,752	24.8	±0.6
Natural resources, construction, and maintenance	21,239	7.6	±0.3
Production, transportation, and material moving	29,060	10.3	±0.3
Industry			
Agriculture, forestry, fishing and hunting, and mining	2,378	0.8	±0.1
Construction	20,066	7.1	±0.3
Manufacturing	24,826	8.8	±0.4
Wholesale trade	7,301	2.6	±0.2
Retail trade	35,158	12.5	±0.4
Transportation, warehousing, and utilities	8,109	2.9	±0.2
Information	8,694	3.1	±0.2
Finance, insurance, real estate, and rental and leasing	16,315	5.8	+0.3
Professional, scientific & management, and administrative & waste management services	44,013	15.7	±0.5
Educational services, health care, and social assistance	70,437	25.1	±0.5
Arts, entertainment & recreation, and accommodation & food service	22,774	8.1	±0.3
Other services, except public administration	12,787	4.6	±0.3
Public administration	8,002	2.9	±0.2

Sources: U.S. Census Bureau 2019a and 2019b

3.6.6 Transportation

The transportation system around Utah Lake includes a major interstate (Interstate 15 or I-15), several highways, and other state and local roadways that are used to access employment, education, recreation/tourist activities, and other services in the vicinity of the lake. The Utah Lake Master Plan encourages efforts to improve access to existing and future destination points around Utah Lake and includes an objective to consider studies to determine the need for and feasibility of cross-lake transportation corridors (Utah Lake Commission 2009). Roads around Utah Lake have generally experienced increased traffic volume as the population in the region has increased. UDOT has estimated annual average daily traffic (AADT) for roadways in the vicinity of Utah Lake (Table 15).

Table 15. Annual Average Daily Traffic (AADT) for Selected Roads in the Vicinity of Utah Lake (2010–2019)

Road Location	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
I-15 2 miles north of Center Street, Provo	111,900	107,300	99,200	113,200	118,200	127,300	145,400	148,500	151,500	159,500
Pioneer Crossing near 7350 W, American Fork	10,000	24,000	24,000	23,000	24,000	37,000	40,000	42,000	45,000	48,000
Pioneer Crossing east of Redwood Road, Lehi	10,000	10,000	9,800	21,000	22,000	23,000	24,000	24,000	25,000	25,000
Redwood Road south of Pioneer Crossing, Lehi	9,600	9,500	9,300	9,100	20,000	21,000	22,000	23,000	23,000	23,000
Redwood Road south of 400 S, Saratoga Springs	9,600	9,500	9,300	9,100	10,000	10,000	11,000	11,000	11,000	12,000
Vineyard Connector Road west of I-15, Vineyard	5,100	5,100	5,000	6,200	6,300	6,600	6,900	7,100	7,200	7,300
4000 South south of Provo Bay, Palmyra	1,800	2,600	2,600	2,500	2,600	2,700	2,800	2,900	2,900	3,000
Center Street east of Utah Lake State Park, Provo	860	850	1,400	1,300	1,300	1,400	1,400	1,500	1,500	1,600
Lakeview Parkway north of Provo Bay, Provo	NA	NA	NA	NA	NA	NA	NA	1,000	1,000	1,000
Redwood Road west of Goshen Bay	1,100	1,100	1,100	1,200	1,200	1,200	1,300	1,300	1,400	1,400
State Route 6 south of Utah Lake	1,900	2,000	2,400	2,300	2,300	2,500	2,600	2,600	2,300	2,400

Source: UDOT (2021)
NA: data not available

3.6.7 Environmental Justice

An environmental justice analysis was conducted in accordance with Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (February 11, 1994), to consider disproportionately high and adverse impacts on minority and low-income populations in the surrounding community resulting from the Project.

Table 16 provides a summary of the census data about minorities living in Utah County based on 2019 Census data.

Table 16. Minority Data for Utah County

Race	Estimate	Percent (%)
White	572,381	94.5
Black or African American	6,957	1.1
American Indian and Alaska Native	6,738	1.1
Asian	17,460	2.9
Native Hawaiian and Other Pacific Islander	10,296	1.7
Hispanic or Latina	13,108	2.2

Note: The total of Census data percentages exceeds 100% due to overlap in race category responses
Source: U.S. Census Bureau (2019c)

3.6.8 Regulatory Framework

3.6.8.1 Federal Regulations

- NEPA (43 USC 4321 et seq.)
- 40 CFR 1500-1508
- EO12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 11, 1994)

3.6.8.2 State Regulations

While it does not have the force of law, the Utah Lake Master Plan is used by the Utah Division of FFSL to guide its management of Utah Lake.

3.7 Geology

Geology in and around the project is described in this section, including the area of analysis, the geologic setting, topography and bathymetry, current islands, geological hazards, paleontology and the regulatory framework. The section focuses on both soils and subsurface geology.

3.7.1 Resource Indicators and Measures

Resource indicators used in the analysis of topography and geology include a description and evaluation of the current topographic and geologic setting of the Project. Measures used to analyze potential impacts to topographic and geologic resources include a qualitative assessment of the Project in relation to the topographic and geologic setting and the potential hazards that are posed by the existing topographic and geologic conditions of the area. The Geologic Resources Indicators include the following:

- Soil Hazards (e.g., expansive soils, erodible soils, and corrosive soils)
- Geologic Hazards
  - Seismic Hazards (e.g., fault zone)
  - Secondary Seismic Hazards (e.g., liquefaction, seismically induced settlements, lateral spreads or slumps, and flooding)

3.7.2 Area of Analysis

The area of analysis is defined as the Project boundary plus a 500-foot buffer and select areas that extend beyond the 500-foot buffer to encompass potential causeway tie-ins areas. The area of analysis is focused on the lakebed of Utah Lake and the immediate surrounding shoreline areas within the Project boundary, but this report also includes a discussion and assessment of the resources within the wider surrounding area, where appropriate, to provide context for the regional geologic setting, potential seismic hazards, and other applicable relevant resources covered by this report.

3.7.3 Geological Setting

3.7.3.1 Regional Geology

Utah Lake is located in the northeast quadrant of Utah Valley, north-northeast of the intersection of the Great Basin, Rocky Mountains, and Colorado Plateau physiographic provinces (Figure 10). Utah Valley is a structural basin that evolved in response to block faulting associated with basin and range extension that followed over 100 million years of folding and overthrust faulting through northern and central Utah from 160 to 50 million years ago (Hunt et al. 1953).

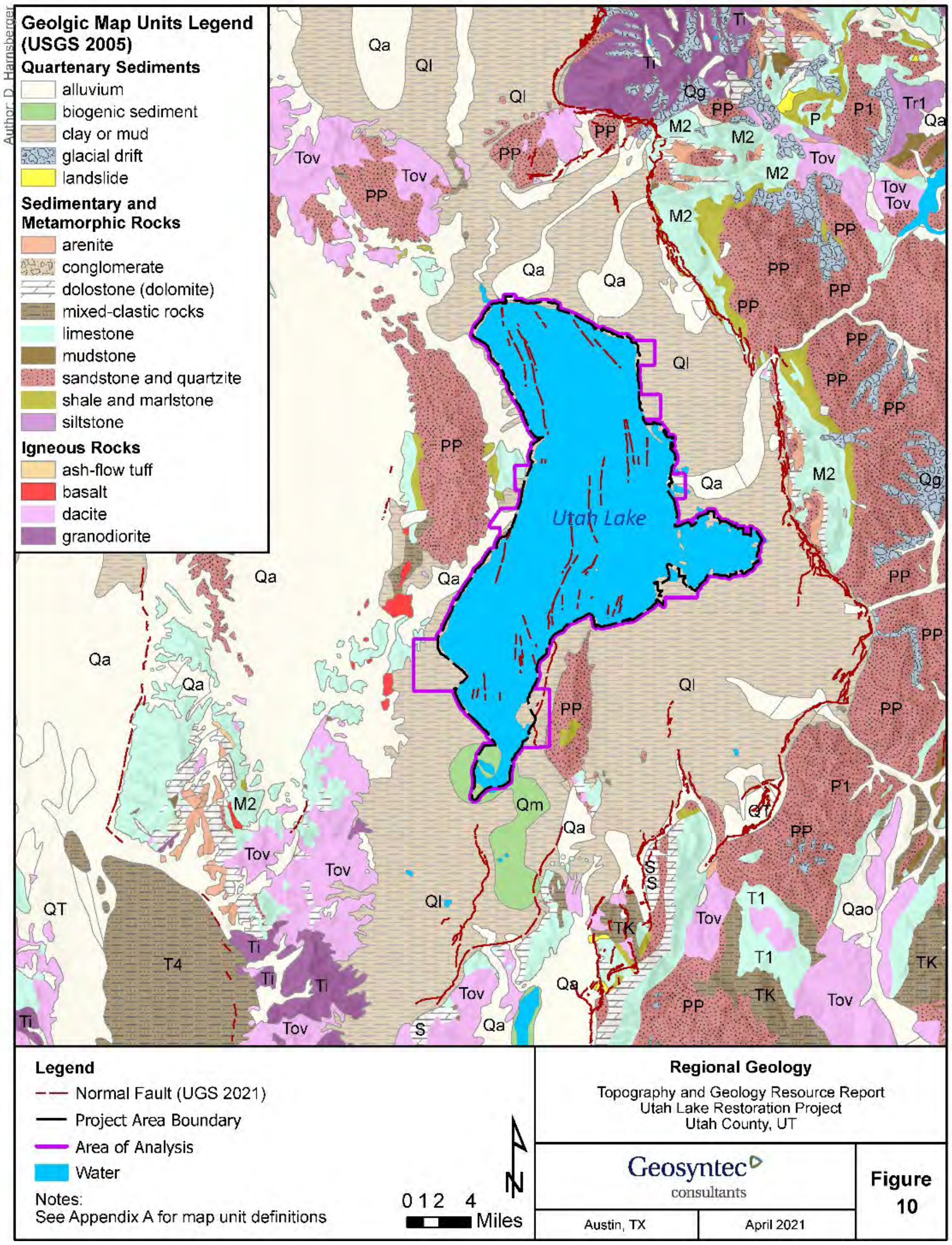

Figure 10. Regional Geology

3.7.3.2 Lake Bonneville

In the late Pleistocene, from about 75,000 to 8,000 years ago, Lake Bonneville occupied Utah Valley and the intermontane basins (Gilbert 1890, Bissell 1968) of the surrounding area. It was a vast lake, comparable in size to modern Lake Michigan, that covered 20,000 square miles of northern Utah and had a maximum depth of about 1,000 feet (Hunt et al. 1953).

As the climate of North America generally became warmer and drier at the end of the Last Glacial Period, roughly 11,700 years ago, and ice sheets formerly occupying much of the northern portions of the continent began to retreat. In the Great Basin, Lake Bonneville retreated south and left the Great Salt Lake and Utah Lake as relict lakes within the Salt Lake and Utah Valleys (Brimhall and Merritt 1981).

3.7.3.3 Utah Lake and Utah Valley

With the final departure of Lake Bonneville approximately 8,000 years ago, Utah Lake was born as a shallow bottom basin lake occupying about 25% of Utah Valley just west of the Wasatch Mountains. The lake is approximately 24 miles long and 13 miles wide at its widest point and has a surface area of approximately 95,500-acres (Horns 2005), with an estimate of 95,500 acres used for purposes of this document. Sources of inflow to the lake include surface water tributaries, precipitation falling on the lake, lake-bottom springs, and groundwater inflow (Horns 2005).

3.7.4 Topography and Bathymetry

Utah Lake is located within the partially enclosed basin of Utah Valley, which is approximately 43 miles long and 20 miles wide. The lake covers approximately 150 square miles (95,500 acres), which is approximately 25% of the valleys area (Horns 2005). The overall topography of the surrounding area is shown on Figure 11.

The maximum elevation of the Utah Lake, known as the Compromise Line elevation (4,489.045 feet amsl), is controlled by a dam at it its outlet to the Jordan River. Surrounding shoreline elevations within the area of analysis range from 4,489.045 (Compromise Line) to 6,640 feet amsl. The maximum elevation occurs along the base of West Mountain in the southern portion of Utah Lake.

The bathymetry data for Utah Lake shows that the lakebed is shallow with a relatively flat bottom (Mountainland Association of Governments 2021). The average depth of lake is between approximately 9 and 10 feet and a maximum depth of approximately 13 feet (Figure 11). The total volume of the lake is reported to be approximately 870,000 acre-feet (AF) at compromise elevation (Morgan 1993).

3.7.5 Current Islands

The only naturally occurring island within Utah Lake is Bird Island, which is in the south-central portion of the lake (see Figure 11). There are currently no other islands within the area of analysis. The island covers an area of approximately 2 acres and is reported to be comprised of tufa underlain by Permian and Pennsylvanian age quartzite bedrock, which is likely an extension of the horst formed by West Mountain to the south (Bissell 1963). The Project would not disrupt or alter the current island.

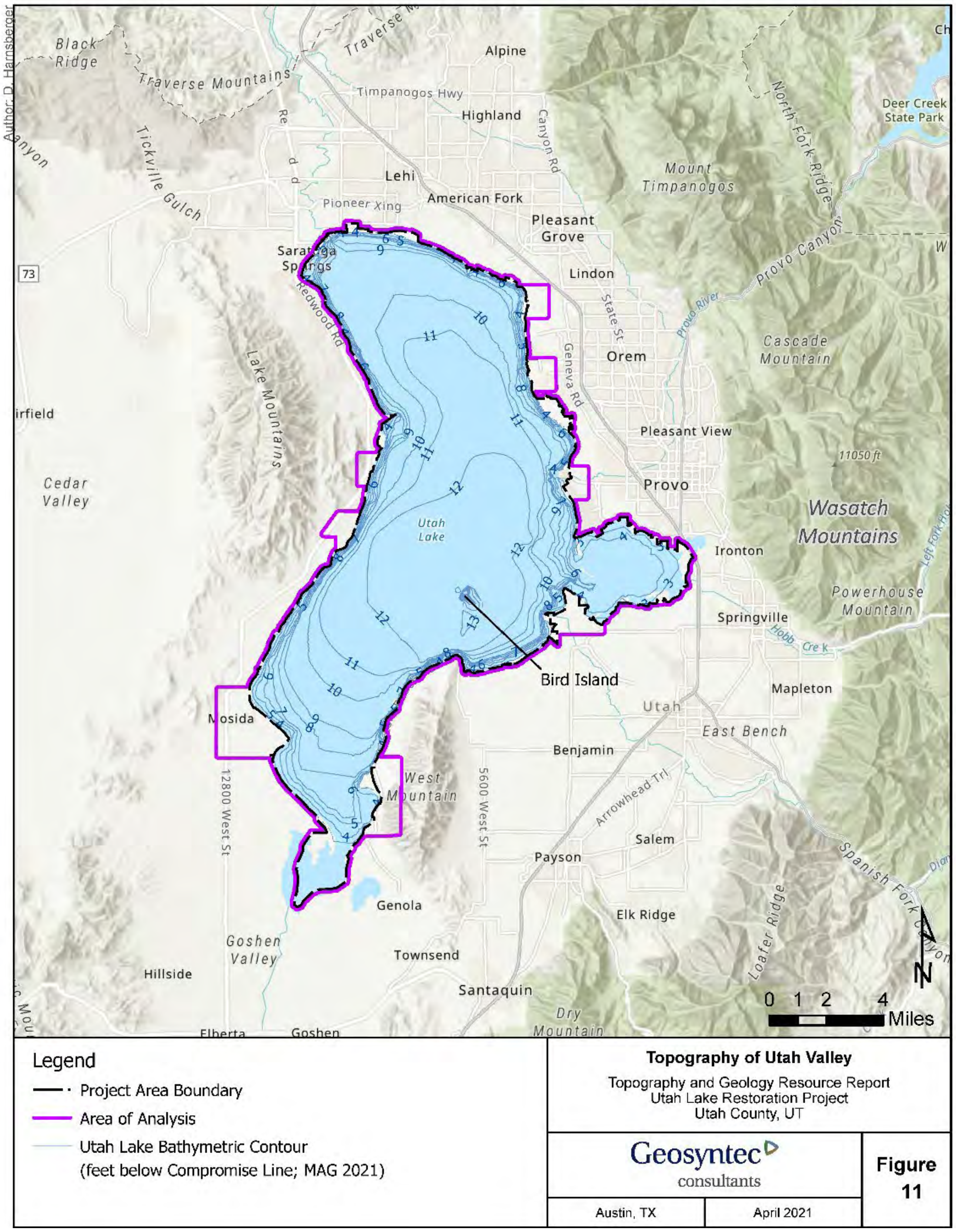

Figure 11. Topography of Utah Valley

3.7.6 Geological Hazards

3.7.6.1 Regional Seismic Setting

Utah is in a tectonically active area due to crustal extension and deformation that occurs along the eastern margin of the Basin and Range physiographic province. This extension results in a north–south trending zone of seismicity along this margin, which runs roughly through the center of the state and is part of what is known as the Intermountain Seismic Belt. Faulting along this boundary is characterized by normal faults with moderate to steep dips. Seismic observations and studies indicate that faults associated with this zone are capable of producing large and potentially damaging earthquakes (Hecker 1993).

3.7.6.2 Utah Lake Paleo Seismology

Dinter and Pechmann (2014) conducted a paleoseismology study of Utah Lake in 2010. The study built on previous work by Cook and Berg (1961), Brimhall et al. (1976), Goter (1990), Baskin and Berryhill (1998), Hecker et al. (2003), and others and is the most detailed and recent seismic study to have been completed on the shallow sediments within Utah Lake to date. The study included 24 seismic reflection profiles across Utah Lake on east–west tracks at approximate spacings of 1.5 kilometers and up to a depth of approximately 25 m.

Results of the study identified the inferred the presence and location of at least two major Quaternary age normal faults identified as the Saratoga Springs fault and Lincoln Point West fault, which run beneath Utah Lake. Additionally, the study inferred the presence of 21 other subsidiary faults and monocline structures with shorter and smaller displacements.

3.7.6.3 Fault Ground Rupture

The potential for fault surface rupture is generally considered to be significant along active faults and potentially active faults. Evidence of mapped active faults and/or tectonostratigraphy are present beneath Utah Lake (Dinter and Pechmann 2014). The Project area boundary is also located in close proximity to the Wasatch Fault Zone (WFZ), which is an active fault zone capable of producing earthquakes of magnitude 7.0 or greater. The potential for fault ground rupture or cracking within the area of analysis is considered high and would require the consideration of mitigation measures to avoid or reduce impacts from the Project. The study identified the presence of at least six large paleoearthquakes in the lake sediments, with five of these interpreted to have potentially occurred between 500 and 6,000 years before present. In addition to the identified faults, the seismic profiles identified evidence of basin-wide liquefaction of the lakebed to a depth of approximately 2 m and probable evidence of seismically triggered debris flows.

3.7.6.4 Strong Ground Shaking

The Project is situated within a seismically active area known as the Intermountain Seismic Belt and will likely experience moderate to severe ground shaking in response to a large-magnitude earthquake occurring on potential local faults within the area of analysis or more distant active faults during the expected lifespan of the Project (e.g., WFZ). Within the area of analysis, the potential for significant seismically induced ground shaking in response to an earthquake occurring along the identified faults beneath Utah Lake, WFZ, or other regional faults is relatively high.

3.7.6.5 Earthquake Induced Landslides or Debris Flows

The paleoseismology study of Utah Lake by Dinter and Pechmann (2014) identified evidence for up to four large debris flows within the shallow sediments (upper 25 m) of Utah Lake. The seismic setting of Utah Lake and evidence of previous landslides and debris flows within lake sediments indicates a potential hazard for earthquake-induced landslides or debris flows within the area of analysis.

3.7.6.6 Liquefaction

Seismically induced liquefaction is a phenomenon in which saturated soils lose a significant portion of their strength and acquire some mobility from seismic shaking or other large, cyclic loading. The immediate surrounding shoreline areas within the area of analysis have been primarily characterized by Utah Geological Survey (UGS) as having a high liquefaction potential, with a few moderate, low, or very low areas in places where the boundary extends further away from the lake (UGS 1994, UGS 2020).

If it is found that liquefaction susceptibility needs to be reduced, then the soil can be improved (thereby reducing liquefaction susceptibility) using a variety of engineering measures that would be evaluated on a site-specific basis. These include dynamic compaction, vibratory compaction, grouting, deep soil mixing (DSM), and others. In lieu of soil improvement, drainage capacity of the potentially liquefiable soil layer can be improved so that earthquake-induced excess pore pressure development is reduced. Pressure-relief wells and earthquake drains can be considered for this purpose.

3.7.6.7 Seismically Induced Tsunami and Seiche

Within the lake environment, tsunamis can be created by abrupt displacement from large landslides, large surface-fault ruptures, or ground shaking from an earthquake source within the lake or surrounding areas. Strong seiching can also develop from a tsunami but can also be generated from other physical mechanisms such as strong winds (Francis et. al. 2011).

Based on the seismic setting of Utah Lake, there may be potential for seismically induced tsunamis and seiching to form from displacement of the lakebed. While specific studies have not been conducted to evaluate the magnitude of this hazard within Utah Lake, a tsunami hazard study conducted on the Great Salt Lake, which is located approximately 30 miles north and has a similar physiographic setting, shows that there is evidence for past seismically induced tsunamis within the Great Salt Lake and that the hazard for future tsunamis and associated seiching is relatively high in that lake (Francis et. al. 2011).

3.7.7 Paleontology

To evaluate potential paleontological resources for the Project, Geosyntec reviewed the BLM Potential Fossil Yield Classifications (PFYCs) ratings for the shoreline sediments around Utah Lake. The BLM PFYC ratings do not cover Utah Lake, but that the age of the sediments and types of fossil resources that are potentially present are generally expected to be the same as the underlying sediments within Utah Lake (i.e., unconsolidated Quaternary lacustrine sediments).

As shown on Figure 12, the PFYC for sediments around the shoreline of Utah Lake are predominately classified as Class 2 or 3 with a very small, isolated area of Class 4 along the western shoreline of the lake near the base of the Lake Mountains. Class 2 sediments are considered to have a low potential fossil yield and are not likely to contain scientifically significant vertebrate or nonvertebrate fossils. Class 3 sediments are considered to have moderate potential fossil yield. Class 4 sediments are considered to have high potential fossil yield (BLM 2007).

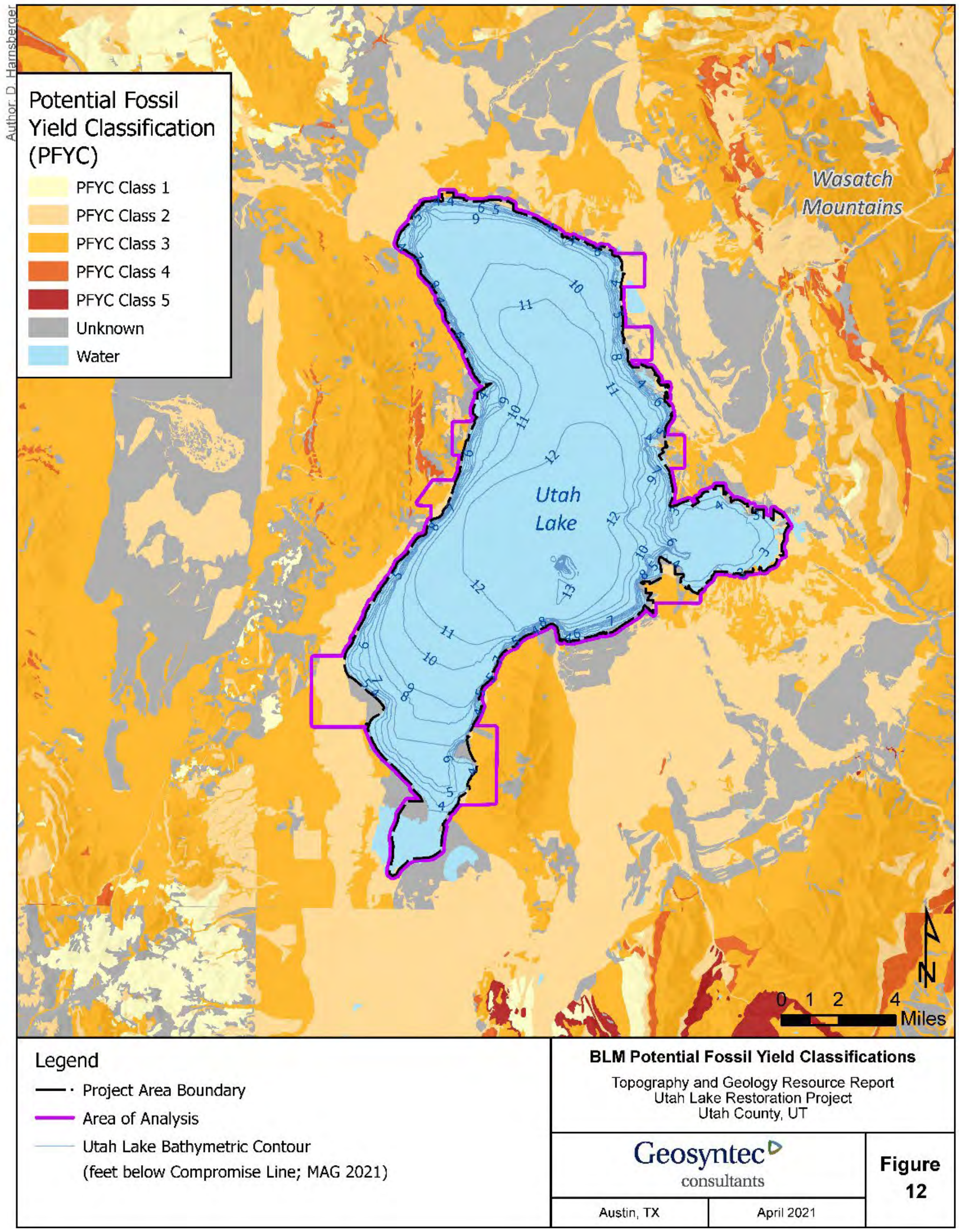

Figure 12. BLM Potential Fossil Yield Classification

3.7.8 Regulatory Framework

3.7.8.1 Federal Regulations

There are no federal regulations that would directly apply to the topography and geology resources of the Project site.

3.7.8.2 State Regulations

- Utah Code Title 65A FFSL
  - Chapter 2 Administration and Management of State Lands, Section 1 Administration of State Lands
  - Chapter 7 Sale, Exchange, and Lease of State Lands
  - Chapter 10 Management of Sovereign Lands
  - Chapter 15 Utah Lake Restoration Act
- 2018 International Building Code
- 2015 International Residential Code
- Utah State Construction Code (Title 15A of the State Construction and Fire Codes Act).

3.8 Soils

Soils in the Project area are described in this section, including the area of analysis, the geologic setting, topography and bathymetry, current islands, geological hazards, paleontology and the regulatory framework. The section focuses on both soils and subsurface geology.

3.8.1 Resource Indicators and Measures

Soils are defined as a mixture of sediments, decayed organic matter, water, and air that, over time, can develop vertical weathering profiles. By comparison, sediments are particles of weathered rock transported by water or wind. Resource indicators used in the analysis of soils related to the Project include a description and evaluation of the existing lake bottom and shoreline soil types, areal distribution, and conditions within the area of analysis. Measures used to analyze potential impacts to soil resources include a qualitative assessment of the proposed Project activity impacts related to potential hazards posed by the existing lake bottom and shoreline soil conditions within the area of analysis. Soil Resource Indicators include the following:

- Soil Hazards (e.g., sensitive soils, erodible soils, and inherent soil productivity)
- Beneficial use of dredged materials (ensure that the material is used or disposed of in an environmentally sound manner)
- Adverse effects to agricultural lands

3.8.2 Area of Analysis

The area of analysis is defined as the Project boundary plus a 500-foot buffer, as well as select areas that extend beyond the 500-foot buffer to encompass potential causeway tie-in areas. The area of analysis is primarily focused on the lakebed of Utah Lake and the immediate surrounding shoreline areas within the Project boundary. This section also includes a discussion and assessment of the resources within the wider surrounding area, where appropriate, to provide context for the regional mapped soils, geologic setting, and other applicable relevant resources covered by this section.

3.8.3 Method

The following informational sources were reviewed to develop an understanding of the existing soil conditions for the Project boundary and surrounding vicinity: publicly available site-specific and regional investigation reports readily available on-line, mapped geologic units and soil types, historical information, and referenced investigations and reports prepared by others. A broad-scale initial GIS-based analysis was used to identify and determine the following:

- Potentially sensitive soil types
- Erosion risk ratings
- Inherent soil productivity
- Other potential limitations related to the likely extent of existing detrimental soil conditions

3.8.4 General Distribution and Characteristics of Soils

In general, soils across the Project area have accumulated within the low-lying Utah Valley through the transport of materials being shed from the surrounding mountains comprised of sedimentary, metamorphic, and volcanic bedrock with subsequent fluvial and alluvial depositional processes. The USDA Natural Resources Conservation Service catalogs the descriptions and distribution of different surface soils mapped in the Project boundary. These soils can be grouped into general categories based on parent materials, mode of deposition, and grain size. Depending on type, some soils are susceptible to increased sensitivity, erosion, and/or expansive behavior, while others are more suitable for construction. General surface soil groups and their relative proportions in the proposed Project area are presented in Table 17.

Table 17. General Soil Groups and Their Relative Extents

Material Classification	SSURGO Map Unit Symbol(s)	Acreage	% of ULRP Area
Beaches	BA, BC	1,536 acres	1.5%
Fine sandy loam	LmA, LnB, Mf, MfB, VnA	435 acres	0.4%
Gravelly fine sandy loam	ScD, ScF	769 acres	0.7%
Gravelly loam	FaB, PlD, ReC, SoD	233 acres	0.2%
Loam	AF, Ch, Ir, Is, JbC, MU, PnA, PoC, Sr, Ss, St, Su	3,526 acres	3.3%
Peat	Lo, Pf, Pg	1,116 acres	1.1%
Peaty silt loam	PY	165 acres	0.2%
Pits and dumps	PK	63 acres	<0.1%
Riverwash	RV	41 acres	<0.1%
Sandy loam	MX	67 acres	<0.1%
Silt loam	Bm, FgB, GbB, GbC, Hc, Hr, Hs, Jo, MbC2, MdB, Mg, Mh, Mn, Po, Rr, Sa, WfA, WfB	5,806 acres	5.5%
Silty clay	Bd, Be, Bf	247 acres	0.2%
Silty clay loam	Bb, Bc, Br, Bs, Ck, Cm, Cn, Co, Cp, Ks, Kt, Ku, Ls, Pd, PsB, Pz, TaB	4,558 acres	4.3%
Stony loam	AcF, AdF, DdC, DdE, DdF, DeF	813 acres	0.8%
Stony sandy loam	HdC, HdD, HdE	623 acres	0.6%
Urban land	UL	361 acres	0.3%
Very cobbly loam	LdF, RkF, SdE, SeF	749 acres	0.7%
Very fine sandy loam	LaC	78 acres	<0.1%
Water	W	84,605 acres	80.0%
Total		105,791 acres	100%

Notes:
Soil group information from Utah Automated Geographic Reference Center (AGRC) System (AGRC 2008).
For a detailed list of Soil Survey Geographic (SSURGO) map unit names, see Appendix C.

3.8.5 Inherent Soil Productivity

Soil productivity is defined as the inherent capacity of a soil to support the growth of specified plants and plant communities, or sequence of plant communities. A potential reduction in agricultural lands resulting from project activities would be considered an impact to inherent soil productivity. Primary agricultural areas are located within the southern and eastern portions of the Utah Lake area extending up to the existing shoreline.

3.8.6 Sensitive Soils

Sensitivity of a soil is a measure of both a soil's resistance (its degree of response to disturbance) and its resilience (its ability to recover after disturbance). Soil sensitivity is an important measure of the loss of strength and structure in the soil body under the effect of static or seismic loading. The disturbance of the natural soil structure during Project activities (for example, dredging or earthwork) would result in a remolding of the material, ultimately changing the engineering properties of the soil. Site-specific information on soil sensitivity through laboratory testing (uniaxial compressive strength testing) is currently not available to fully evaluate soil sensitivity. Nevertheless, given the depositional setting of a lacustrine environment and accumulation of soils with higher percentages of silts and clays, soils within the southern portion of Utah Lake are considered to be sensitive.

3.8.7 Regulatory Framework

3.8.7.1 Federal Regulations

- *Beneficial Use Planning Manual* prepared by USACE and the United States Environmental Protection Agency (EPA) (USACE and EPA 2007)
- *Dredging and Dredged Material Management* manual (EM No. 1110-2-5025) prepared by the USACE (USACE 2015)
- CWA of 2001
- Water Resources Development Act of 2020
- NEPA (42 USC § 4321-4347)
- FLPMA of 1976 (43 USC 1701 et seq.)
- Food Security Act of 1985

3.8.7.2 State Regulations

- Utah Admin Code R315-261
- Utah Admin Code R315-268
- State Code, Title 17D, Chapter 3
- Utah State Legislature Code, Title 17, Chapter 41
- The use of water in the state of Utah must be established through the appropriation process administered by the Utah Division of Water Rights (DWRi) and requires an "*Application to Appropriate Water*" permit.

3.9 Water Resources

Water Resources in the Project area are described in this section, including the area of analysis, the setting and background, limnology and ecology, water quality, hydrology and geohydrology and aquatic resources. The section focuses on water quantity and quality.

3.9.1 Area of Analysis

The area of analysis for water resources is the Project boundary presented in Figure 1 and select areas that extend beyond the settled boundary line to encompass potential causeway tie-in areas.

3.9.2 Setting and Background

3.9.2.1 Utah Lake

Historically, Utah Lake was part of Lake Bonneville, but erosion and prolonged drought reduced the extent of Lake Bonneville from nearly 20,000 square miles to a smaller patchwork of lakes, including present-day Great Salt Lake and Utah Lake (Bissell 1963). Utah Lake is a natural lake that was enlarged by a dam in 1872. At the lake's widest points, it is approximately 24 miles long and 13 miles wide with a surface area of approximately 150 square miles (approximately 95,500 acres). The lake is a key storage facility in the Central Utah Water Project and is filled with a combination of native basin flows and transbasin flows diverted from the Colorado River basin (BOR 2021). The ordinary high-water surface (CL) of the lake is 4,489.045 feet elevation amsl.[1] This elevation corresponds to the compromise lake elevation,[2] as modified in 1985. At capacity, the lake can store approximately 870,000 AF of water (Utah Division of Water Resources [UDWRe] 2014) (total storage). Despite being the third-largest lake west of the Mississippi River by surface area, the volume of the lake is relatively low due to shallow water depth. At its deepest point, the lake has a maximum depth of approximately 13 feet and an average depth of between 9 and 10 feet (PSOMAS and SWCA 2007).

Utah Lake is managed for water storage and delivery for beneficial use (agriculture). The first 8.7 feet of storage below the compromise level is considered active storage (710,000 acre-feet) ((Morgan 1993). Active storage is managed by pumping systems at the outlet of the lake to the

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[1] The datum for the CL is given in Sea Level Datum of 1929, used interchangeably with National Geodetic Vertical Datum of 1929 (NGVD29) based on https://waterrights.utah.gov/wrinfo/policy/ut_lake/utah_lake_control.pdf, page 10. See https://geodesy.noaa.gov/datums/vertical/national-geodetic-vertical-datum-1929.shtml. NGVD29 was superseded by North American Vertical Datum of 1988 (NAVD88). As such, many newer datasets, such as light detection and ranging (LiDAR), will be in NAVD88. They differ by about 1 meter at this location. See https://geodesy.noaa.gov/TOOLS/Vertcon/Vertcon_Map.html.

[2] The compromise lake elevation was initially established in 1885 to resolve conflicts between the Utah Lake dam operations and surrounding agricultural properties, which suffered increased flooding frequency and duration following dam construction. When Utah Lake is above the compromise lake elevation, Utah Lake dam outlets must be fully opened.

Jordan River. The first 125,000 AF of the active storage pool is known as primary storage and is dedicated for use by primary water rights owners (decreed in 1901 by Judge Morse) (Morgan 1993). The remaining 585,000 AF of active storage is known as system storage and is available for secondary water rights owners (decreed in 1909 by Judge Booth). Below the active storage pool, Utah Lake contains another approximately 160,000 AF of inactive storage that is not accessible to the Jordan River pumping facilities (Morgan 1993) and which is not feasibly diverted for beneficial use.

3.9.2.2 Utah Lake Basin (including tributaries and diversions)

The Utah Lake Basin covers approximately 3,000 square miles and includes areas east and west of the Wasatch Fault line (see Figure 13). Utah Lake is located within the Basin and Range province, which is characterized by steep, narrow north–south-oriented mountains and broad, flat, sediment-filled basins (PSOMAS and SWCA 2007).

UDWRe defines the area of the Utah Lake Basin as all lands draining to Utah Lake and the Jordan River at the Salt Lake County line (UDWRe 2014). The Utah Lake Basin includes several major waterways. The Provo River, the Spanish Fork River, Mill Race Creek, Hobble Creek, and Dry Creek are considered the primary sources of surface water flow into Utah Lake (see Figure 13). Other significant surface water input sources include Spring Creek, Benjamin Slough, and Powell Slough. Together, these tributaries contribute roughly 43% of total surface inflow to Utah Lake. Minor tributaries and several other surface flows contribute an additional 8% of total surface inflow (PSOMAS and SWCA 2007). Utah Lake also receives water inputs from springs and seeps, groundwater, and direct precipitation. These water inputs breakdown approximately as follows by percent (PSOMAS and SWCA 2007, UDWQ 2018):

- Cumulative stream inflow to Utah Lake accounts for 53% of total lake inflow
- Groundwater and springs account for 22% of total lake inflow
- Precipitation accounts for 17% of total lake inflow
- Miscellaneous surface drains and surface flow account for the remaining 8%

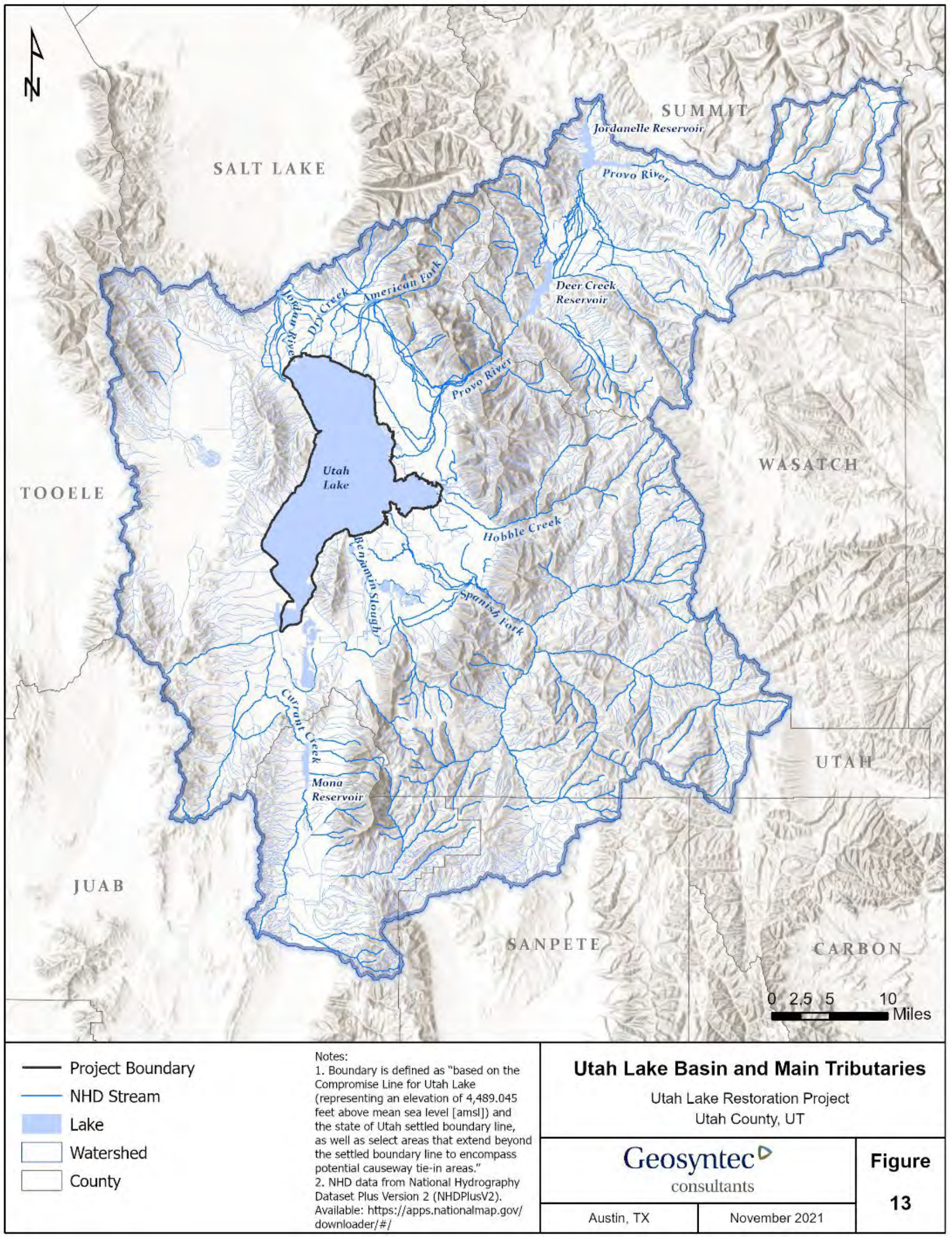

Figure 13. Utah Lake Basin and Main Tributaries

3.9.3 Limnology and Ecology

Utah Lake is unique because of the shallow nature of the lake paired with a large surface area. The shallow nature of the lake allows wind action to constantly stir up and remix bottom sediments (PSOMAS and SWCA 2007) and minimizes thermal stratification of the water column. Water level fluctuations resulting in dramatic reductions in the surface area of the lake are partly due to the shallow depth and high summer evaporative losses as well as large water withdrawals by downstream water users (Central Utah Water Conservancy District 2007). The lake contains one small island—Bird Island, which is near Lincoln Beach at the south end of the lake—that may be completely submerged during high water years. Utah Lake is a highly turbid lake, due in part to the resuspension of bottom sediments (a result of wind action and fish feeding) and the precipitation of calcium carbonate ($CaCO_3$) and other minerals from the water column. Nutrient loading to Utah Lake is recognized as an issue contributing to the eutrophication of the lake.

3.9.3.1 Trophic State Index

Utah Lake is a highly productive system (with high nutrient concentrations and low water clarity) that is largely considered to be eutrophic, as it is characteristic of the general description of eutrophication. The most characteristic features of eutrophic lakes are high nutrients and the abundance of planktonic or attached algae; these lakes are often plagued by surface blooms of blue-green algae (cyanobacteria). The Carlson index (trophic state index [TSI] uses measures of Secchi disc depth (SDD, a measure of water clarity), phosphorus, and chlorophyll *a* to assess the trophic state of a given lake.

As shown in Figure 14, TSI values for Utah Lake generally indicate eutrophic conditions based on chlorophyll *a* and TP. TSI calculated from SDD indicates hypereutrophic conditions; however, water clarity in Utah Lake is influenced by inorganic turbidity from suspension of sediments from wind action and precipitation of calcium compounds in the water column. Therefore, TSI values based on SDD measurements can be misleading.

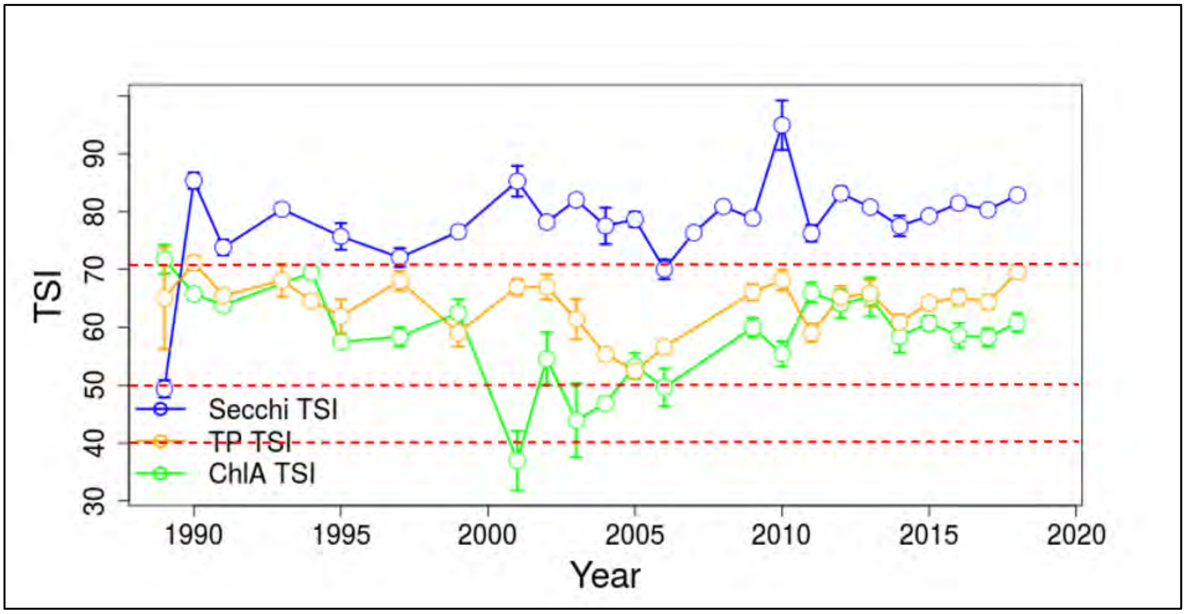

Figure 14. Utah Lake (not including Provo Bay) TSI Values (1989–2018) (Tetra Tech 2021)

Note: Lakes with TSI values less than 40 are considered to be oligotrophic; lakes with TSI values between 40 and 50 are considered to be mesotrophic; lakes with TSI values between 50 and 70 are considered to be eutrophic; and TSI values above 70 are considered to be hypereutrophic.

3.9.3.2 Nutrient Cycling

Utah Lake is generally considered to be eutrophic, with high concentrations of nutrients such as phosphorus and nitrogen. The lake receives nutrient inputs from external sources, including point sources such as WWTPs, nonpoint sources such as agriculture, and internal sources such as nutrient cycling from benthic sediments.

3.9.3.2.1 Point Sources

Wastewater Treatment Plants

Major point sources of pollution in the Utah Lake Basin include WWTPs and stream tributaries (Figure 15). There are seven WWTPs in the vicinity of Utah Lake (Table 18).

Table 18. WWTPs in the Vicinity of Utah Lake

Wastewater Treatment Plant	Discharge Receiving Water
Salem	Benjamin Slough
Payson	Benjamin Slough
Provo City	Mill Race Creek
Orem	Powell Slough
Spanish Fork	Dry Creek
Springville	Spring Creek
Timpanogos	Utah Lake

Source: PSOMAS and SWCA (2007)

Utah Lake Tributaries

The two largest inflows to Utah Lake are the Provo River and the Spanish Fork River (see Figure 15), which combined account for 60% of the total surface water inflow (UDWQ 2018). The Provo River contributes the greatest flow to Utah Lake, representing 36% of the total stream inflow to the lake.

Figure 15. Major Tributaries and Local WWTPs That Discharge to Utah Lake (Randall 2017)

3.9.3.2.2 Nonpoint Sources

Stormwater

Within the Utah Lake Basin, approximately 7% of the land area is made up of developed lands that have the potential to contribute stormwater to Utah Lake (UDWQ 2018) due to their proximity to the lake.

Atmospheric Deposition

Due to the large surface area, the lake is more susceptible to the atmospheric deposition of nutrients (Olsen et al. 2018). Based on the current knowledge of regional estimates of dust deposition and the current knowledge of total and soluble phosphorus loading from dust, Brahney (2019) made estimates of annual atmospheric deposition rates of nitrogen and phosphorus to Utah Lake. It is estimated that between 2.2 and 10.0 tons of total phosphorous (TP) and between 168.0 and 317.0 tons of nitrogen are deposited per year into Utah Lake (Brahney 2019). Additional study of atmospheric deposition is ongoing, with work being conducted by the Wasatch Front Water Quality Council along with the Utah Lake Science panel (see Miller et. al, 2021).

3.9.3.3 Lake Levels

In western, arid regions, increases in air temperature significantly contribute to increased evaporation of lake waters into the atmosphere. Because Utah Lake is both shallow and has a large surface area, it is more susceptible to high rates of evaporation. Utah Lake is considered a semi-terminal lake, having almost twice the amount of water inflow volume than outflow (Abu-Hmeidan et al 2018). Despite significant amounts of groundwater contribution to the lake, evaporation has been estimated to account for 41% (Abu-Hmeidan et al. 2018) to 52% (PSOMAS and SWCA, 2007) of lake outflows. The estimate included in section 3.9.5.2 is 43% of lake outflows.

3.9.4 Water Quality

3.9.4.1 Method

To assess Utah lakes and reservoirs, UDWQ has a robust assessment method that involves two tiers of data collection and analysis. Tier 1 focuses on determining the support status for Class 2, Class 3, and Class 4 beneficial uses by looking at dissolved oxygen (DO), temperature, pH, toxicants, and *Escherichia coli* (*E. coli*) (UDWQ 2016). Tier II focuses on the weight of evidence criteria: TSI, fish kills, and algal composition (UDWQ 2021a).

To assess lakes for impairments, UDWQ classifies a water body as either mixed or stratified based on depth profiles. Utah Lake is considered a mixed water body and, therefore, was assessed by UDWQ using the protocol for mixed lakes (UDWQ 2016).

3.9.4.2 Water Quality Monitoring

There is an abundance of public water quality data on Utah Lake and the surrounding area over the last several years. In 2017, UDWQ created a monitoring plan to focus efforts on tributary monitoring around Utah Lake to better quantify inflows and pollutant loading and now regularly monitors the major inflows and open water sites shown in Figure 16 for parameters listed in Table 19 (open-water monitoring) and Table 20 (tributary monitoring) (UDWQ 2018).

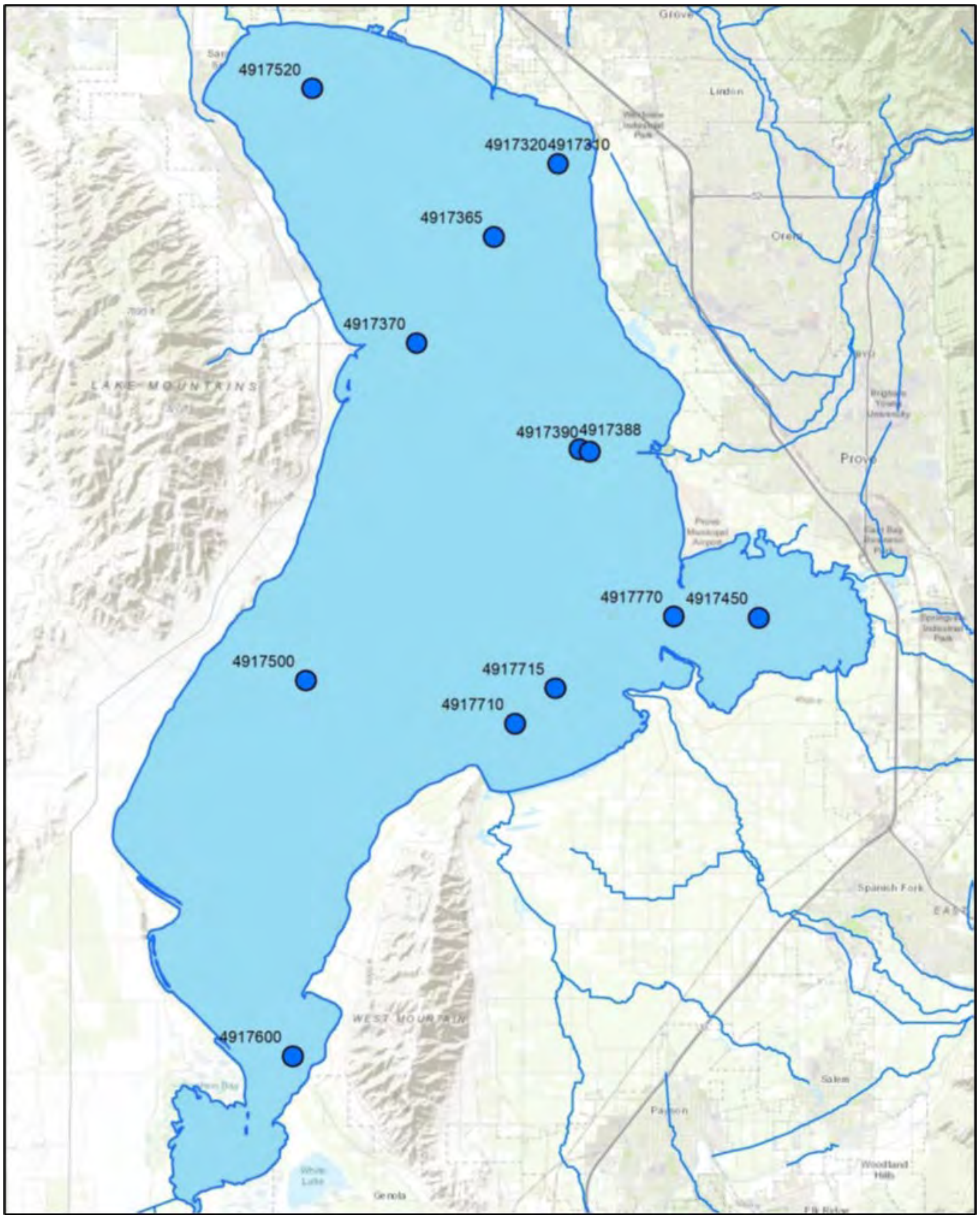

Figure 16. Utah Lake Open Water Monitoring Locations (UDWQ 2018)

Table 19. Water Chemistry Parameters Analyzed for Utah Lake Open Water Sites (monthly monitoring)

Field parameters	Temperature, specific conductance, pH, DO, and Secchi disc depth
Sonde parameters	Temperature, specific conductance, pH, DO, turbidity, Chlorophyll *a*, and phycocyanin
Non-filtered nutrients	Ammonia, nitrate/nitrite, TP, total nitrogen, and total organic carbon
Dissolved (filtered) nutrients	Ammonia, nitrate/nitrite, total dissolved nitrogen, dissolved organic carbon, dissolved phosphate
General chemistry	Alkalinity, chlorine, specific conductance, sulfate, total dissolved solids, total suspended solids, turbidity, and total volatile suspended solids
Filtered metals	Calcium, magnesium, potassium, and sodium
Others	Chlorophyll *a*, *E. coli*, cyanotoxins, and phytoplankton

Source: UDWQ (2018)

Table 20. Water Chemistry Parameters Analyzed for Utah Lake Tributary Sites (monthly monitoring)

Field parameters	Temperature, specific conductance, pH, DO, and Secchi disc depth
Biochemical oxygen demand (BOD)	Carbonaceous BOD5 (cBOD5) only at WWTPs
Non-filtered nutrients	Ammonia, nitrate/nitrite, TP, total nitrogen, and total organic carbon
Dissolved (filtered) nutrients	Ammonia, nitrate/nitrite, total dissolved nitrogen, dissolved organic carbon, dissolved phosphate
General chemistry	Alkalinity, chlorine, specific conductance, sulfate, total dissolved solids, total suspended solids, turbidity, and total volatile suspended solids
Others	Chlorophyll *a* and *E. coli*

Source: UDWQ (2018)

3.9.4.3 Water Quality Parameters

3.9.4.3.1 Field Parameters

In addition to laboratory-measured water quality parameters, UDWQ also monitors parameters at both open water and tributary sites monthly in the field, including temperature, pH, DO, SDD, and specific conductivity. These field parameters in Utah Lake are impacted by climate, wind, evaporation rates, atmospheric deposition, and physical and chemical processes within the water column. UDWQ routinely collects pH, temperature, and DO measurements at 1-m intervals throughout the water column, from surface to bottom, at all open water and tributary sites on Utah Lake (UDWQ 2016).

pH

The pH of a body of water determines the form, solubility, and biological availability of many other chemical constituents in the water. Sources of pH include natural geologic sources and human contaminants from agricultural runoff. The pH in Utah Lake is generally basic, and pH measurements typically fall between 8.2 and 8.8, not including Provo Bay.

Dissolved Oxygen

DO is necessary for a healthy aquatic ecosystem and can significantly impact other water quality parameters. The water in Utah Lake is generally well oxygenated, with DO concentrations ranging from 6 to 13 milligrams per liter (mg/L). This is largely due to several factors: the general well-mixed nature of the lake and lack of vertical stratification, primary production, and reaeration from wind disturbance.

Temperature

All types of aquatic species, such as fish, zooplankton, and phytoplankton, have preferred temperature ranges, and, as water temperature fluctuates outside of the preferred ranges, aquatic species can be negatively affected. Water temperature also affects the rate at which chemical reactions take place within the water column; therefore, water quality parameters such as ammonia, phosphorus, and DO are impacted by water temperature. Higher water temperatures contribute to increased chemical activity, release of nutrients from sediments, and decreased DO concentration in the water column.

In Utah Lake, temperature is monitored at both open water and tributary sites monthly. The lowest average surface temperature values are seen at the Utah Lake State Park Marina (Tetra Tech 2021) monitoring location located on the east side of the lake near the input of the Provo River, and the highest average surface water temperature values are seen at the American Fork Beach monitoring location (Tetra Tech 2021).

3.9.4.3.2 Turbidity

In Utah Lake, turbidity is affected by primary production (phytoplankton), soil erosion, wind events, bottom feeder fish populations that stir up sediments, suspended sediment from tributaries, and the precipitation of calcium carbonate and other minerals (PSOMAS and SWCA 2007). Sedimentation has the potential to increase turbidity, which reduces the amount of sunlight reaching aquatic plants, covers fish spawning areas and food supplies, and clogs the gills of fish.

Turbidity in Utah Lake is naturally elevated due to the precipitation of calcium compounds from calcite adsorption. Additionally, frequent windy conditions cause resuspension of fine benthic sediments, which can dramatically increase turbidity. While phytoplankton growth and HABs can further increase turbidity, turbidity is recognized as a factor that may limit primary production in Utah Lake (Olsen et al. 2018).

3.9.4.3.3 Total Dissolved Solids

Total dissolved solids (TDS) is a measurement of the total amount of dissolved matter (ions) in a sample of water. Major ions found in Utah Lake are calcium, magnesium, sodium, bicarbonate, chloride, and sulfate (Horns 2005). Sources of these different dissolved materials include dissolution of natural sources, wastewater, stormwater runoff, groundwater, and lake-bottom springs (Horns 2005). Water depth and wind action can affect TDS values in a body of water, as wind moving across a shallow body of water can resuspend dissolved chemicals trapped in sediment at shallow depths and cause TDS to increase (Horns 2005, PSOMAS and SWCA 2007). Average TDS concentrations in Utah Lake (not including Provo Bay) typically fall between 1,000 and 1,500 mg/L. Generally, higher TDS values occur during periods of low lake elevation (where solids are concentrated through evaporation); however, there are other variables besides lake level that impact TDS, such as wind, precipitation, and point and nonpoint source loading (Horns 2005).

3.9.4.3.4 Chlorophyll a

Chlorophyll *a* is green pigment that is most often found in eukaryotic algae, including all groups of phytoplankton, and is used by plants to convert sunlight to chemical energy. Measuring the amount of chlorophyll *a* in the water column helps to determine algal abundance. Algal blooms in a body of water most often occur when there are excess nutrients in the water from fertilizers, septic systems, sewage treatment plants, or urban runoff; however, other physical water characteristics also impact algal growth, such as temperature, DO, and sunlight (PSOMAS and SWCA 2007). Based on the 20-year average data, surface chlorophyll *a* concentration in Utah Lake, not including Provo Bay, is highest in Goshen Bay (monitoring location ID [MLID] = 4,917,600) and second highest at the Provo Bay outlet (MLID = 4,917,770) (Tetra Tech 2021). The highest concentrations of chlorophyll *a* are found in Provo Bay, with some measurements of up to 400 micrograms per liter (µg/L).

Phytoplankton

In Utah Lake, phytoplankton play a central role between the sediments in Utah Lake and nutrients in the water column (Miller and Richards 2017). They are also the major link between water nutrients and zooplankton grazers (Miller and Richards 2017). Phytoplankton are regularly sampled by UDWQ as part of efforts to understand eutrophication in Utah Lake (UDWQ 2021a). Phytoplankton data are used in the Tier II assessment process to determine a lake's potential to have HABs and a harmful effect on aquatic life (UDWQ 2021a). Utah Lake has a diverse assemblage of phytoplankton species; however, most of the lake is dominated by *Aulacoseira* and *Desmodesmus*, both unicellular green algae.

Harmful Algal Blooms

HABs is a term used to describe a rapid increase of algae that are potentially toxin-forming in a body of water. These blooms are typically composed of blue-green algae (cyanobacteria), some of which can be toxic to both aquatic and human life (UDWQ 2021a). Most cyanobacteria are oxygen-forming photosynthetic bacteria that contain gas vesicles that lend buoyancy and lead to the formation of surface scums under calm conditions (Dodds and Whiles 2010). HABs have occurred in Utah Lake since at least the 1970s; however, there was no assessment method for HABs until 2015, when UDWQ adopted a new method that is now included in the 2016 integrated report (King 2019, UDWQ 2016). HABs observed on Utah Lake in 2020 are listed in Table 21, and more information on the specific results of HAB sampling completed by UDWQ can be found on the Utah Lake Algal Bloom Monitoring 2020 webpage (UDWQ 2020b).

Table 21. Harmful Algal Blooms on Utah Lake in 2020

Date of Observed Habitat	Date of Warning Lift	Location	Description
September 17, 2020	November 2, 2020	State Park Marina	Results showed cyanobacteria cell counts over seven times the health advisory threshold.
September 3, 2020	November 2, 2020	American Fork Marina, Lindon Marina, Lincoln Marina, open water	Cyanotoxin present and cyanobacteria cell counts were above the health advisory threshold.
August 27, 2020	November 2, 2020	American Form Marina, Lindon Marina, Lincoln Marina, open water	Cyanobacteria cell counts were five times the health advisory threshold.
August 19, 2020	November 2, 2020	Open waters of Utah Lake	The Utah County Health Department issued a warning advisory for the open waters of Utah Lake. The toxigenic cell concentration exceeded the recommended warning advisory by a factor > 7, and the bloom was heavily dominated by *Planktothrix*.
July 10, 2020	November 2, 2020	The open water between American Fork Marina and Lindon Marina	The Utah County Health Department issued a warning advisory. Microcystin levels exceeded the recreational health–based threshold for a warning advisory (8.0 µg/L).
July 19, 2020	November 2, 2020	Lincoln Marina	Sampling resulted in microcystin levels (193 µg/L) exceeding the recreational health–based threshold for a warning advisory (8.0 µg/L).

Date of Observed Habitat	Date of Warning Lift	Location	Description
July 31, 2020	November 2, 2020	Lincoln Marina, Lincoln Beach, Lindon Marina, American Form Marina	The Utah County Health Department issued a warning advisory. Toxin test results showed microcystin levels exceeding the recreational health–based thresholds in surface and water column samples.

Source: UDWQ (2020b)
Note: All advisories were removed on November 2, 2020, as a result of the end of the sampling and recreation season.

3.9.4.3.5 Nutrients

Several factors contribute to the eutrophication of Utah Lake, including land use in the Utah Lake Basin, sediment resuspension by carp, point and nonpoint source pollution, atmospheric deposition of nutrients, and turbidity increase from wind action (Miller and Richards 2017).

Nitrogen

Nitrogen sources include agricultural fertilizer, domestic wastewater, groundwater, and animal waste. These sources of nitrogen enter Utah Lake through a variety of pathways, such as runoff and atmospheric deposition (Olsen et al. 2018). Excess nitrogen can cause overgrowth of aquatic plants, which affects other water quality parameters such as DO and pH. Nitrogen in Utah Lake has been extensively studied because of its major contribution to the eutrophic state of the lake. In the lake, surface nitrogen values range between 0 and 1.5 mg/L, and bottom lake nitrogen values range from around 0.4 to 1.0 mg/L (Tetra Tech 2021)

Ammonia

Chemically, ammonia exists in freshwater ecosystems in two forms, as an ammonia ion (NH_4^+) and as unionized ammonia (NH_3), and both forms are summed together for the most common measurement of ammonia, total ammonia, or sometimes referred to as total ammonia nitrogen (EPA 2013). Combined ammonia plus ammonium concentrations in Utah Lake (not including Provo Bay; see Section 3.3.5.3 for Provo Bay) range from 0.01 mg/L to 0.8 mg/L (Salk 2021), with the highest relative averages occurring near the input of the Provo River (MLID = 4,917,390) and at Goshen Bay (MLID = 4,917,600) (Tetra Tech 2021).

Phosphorus

Phosphorus is a reactive element that occurs naturally in soils, rocks, and animal waste. Phosphorus typically enters water bodies through stream erosion, agricultural fertilizer, animal waste, wastewater, and stormwater runoff. Phosphorus in Utah Lake is typically measured in two ways: as TP and as dissolved phosphorus. TP is a measure of all forms of the phosphorus element present in a sample of water (orthophosphate, condensed phosphate, and organic phosphate), and dissolved phosphorus is a measure of the amount of TP that is dissolved in the water column. Phosphorus is mainly found in only one inorganic form (phosphate). It is common for phosphorus to be a limiting nutrient in lakes and reservoirs, and it can be a contributing factor to eutrophication (Dodds and Whiles 2010, Merrell 2015).

Utah Lake's sediments are known to be a major sink for phosphorus, due to the presence of calcium compounds, metals, and other ions that might bind with phosphorus and cause it to precipitate out of the water column. Utah Lake sediments have recently been studied in efforts to determine the condition of the sediment and possible ways to mitigate phosphorus loading from sediment.

While Utah Lake's benthic sediments are a sink for phosphorus, under certain conditions they become a source of phosphorus to the water column, fueling primary production, including HABs. Rates of phosphorus release from sediments to the water column have been estimated at 0.001 to 0.07 grams per square meter per 24 hours ($g/m^2/d$) (Hogsett et al. 2018).

Provo Bay

The Provo Bay portion of the Utah Lake assessment unit is currently listed as impaired for the warm water aquatic life (Class 3B) beneficial use based on exceedances of ammonia and TP as phosphorus (UDWQ 2021a).

3.9.4.3.6 E. coli

The Utah Lake other than Provo Bay assessment unit and the Provo Bay portion of Utah Lake assessment unit have no beneficial uses that are impaired due to exceedances of *E. coli* (UDWQ 2021b). *E. coli* is used for the Tier 1 assessment of Utah lakes and reservoirs to determine beneficial use attainment for recreational use (Class 2), aquatic life use (Class 3), and agricultural use (Class 4) (UDWQ 2021a).

Routine sampling at Lindon Beach during February 2019, outside of recreation season (March through October), showed *E. coli* values above the health advisory threshold. Subsequent sampling in March and July 2019 showed levels consistently below the health advisory threshold, and the site was not officially listed in February 2019 (M&).

The 2018/2020 Integrated Report resulting assessment determinations were made using data collected from October 1, 2010, and September 30, 2018 (UDWQ 2010). Since September 30, 2018, there have been two health advisories due to *E. coli* levels (UDWQ 2019). Health advisories occur as a result of *E. coli* values that exceed the water quality standard threshold of more than 409 most probable number per 100 milliliters (mL) (UDWQ 2019). Health advisories for *E. coli* can be lifted once 4 consecutive samples over a 2-week period are below the health advisory threshold (UDWQ 2019).

3.9.4.3.7 Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) are human-made organic chemicals grouped in the family of human-made chlorinated hydrocarbons (EPA 2020) that are hydrophobic, tending to adhere to organic materials. These chemicals were banned from production in 1979; although they are no longer produced in the United States, PCBs can still be present in products produced before 1979, including electrical equipment, oils, plastics, and adhesives (EPA 2020). Sources of PCBs now include leaks from hazardous waste sites, illegal disposal of PCB waste, and improper disposal of PCB-containing products (EPA 2020).

In May of 2006, there was a fish advisory issued for carp in Utah Lake based on samples collected in November 2005 (Wingert 2008). The filet (muscle) samples collected in 2005 had an average concentration of 47.8 parts per billion (ppb), also equivalent to mg/kg for total PCBs, and the offal (internal organ) samples had an average concentration of 139 ppb, which is higher than the EPA's cancer screening level of 20 ppb (Wingert 2008). This exceedance drove the first fish advisory in 2006 (Wingert 2008). Following the initial sampling for PCBs in fish in Utah Lake, another sample was taken in June 2006 to measure PCB concentrations in fish. The mean results of that study further demonstrated elevated concentrations in numerous fish species.

3.9.4.4 Regulatory Framework

- Clean Water Act of 1972

3.9.5 Hydrology and Geohydrology

3.9.5.1 Area of Analysis

The area of analysis includes Utah Lake, the Jordan River downstream from Utah Lake, and the basin draining to Utah Lake (Figure 13).

3.9.5.2 Utah Lake Water Balance

There have been several efforts to develop a water balance for Utah Lake through the years. Here the independent development of a water balance is described for comparison with previous efforts. The water balance is summarized in Table 22.

3.9.5.2.1 Inputs

The inputs analyzed in this water budget are major tributaries monitored by the USGS, wastewater outfall estimates, groundwater seeps and springs, precipitation, and stormwater runoff. The total estimated water input to Utah Lake was estimated to be 747,997 AF.

Table 22. SWCA Water Balance Summary

		Date Ranges	Number of Years	Monthly Averages of Inflows and Outflows (acre-feet)													
				Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**	**Percentage Total (%)**
Inflows	Gaged tributaries	1975–2021	46	17,274	20,200	26,712	37,670	68,471	46,787	11,006	6,448	7,850	16,961	16,429	16,677	292,484	39%
	Ungaged tributaries	1980–2003	23	10,800	11,700	13,000	9,400	7,500	6,100	4,800	4,900	5,800	8,200	9500	9,600	101,300	14%
	NPDES outfalls	2020	1	4,317	4,317	4,517	4,417	5,017	5,317	5,517	5,617	5,317	4,917	4,517	4,417	58,207	8%
	Groundwater	1980–2003	23	7,000	8,100	10,300	11,700	25,100	22,600	12,300	14,600	17,800	13,200	9,100	13,600	165,400	22%
	Precipitation	1980–2014	34	12,598	12,848	11,325	13,254	15,105	7,750	5,438	6,196	9,764	12,979	10,683	12,666	130,606	17%
Monthly Total Inflows				**51,989**	**57,165**	**65,854**	**76,441**	**121,193**	**88,554**	**39,061**	**37,761**	**46,531**	**56,257**	**50,229**	**56,960**	**747,997**	
Outflows	Utah Lake dam releases	1935–1991	56	11,344	14,109	16,171	19,693	36,430	42,266	45,870	42,040	33,216	15,059	9,568	10,265	296,032	46%
	Evaporation	1920–2020	100	0	9,421	15,362	24,496	35,181	46,141	51,206	43,733	27,794	16,853	7,269	0	277,454	43%
	Groundwater seepage and withdrawal	1980–2003	23	3925	3,125	7,425	7,625	4,325	4,125	8,825	6,225	7,025	7,425	2,425	4,825	67,300	11%
Monthly Total Outflows				**15,269**	**26,655**	**38,958**	**51,814**	**75,936**	**92,532**	**105,901**	**91,998**	**68,035**	**39,337**	**19,262**	**15,090**	**640,786**	
																107,208	AF

National Pollutant Discharge Elimination System (NPDES) outfall estimates are based on the maximum monthly averages allowed by UDWRe and as outlined in the annual Utah Pollutant Discharge Elimination System (UPDES) permit records.

Gaged Tributaries

The USGS maintains several continuous flow monitoring stations surrounding Utah Lake, with gages on four significant tributaries: the Provo River, Hobble Creek, the American Fork River, and the Spanish Fork River. Based on our analysis, gaged surface flows account for approximately 292,484 AF of water into Utah Lake annually (39% of the total input). This estimation is similar to UDWRi, which estimates an average inflow (1983–2000) of 308,692 AF to Utah Lake (Larsen 2021).

Ungaged Tributaries

For this analysis, surface water inputs from Mill Race Creek, Spring Creek, Benjamin Slough, Powell Slough, Dry Creek (south of Provo Bay), Mill Pond, White Lake Overflow, Big Dry Creek, Little Dry Creek, and Minnie Creek were used to estimate the total discharge of ungaged tributaries to Utah Lake. These estimates are based off the natural stream flows reported in PSOMAS and SWCA (2007) and do not include discharge estimates from National Pollutant Discharge Elimination System (NPDES) outfalls. We estimate that ungaged tributary flow accounts for approximately 101,300 AF annually (14% of the total inflow into Utah Lake).

National Pollutant Discharge Elimination System Outfalls

Several of Utah Lake's tributaries are affected by wastewater discharge: Mill Race Creek, Dry Creek, Spring Creek, the Powell Slough Waterfowl Management Area, and Benjamin Slough of the Utah Lake Wetlands Preserve. The estimates provided in this water budget are based upon maximum daily discharge estimates, as determined by WWTP permits filed with UDWQ. Based on our analysis, NPDES outfalls contribute approximately 58,207 AF annually (8% of the total inflow into Utah Lake).

Groundwater

Groundwater input to Utah Lake can vary greatly based on precipitation averages, surface flows, and surface permeability. Groundwater discharge estimates range from 116,700 (Cederberg et al. 2009) to 196,600 (PSOMAS and SWCA 2007) AF annually. The estimates provided in this water budget, 165,400 AF annually (22% of the total inflow into Utah Lake) are based on the data provided in the PSOMAS and SWCA (2007) report, which is the most comprehensive, publicly available dataset of monthly groundwater averages.

Precipitation

Sources estimate that direct precipitation to the lake varies between 87,410 AF (von Stackelberg and Su 2020) to 128,000 AF (PSOMAS and SWCA 2007), or approximately 15% of the overall inflow to Utah Lake (PSOMAS and SWCA 2007). For the purpose of this analysis, monthly mean precipitation values were calculated from the National Oceanic and Atmospheric Administration (NOAA) Climate Data Online portal using the weather station based in Provo, UT. The station (COOP:427064) is located on the eastern shore of Utah Lake and has a comprehensive dataset dating back to 2005. These averages were multiplied by the surface area of the lake to estimate the precipitation input for this water budget. Monthly mean precipitation rates multiplied by monthly mean surface area gives a monthly average of precipitation volume falling directly over the lake. This equates to an annual average of 130,606 AF of precipitation or roughly 17% of the total inputs to the water budget. This estimate is similar to PSOMAS and SWCA (2007).

Stormwater

Stormwater runoff includes surface runoff from drains, irrigation ditches, and unmonitored tributaries. While it is known that some canals within the Utah Lake Basin have stormwater inputs that are directly integrated to the canal diversion flows, the exact magnitude of these flows are not known at this time. Currently, only the City of Provo has a separate stormwater plan and report available for review. The remaining municipal stormwater discharges within the area operate under a general permit for municipal separate storm sewer systems (MS4) for small operators, and stormwater discharges are not required to be monitored (PSOMAS and SWCA 2007).

3.9.5.2.2 Outputs

The two primary sources of water output from Utah Lake are evaporation and surface flow into the Jordan River. These sources account for approximately 42% and 51% of the total lake output, respectively (PSOMAS and SWCA 2007). Additional sources of water withdrawal include groundwater percolation and surface water withdrawals for beneficial use such as municipal and industrial (M&I) withdrawal and agricultural and irrigation withdrawal.

Estimated Evaporative Loss

Average evaporation from Utah Lake is difficult to measure and has been estimated to be 201,000 (UDWRe 2014), 349,800 (PSOMAS and SWCA 2007), and 380,000 (Morgan 1993) AF per year. For the purposes of this water budget analysis, historic and accurate data were accessed from the closest weather station available from the National Oceanic and Atmospheric Administration (NOAA) Climate Data Online portal. From this weather station’s data, R software was used to compute the mean monthly evaporation rates. These rates were then applied to the mean monthly surface area estimates for the lake. This process provides a mean monthly volume output of 277,454 AF (53% of the total output) for evaporation. An analysis by von Stackelberg and Su (2020) found that estimates vary widely depending on which model for calculating evaporation is used, and that a method that incorporates air temperature, wind speed, relative humidity, solar radiation, and lake water temperature (Penman-Monteith McJannet) yields higher estimates. This is being further assessed as part of the ongoing lake circulation modeling (see section 3.9.5.3).

Surface Discharges

The Jordan River is Utah Lake's only surface water outflow. The outflow has been estimated to represent an annual average of 308,000 (UDWRe 2014) to 428,200 (PSOMAS and SWCA 2007) AF (approximately 51% of the total lake discharge). The flow of the Jordan River is regulated at Turner Dam, which is located 41.8 miles from the river’s mouth (at Great Salt Lake) within a section of the river known as the Jordan Narrows. Turner Dam diverts water to the East Jordan and Salt Lake Canals (Hooton 1989). A gage located at the dam is currently the closest source of continuous flow data. However, the dataset only dates back to 2017 and, therefore, only reflects recent hydrologic conditions. UDWRe estimated annual average discharge was considerably lower when compared to other data sources. From 1935 to 1991, the flow for the Jordan River was recorded at a historic USGS gaging station (#10167000) at the Jordan Narrows and at canals that bypass the gage, including the Utah and Salt Lake Canal and the East Jordan Canal. The gage is no longer operable; therefore, estimations based on this dataset alone do not reflect hydrologic conditions from the last 30 years. The UDNR uses this dataset to estimate the discharge of the Jordan River (UDWRe 2014). The Utah Lake Water Quality Salinity Model (LKSIM) includes past USGS data and more recent data from the Jordan River Commission's report to estimate annual discharge (PSOMAS and SWCA 2007). The 2020 distribution report estimates an average of 276,406 AF per year from 1986 to 2020 (Larsen 2021). After comparing data from multiple sources, we determined that the data from the historic USGS gaging station (#10167000) is a conservative estimate of average annual discharge (296,032 AF), and this is the value included in this water budget analysis.

Percolation and Subsurface Outflows

Percolation, or seepage into groundwater, accounts for 2,500 (Cederberg et al. 2009) to 5,500 AF (Gardner 2009) annually. It is estimated that an additional 2,000 to 3,300 AF of subsurface flows leave Utah Lake annually from unconsolidated rock and basin-fill deposits. This analysis included an annual average discharge of 5,100 AF based on the groundwater flow model of northern Utah Valley (Cederberg et al. 2009) and the conceptual groundwater budget for 2004 (Gardner 2009).

Withdraws for Beneficial Use

Groundwater withdrawal is a primary source for drinking, irrigation, agricultural, and industrial water resources and is accessed via wells and diversion canals. Direct withdrawal for beneficial use is estimated to be between 52,000 (UDWRe 2014) and 61,000 AF (Cederberg et al. 2009) annually. For this analysis, we included the monthly averages for "Other Outflows" provided in the PSOMAS and SWCA report (2007), which include monthly estimates for groundwater withdrawals and closely align with the estimates reported in Cederberg et al. (2009). Groundwater seepage and subsurface flow estimates were combined with these monthly totals for this analysis (67,300 AF, or 11% of the total Utah Lake output).

3.9.5.3 Lake Circulation, Current Conditions

Water circulation in a lake has implications for water temperature and water quality. For example, understanding mixing patterns that occur near tributaries or other inputs can inform focus areas for management and water quality improvement. Water circulation in Utah Lake is impacted by tributary currents as well as winds, including wind-driven waves. This section describes modification and use of a water circulation model to better understand water circulation patterns in the lake under current conditions.

3.9.5.3.1 Lake Model, Current Conditions

Background

The Environmental Fluid Dynamics Code (EFDC) model described in von Stackelberg and Su (2020) was acquired from the state of Utah and then modified. The model was updated with boundary condition data to run from October 1, 2017, to September 1, 2020.

Model Update

The existing EFDC water circulation model was updated to better understand current conditions in the lake. The model grid was modified to use a higher resolution, with grid cells of 250 × 250 m (compared with the original model grid, which uses 1 × 1–kilometer cells). The updated model uses five vertical layers of equal thickness. The updated model was run using the DSI, LLC version of the EFDC model, version 10.3 (DSI 2021).

Preliminary Assessment of Lake Circulation

Preliminary modeling of water age (length of time since the water entered the lake from a tributary, WWTP, or precipitation) indicates that the "newest" water is concentrated on the east side of the lake (in particular, Provo Bay). This is because the major tributaries (in particular, the Provo River, the Spanish Fork River, and Hobble Creek) all enter the eastern portion of the lake. Provo Bay includes the location of one of the major tributaries (Hobble Creek) and several smaller tributaries (Mill Race Creek and Dry Creek). The flows of the Provo City, Spanish Fork, and Springville WWTPs enter Utah Lake via tributaries into Provo Bay. Provo Bay is shallow in depth. The combination of significant flow and shallow depth allows relatively fast mixing and exchange in Provo Bay.

Overall, the preliminary modeling results can be summarized as follows:

- Tributary inflows are concentrated on the eastern portion of the lake, including Provo Bay, and are primarily mixed along the northwest-southeast axis due to winds.
- Provo Bay has some of the newest water in the lake due to its shallow depth and significant tributary inputs; however, this is not indicative of good water quality.
- The southern portion of the lake, including Goshen Bay, experiences relatively little mixing with the northern portion of the lake.

3.9.6 Aquatic Resources

3.9.6.1 Area of Analysis

The area of analysis for aquatic resources is defined as the Project boundary plus a 500-foot buffer, as well as the select areas that extend beyond the 500-foot buffer to encompass the potential causeway tie-in areas. The wetland desktop assessment boundary area is 146,246.90 acres. With the 500-foot buffer applied, the acreage expands to 151.959.28 acres, or approximately 239 square miles. The area of analysis was based on the extent of fringe wetlands in desktop references (Figure 17).

3.9.6.2 Method

A GIS desktop assessment of wetlands using Esri's ArcGIS was completed within a predetermined area of analysis surrounding Utah Lake. The GIS desktop assessment was conducted to identify potential water resources associated with wetlands, streams, seeps/springs, water bodies, and other WOTUS and/or state to be further supported by ground-truthing of the results with pedestrian field verifications. The desktop assessment used a variety of publicly available datasets and remote sensing technologies that consist of the following:

- USGS 1:24,000 quadrangles
- LiDAR-derived digital elevation model or digital terrain model backgrounds
- Image classification and multispectral analysis using current and historical high-resolution visible and infrared aerial imagery and georeferenced aerial photography
- USFWS National Wetlands Inventory (NWI)
- Utah State Geographic Information Database wetlands
- USGS National Hydrography Dataset flowlines and water bodies
- USDA Natural Resources Conservation Service soil series and hydric soils
- Federal Emergency Management Agency National Flood Hazard Layer
- USGS GAP/LANDFIRE National Terrestrial Ecosystems and National Land Cover Database land cover datasets
- Antecedent Precipitation Tool, National Weather Service NOAA Online Weather Data Climatic Summary, and United States Drought Monitor
- UDWR Utah Lake contents

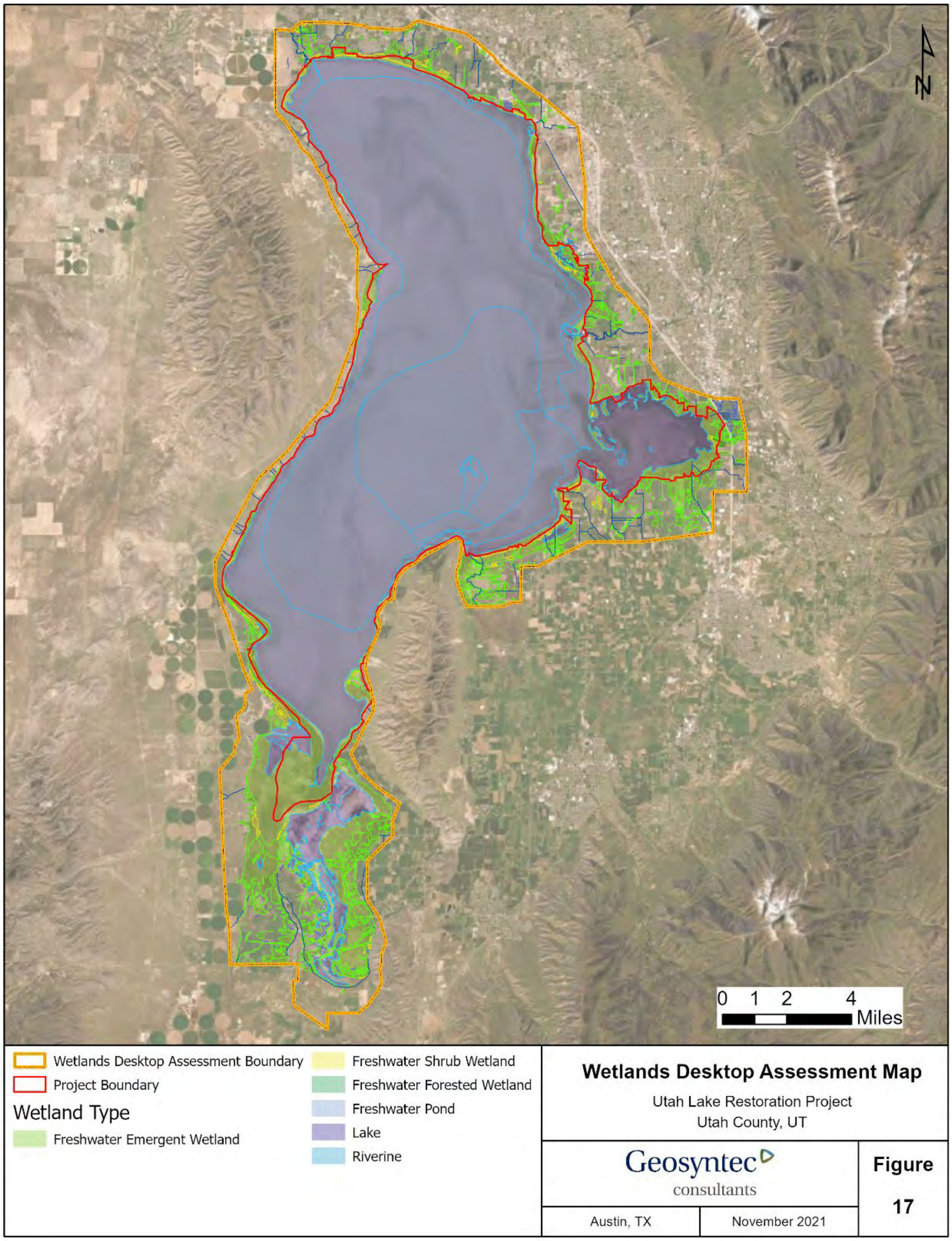

Figure 17. Wetland Desktop Assessment Map

3.9.6.3 Wetlands Adjacent to Utah Lake

The wetland assessment resulted in the wetland types summarized in Table 23.

Table 23. Summary of Wetland Types Identified in the Desktop Assessment within the Study Area

Wetland Type	Acres
Freshwater Emergent Wetland	21,371.48
Freshwater Forested Wetland	32.37
Freshwater Pond	327.31
Freshwater Shrub Wetland	910.07
Lake	89,212.84
Riverine	210.06
Total	112,064.14

Adopted by the USFWS in 1979, the NWI code is based on the *Classification of Wetlands and Deepwater Habitats of the United States* developed by Cowardin, which serves as the national mapping standard for classifying wetlands and deepwater habitats (Cowardin et al. 1992). During the desktop assessment, each wetland polygon was mapped and assigned an NWI mapping convention that classifies the wetland type. Table 24 details the wetland types from the desktop assessment.

Table 24. NWI and Cowardin Classification Results of the Wetlands Desktop Assessment

Wetland Type	Common Description	NWI Code*	Cowardin Classification (System, Subsystem, Class)	Acres
Lake	Deepwater lake	L1UB (G,H)	Lacustrine, limnetic, unconsolidated bottom	63,039.04
Lake	Shallow lake marshes	L2AB (F,H)	Lacustrine, littoral, aquatic bed	22,685.79
Lake	Shallow lake	L2UB (F)	Lacustrine, littoral, unconsolidated bottom	32.85
Lake	Dry alkaline lake beds	L2US (A,C,F)	Lacustrine, littoral, unconsolidated shore	3,455.16
Freshwater Pond	Deep basins, impoundments, sewage treatment ponds, beaver ponds	PAB (F,G,K)	Palustrine, aquatic bed	111.55

Wetland Type	Common Description	NWI Code*	Cowardin Classification (System, Subsystem, Class)	Acres
Freshwater Pond	Open water, gravel pits	PUB (F)	Palustrine, unconsolidated bottom	90.42
Freshwater Pond	Salt flats	PUS (A,C,K)	Palustrine, unconsolidated shore	125.34
Freshwater Emergent Wetland	Sparsely vegetated playas, salt flats	PEM1/US (A)	Palustrine, emergent persistent / unconsolidated shore	89.23
Freshwater Emergent Wetland	Basins, depressions, marches, meadows, springs, seeps, or vegetated drainage areas	PEM1 (A,B,C,F)	Palustrine, emergent persistent	21,282.25
Freshwater Forested Wetland	Cottonwood, riverbanks, floodplains, or drainage areas	PFO (A)	Palustrine, forested	32.37
Freshwater Shrub Wetland	Willow thicket, riverbanks or drainage areas	PSS (A,C)	Palustrine, scrub-shrub	910.07
Riverine	Meandering rivers, low gradient	R2UB (G,H)	Riverine, lower perennial, unconsolidated bottom	55.25
Riverine	Small streams, creeks, or irrigation ditches	R4SB (C)	Riverine, intermittent, streambed	112.45
Riverine	Irrigation ditches	R5UB (F,H)	Riverine, unknown perennial, unconsolidated bottom	42.36
Total				**112,064.13**

* Water Regime Modifiers are identified in parenthesis: A = Temporary Flooded, B = Seasonally Saturated, C = Seasonally Flooded, E = Seasonally Flooded/Saturated, F = Semipermanently Flooded, G = Intermittently Exposed, H = Permanently Flooded, K = Artificially Flooded.
** NWI Codes are generally defined in the Cowardin Classification column
L2UB

3.9.6.4 Wetland Verification

Geosyntec performed a WOTUS delineations of the Project in accordance with the three-parameter method outlined in the 1987 USACE Wetlands Delineation Manual (Manual; Environmental Laboratory 1987); the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region Version 2.0 (Environmental Laboratory, 2008); and recent guidance issued jointly by the EPA and the USACE that resulted from the Rapanos vs. United States and Carabell vs. United States Supreme Court decisions (Rapanos, et al. 2006, Carabell et al. 2005). The detail of the Wetland Verification is provided in the Wetland Delineation Report (Appendix B). Table 25 provides a summary of the results of the Wetland Verification.

Table 25. Wetland Verification Results

Wetland Type	Verified Wetlands (acres)
Palustrine Emergent (PEM)	26,766
Palustrine scrub-shrub (PSS)	523
Palustrine forested (PFO)	89
Freshwater Pond	337
Open Water	84,448
Riverine	213

3.10 Air Quality and Climate

Air Quality is described in this section, including the area of analysis, method of review, affected resource and regulatory framework. The section focuses on air quality in the Southern Wasatch Front.

3.10.1 Resource Indicators and Measures

3.10.1.1 Air Quality

Air quality is determined by the concentrations in ambient air of pollutants that can be harmful to public health and the environment. Specifically, EPA has identified six criteria air pollutants to function as air quality indicators: carbon monoxide, ground-level ozone, particulate matter, sulfur dioxide, nitrogen dioxide, and lead. National Ambient Air Quality Standards (NAAQS) for each criteria air pollutant are set by the EPA, as required by the Clean Air Act, and are codified in Title 40 of the CFR, Part 50 (40 CFR 50). Current primary and secondary NAAQS are identified in Table 26.

Table 26. National Ambient Air Quality Standards

Pollutant	Averaging Time	Standard Type	Standard	Form
Carbon dioxide	1 Hour	Primary	35 ppm	Not to be exceeded more than once per year
	8 Hour	Primary	9 ppm	Not to be exceeded more than once per year
Ozone	8 Hour	Primary and Secondary	0.070 ppm	Annual fourth highest daily maximum 8-hour concentration, averaged over 3 years
PM10	24 Hour	Primary and Secondary	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
PM2.5	24 Hour	Primary and Secondary	35 µg/m^3	98th percentile, averaged over 3 years
	Annual	Primary	12 µg/m^3	Annual mean, averaged over 3 years
	Annual	Secondary	15 µg/m^3	Annual mean, averaged over 3 years
Sulfur dioxide	1 Hour	Primary	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	3 Hour	Secondary	0.5 ppm	Not to be exceeded more than once per year
Nitrogen dioxide	1 Hour	Primary and Secondary	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Annual	Primary and Secondary	0.053 ppm	Annual mean
Lead	3 Month	Primary and Secondary	0.15 µg/m^3	Not to be exceeded

µg/m3: micrograms per cubic meter
PM: particulate matter
ppb: parts per billion
ppm: parts per million

3.10.1.2 Climate Change

Climate change is most commonly quantified by the average temperature increase of the planet and is linked to increasing concentrations of greenhouse gases (GHGs) in the atmosphere. As climate change is a long-term global concern, the direct impacts to climate change from discrete projects are not quantifiable. Therefore, the GHG emissions from projects function as an indicator for climate change. GHG emissions from potential sources are estimated using engineering calculations and/or emissions models.

3.10.2 Area of Analysis

For the purposes of air quality analyses, the Project's area of analysis is the Southern Wasatch Front. The Southern Wasatch Front is Utah's recommended attainment area for the Project location and includes the parts of Utah County that lie in the valley west of the Wasatch Mountains (Figure 18).

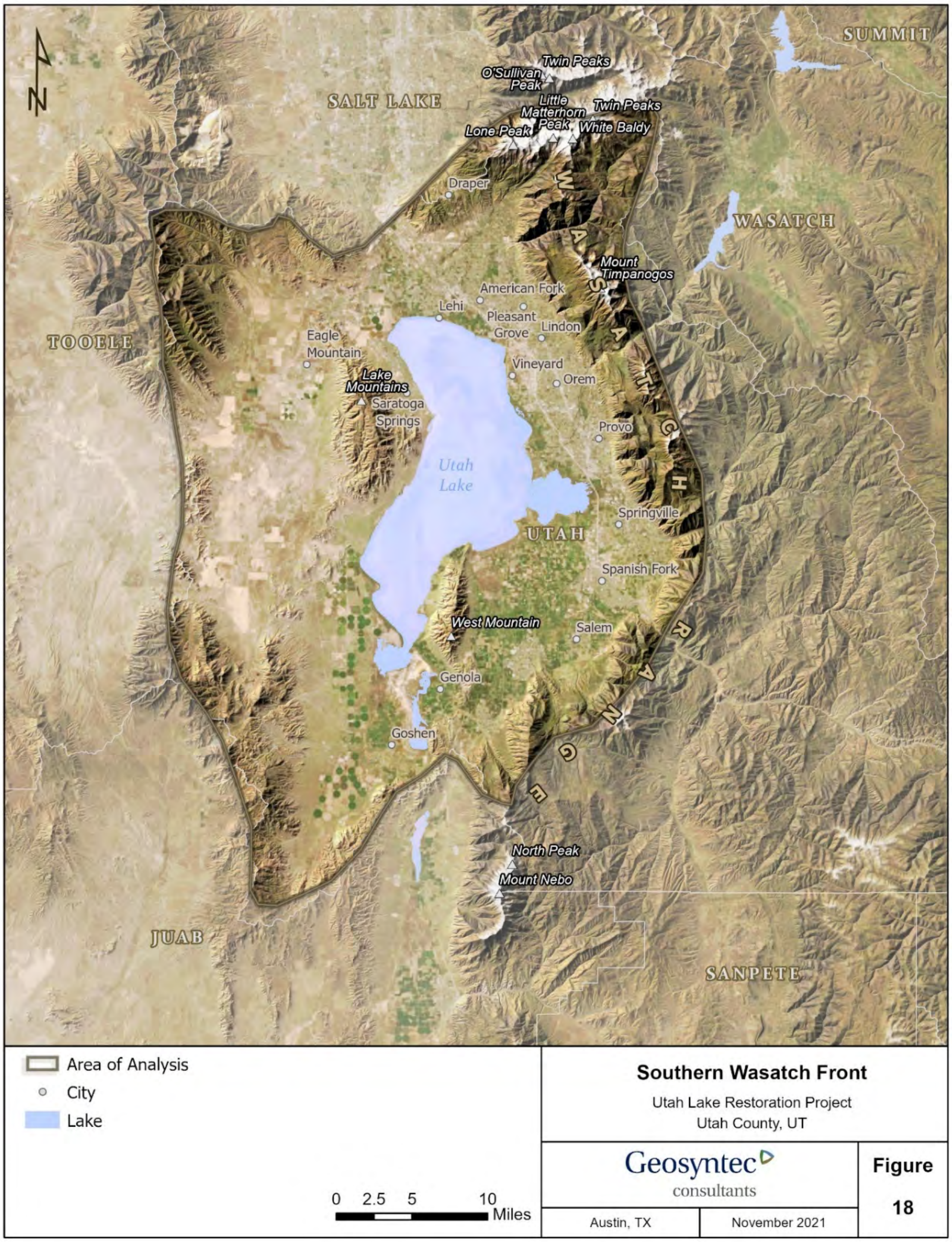

Figure 18. Southern Wasatch Front

3.10.3 Method

3.10.3.1 Construction Emissions

Potential construction emissions from the Project are anticipated to be associated with combustion-driven vehicles and construction equipment, and construction activities. Vehicle and construction equipment emissions are estimated using the EPA Motor Vehicle Emission Simulator (MOVES) modeling system. Emissions are modeled based on the anticipated types, ratings, counts, and operating schedules of vehicles and construction equipment throughout Project construction. Potential emissions from Project construction activities are estimated using emissions estimation guidance for heavy construction operations provided by the EPA in AP-42, Compilation of Air Pollutant Emission Factors, Chapter 13, Section 13.2.3.

3.10.3.2 Operating Emissions

As the Project does not include specific requirements or restrictions regulating factors such as the number of cars or businesses allowed after construction, emissions specific to the Project cannot be quantified. Operating emissions will be estimated based on the current average per capita emission rate in the state of Utah.

3.10.3.3 Air Quality Analysis

It is almost certain that the state of Utah, and more specifically the Utah Division of Air Quality (UDAQ), will require an air quality analysis for estimating potential air quality impacts and assessment of control strategies employed to minimize these impacts that will include air quality modeling. The UDAQ currently publishes an emissions impact assessment guideline which documents the steps necessary for a proper analysis in the state of Utah. While the details of this assessment depend on many factors currently unknown, the steps include:

- Estimate the emissions from the project to determine level of assessment required.
- If modeling is required, provide UDAQ with a modeling protocol which provides details regarding relevant details of the proposed assessment. This document must be approved before any assessment results can be submitted to UDAQ.
- Perform modeling per the protocol document and submit a modeling report to UDAQ with results.

3.10.3.4 Climate Change Analysis

Potential GHG emissions associated with construction, however, are unique to the Project and potential climate change impacts from construction will be analyzed. Potential GHG emissions from Project construction are associated with fuel combustion in vehicles and construction equipment. The method for estimating construction emissions, including GHGs, is presented in Section 3.10.3.1.

The net potential GHG emissions associated with proposed Project include the temporary increase in GHG emissions associated with construction activities as well as the long-term reduction in eutrophication-related GHG emissions associated with Utah Lake enhancement. Additional analysis of the Project's effects on GHG emissions is warranted.

3.10.4 Affected Resources

3.10.4.1 Ambient Air Quality

Representative ambient air quality within the Southern Wasatch Front is summarized below in Table 27.

Table 27. Southern Wasatch Front Ambient Air Quality

Criteria Pollutant	Standard	Ambient Air Concentration			Current Attainment Status
		Lindon	Spanish Fork	Maximum	
carbon monoxide	8-Hour	0.9 ppm	--	0.9 ppm	Attainment (Maintenance)
	1-Hour	2 ppm	--	2 ppm	Attainment (Maintenance)
Ozone	8-Hour	--	0.070 ppm	0.070 ppm	Non-attainment (Marginal)
PM10	24-Hour	80 $\mu g/m^3$	--	80 $\mu g/m^3$	Attainment (Maintenance)
PM2.5	1-Year	7 $\mu g/m^3$	7 $\mu g/m^3$	7 $\mu g/m^3$	Non-attainment (Serious)
	24-Hour	--	30 $\mu g/m^3$	30 $\mu g/m^3$	Non-attainment (Serious)
Nitrogen dioxide	1-Hour	40 ppb	40 ppb	40 ppb	Attainment
	1-Year	8 ppb	7 ppb	8 ppb	Attainment
Criteria Pollutant	**Standard**	**Representative Ambient Air Concentration**			**Current Attainment Status**
		Copperview			
Sulfur dioxide	1-Hour	4 ppb		4 ppb	Attainment/ Unclassifiable
	3-Hour	0.001 ppm		0.001 ppm	Attainment/ Unclassifiable

$\mu g/m^3$: micrograms per cubic meter
PM: particulate matter
ppb: parts per billion
ppm: parts per million

3.10.4.2 Air Quality Standard

The Project has the potential to impact ambient air concentrations within the Southern Wasatch Front. As such, it is then required that the Project not exceed any existing air quality standard within the region, either by demonstrating insignificant emission rates for the Project or by an air quality analysis.

3.10.4.2.1 Criteria Pollutants

The first step in determining potential impact to any air quality standard is to determine the various pollutant emissions from the Project. If all pollutant predicted impacts from the Project-alone modeling are below the respective significant impact levels above, the Project requires no further modeling. However, should any of these significant impact levels be exceeded by the Project's predicted air quality impacts, then a cumulative modeling analysis for comparison to the NAAQS would then be required for each exceedance on pollutant and averaging time basis.

3.10.4.2.2 Hazardous Air Pollutants

As with criteria pollutants, it is required that the Project report all potential hazardous air pollutants emitted, and the quantities of these potential emissions. If modeling results for any hazardous air pollutants are shown to have ambient concentration levels greater than the toxic screening level for any hazardous air pollutant, submittal of additional information for evaluation by UDAQ is necessary.

3.10.4.3 Climate Change

The Project has the potential to influence the regional contribution to global climate change though direct and indirect changes to the production of several GHG pollutants within the Southern Wasatch Front. Initially, the Project has the potential to emit measurable quantities of GHGs during the initial construction phase that will likely add to the region's overall GHG emissions, mainly in the form of carbon dioxide emissions from large construction and marine engines.

Once the construction period is finished, however, potential sources of GHG emissions from Project operation include, but are not limited to, transportation, utilities, private businesses, and residential activities. This stands to lend a large regional benefit to the GHG budget of the region by providing the most up-to-date and efficient means of productivity through all of these large-scale processes, therefore reducing the per-capita GHG for the entire Wasatch Front. Further, with the anticipated enhancement of Utah Lake to a vibrant natural ecosystem, this will result in a massive decrease in atmospheric methane, as Utah Lake will no longer be a 96,000-acre producer of methane from the current extensive eutrophic algal blooms.

3.10.5 Regulatory Framework

3.10.5.1 Federal Regulations

- NEPA (42 U.S.C. § 4321-4347)
- Clean Air Act of 1963 (42 U.S.C. § 7401 – 7671q)
- Clean Air Act, NAAQS (42 U.S.C. §7409 and 40 CFR Part 50)
- Clean Air Act, Hazardous Air Pollutants (42 U.S.C. § 7412)
- Clean Air Act, General Conformity (Section 176(c)). General Conformity Rule (40 CFR Part 93, Subpart B)
- Clean Air Act, Prevention of Significant Deterioration (42 U.S. C. §7470-7492)
- Clean Air Act, Prevention of Significant Deterioration, Visibility (42 U.S.C. § 7491-7492)
- Regional Haze Rule (Section 169A of Clean Air Act) (40 CFR Parts 51 and 52); Federal Implementation Plan for Visibility (77 FR 23988)
- Clean Air Act, Prevention of Significant Deterioration, Acidic Deposition 42 U.S.C. §7651-7651o)
- Clean Air Act, Regulation of Pollutant Concentrations Including Nitrogen Dioxide

3.10.5.2 State Regulations

- Utah Air Quality Regulations (Utah Administrative Code, Title R307)
- Utah Air Quality Regulations (Utah Administrative Code, Title R307, Section 101)
- Utah Air Quality Regulations (Utah Administrative Code, Title R307, Section 305
- Utah Air Quality Regulations (Utah Administrative Code, Title R307, Section 309, Fugitives for Maintenance Area
- Utah Air Quality Permit Requirements (Utah Administrative Code, Title R307, Sections 401-424.)

3.11 Noise

Noise is described in this section, including the area of analysis, method of review, affected resource and regulatory framework. The section focuses on existing community noise within 1-mile of the Project boundary.

3.11.1 Resource Indicators and Measures

Community noise exposure is typically measured with a sound meter using the "A-weighting" filter, which simulates the sensitivity of the human ear by de-emphasizing low and high frequency sounds. A-weighted sound levels are expressed in units of A-weight decibels (dBA). Estimated noise boundary levels from Project dredging, construction, maintenance, and operation will serve as an indicator of noise impacts.

3.11.2 Area of Analysis

The area of analysis for noise is within a 1-mile buffer of the Project boundary. This area of analysis was chosen because it encompasses the area within and around Utah Lake that is most likely to be affected by the Project.

3.11.3 Method

The method for analyzing potential noise impacts in and around Utah Lake focuses on noise studies related to the equipment list for Project dredge, construction, and estimated noise levels: (1) within a short-distance radius of aquatic construction equipment (e.g., dredgers) for potential impacts to marine biology and (2) at municipal boundaries and sensitive terrestrial receptors bordering Utah Lake.

3.11.4 Affected Resources

3.11.4.1 Noise Background

The area of analysis contains a mix of public lands (approximately 13,422 acres in land and approximately 95,500 acres for the bed of Utah Lake) and private lands (approximately 44,067 acres). The majority of private lands is zoned for agricultural uses (approximately 31,013 acres), particularly in western, southern, and southeastern regions bordering the lake. Within the area of analysis, the most-developed regions encompass the northwestern shoreline (from Saratoga Springs) and span eastward to Springville, southeast of Provo Bay. These developed regions constitute the majority of the private residential (approximately 6,496 acres) and commercial/industrial (approximately 4,975 acres) zoning.

Existing noise sources within the area of analysis consist of four general types: agricultural, recreational, general stationary, and general mobile. Agricultural, recreational, and general stationary noise sources are subject to local noise ordinances.

3.11.4.2 Noise Sources

The sources of noise related to the Project are anticipated to include in-water dredgers, a variety of heavy equipment at some locations on the shorelines creating beaches, docks, and access points to the water; trucks providing off-site supplemental material (e.g., gravel, rock, riprap) and delivering supplies (e.g., geotubes or other containment supplies); and other related equipment.

3.11.4.3 Noise-Sensitive Land Uses and Receptors

Noise-sensitive land uses include places where tranquility and quiet are an essential element of the land use's intended purpose (e.g., residential zoning). Noise-sensitive receptors include population groups whose activities and/or health are dependent upon tranquility and quiet. Aquatic species may also experience impacts from construction noise. To better assess potential aquatic species effects associated with dredge specific noise impacts from dredging activities, a field investigation to characterize sounds emitted by bucket, hydraulic cutterhead, and hopper dredge operations may be warranted.

3.11.5 Regulatory Framework

3.11.5.1 Federal Regulations

- NEPA (42 U.S.C. § 4321-4347)
- Noise Control Act of 1972 (42 U.S.C. § 4901)
- Quiet Communities Act of 1978 (42 U.S.C. § 4901)

3.11.5.2 State Regulations

Utah has statewide regulations for occupational noise, but not for community noise. Community and general construction noises are regulated at the county and municipal level.

3.11.5.3 County and Municipal Ordinances

- Utah County Code (U.C.C §12-1-2(e))
- Utah County Code (U.C.C. §17-5-3)
- City of Saratoga Springs Municipal Code (C.S.S.M.C §10.10.06.1-10.10.06.2)
- City of Lehi (L.C.C. §5-3-1 - 5-3-7)
- City of American Fork (A.F.M.C. §9.15.010(B))
- City of Pleasant Grove (P.G.C.C. §5-2B-1)
- City of Pleasant Grove (P.G.C.C. §10-15-29(K))
- City of Lindon (L.C.C. §8.20.030.2u)
- City of Vineyard (V.M.C. §8.08.010(C)2p)
- City of Orem (O.C.C § 9-2-9B)
- City of Provo (P.C.C §9.06.010-9.06.040)

- City of Springville (S.C.C. §8-2-101)
- Town of Genola (T.G.M.C §20.11.10)

4 DESCRIPTION OF PROPOSED ACTIVITY

The Project includes hydraulic and/or mechanical dredging approximately 62,400 acres within the lake with an average increased depth of 7 feet, below the Comprise Line level of 4,489.045 feet (lake full level, not mud line level). The dredge depths will vary and could range from 3 feet to 35 feet. The dredging will remove an estimated 957,710,915 cubic yards of new dredged material and be placed into 34 constructed containment areas totaling approximately 18,000 acres. The dredging acreage and volume estimates provided above do not include the areas where the containment areas will be located and assume these areas will be used as the base for the containment areas. Some material within the location of the containment areas may be removed and mixed with new dredge material or imported material to make it suitable for development.

The dredging will remove nutrient loaded sediment from the lake bottom and place it in containment areas for the beneficial uses of sequestering phosphorus, nitrogen, TDS, and other constituents out of the lakebed and water column; providing additional shoreline for littoral planting and wildlife usage; and development including single-family and multi-family residential, commercial/ retail, mixed use, amusement/ hospitality, public/ institutional, cultural, recreation, and open space land uses.

4.1 Containment Areas/Islands

The containment areas will be formed with sediment-filled geotextile tubes outlining the islands and infilled with dredged sediment. The containment areas will be developed as multiple islands to ensure water circulation and aquatic movement throughout the lake. Additionally, the containment areas will reduce the surface area of the lake by approximately 20% to reduce evaporation and conserve water to increase water supply for the state.

Containment area islands will dramatically increase the amount of shoreline habitat available to native plant and animal species, and the riparian and littoral zones created around the islands will increase the lake's littoral zones significantly. The placement and topography of each island have been modeled to provide ecological conservation and improved water quality.

The three types of containment areas/islands include estuary islands, recreation islands, and development islands.

- Estuary islands will be strategically placed to provide wind and wave shelter to allow restoration of submerged aquatic vegetation (SAV) in the littoral zones positioned between the estuary islands and lake shoreline, protect wetlands and riparian areas from shearing effects of the lake's ice flows, and provide habitat for birds and animals.
- Recreation islands will provide areas to boat, relax, picnic, recreate, or camp. Recreation islands will serve a key conservation role, will be accessible to the public, and some may

offer low cost overnight stay opportunities. Recreation island shoreline will include the addition of sand beaches and possibly gravel beaches. The recreation islands will also be populated with native flora and fauna.

- Development islands provide the funding mechanism to enable the ecosystem restoration and enhancement. They will be developed for single-family and multi-family residential, commercial/retail, mixed use, amusement/hospitality, public/institutional, cultural, recreation, and open space land uses using environmentally sustainable development practices. These new communities will also provide additional housing for the growing population of Wasatch Front, including attainable housing.

Table 28 identifies each of the containment areas with a containment area ID, area in acres, perimeter in feet and miles, primary intended use, anticipated construction phase, estimated amount of fill in cubic yards, whether special aquatic sites are known to be present, and the latitude and longitude of the containment area center point.

Table 28. Containment Areas

Containment Area ID	Area (AC)	Perimeter (ft)	Perimeter (mi)	Primary Intended Use	Construction Phase	Estimated Fill (CY)*1	Special Aquatic Site Present (Yes/No)*2	Latitude	Longitude
Estuary Islands									
E1	160.18	16,976	3.22	Estuary	3	8,527,751	No	40.345092	-111.821301
E2	121.94	14,564	2.76	Estuary	3	6,491,837	No	40.349439	-111.847585
E3	41.68	8,483	1.61	Estuary	4	2,218,849	No	40.327099	-111.887563
E4	69.86	10,999	2.08	Estuary	4	3,719,336	No	40.314322	-111.878966
E5	35.48	6,385	1.21	Estuary	4	1,888,699	No	40.297667	-111.866485
E6	40.94	7,677	1.45	Estuary	4	2,179,837	No	40.287519	-111.858627
E7	139.55	15,558	2.95	Estuary	5	7,429,758	No	40.125006	-111.853152
E8	139.96	13,570	2.57	Estuary	5	7,451,591	No	40.109578	-111.864502
Recreation Islands									
R1	563.95	38,083	7.21	Recreation	4	30,024,538	No	40.334707	-111.857472
R2	174.13	14,571	2.76	Recreation	3	9,270,469	No	40.332391	-111.831361
R3	150.78	20,735	3.93	Recreation	1	8,027,415	No	40.261052	-111.751832
R4	30.23	6,222	1.18	Recreation	4	1,609,487	No	40.194015	-111.819796

Geosyntec consultants

Containment Area ID	Area (AC)	Perimeter (ft)	Perimeter (mi)	Primary Intended Use	Construction Phase	Estimated Fill (CY)*1	Special Aquatic Site Present (Yes/No)*2	Latitude	Longitude
R5	26.78	5,443	1.03	Recreation	3	1,425,561	No	40.170784	-111.8108
R6	67.30	9,806	1.86	Recreation	3	3,583,254	No	40.162985	-111.826017
R7	154.40	21,091	3.99	Recreation	5	8,220,136	No	40.149263	-111.776952
R8	144.66	15,974	3.03	Recreation	5	7,701,560	TBD	40.109742	-111.906859
Development Islands									
D1	1,234.23	79,702	15.10	Development	1	65,710,255	TBD	40.317495	-111.795885
D2	117.81	10,675	2.02	Development	1	6,272,101	No	40.327844	-111.807821
D3	449.78	37,694	7.14	Development	1	23,946,430	No	40.316526	-111.82183
D4	119.39	11,969	2.27	Development	1	6,356,217	No	40.300787	-111.814621
D5	205.99	13,559	2.57	Development	1	10,966,998	No	40.291537	-111.797855
D6	130.51	13,317	2.52	Development	1	6,948,474	No	40.289543	-111.810652
D7	464.47	33,670	6.38	Development	1	24,728,475	TBD	40.286442	-111.778854
D8	170.68	21,528	4.08	Development	1	9,086,829	No	40.27782	-111.789838
D9	35.36	8,474	1.60	Development	1	1,882,687	No	40.278325	-111.769285
D10	2,091.35	67,205	12.73	Development	2	111,343,605	TBD	40.238759	-111.822036
D11	1,771.98	68,247	12.93	Development	2	94,340,202	TBD	40.237967	-111.77756
D12	1,671.96	82,743	15.67	Development	3	89,015,272	No	40.209829	-111.772212
D13	727.21	32,791	6.21	Development	4	38,716,871	No	40.219626	-111.835424
D14	2,605.39	112,661	21.34	Development	4	138,710,895	No	40.189241	-111.842799
D15	1,931.59	68,783	13.03	Development	3	102,837,910	TBD	40.180201	-111.778704
D16	355.36	29,837	5.65	Development	3	18,919,146	TBD	40.164608	-111.807935
D17	894.44	41,903	7.94	Development	5	47,620,029	No	40.129051	-111.897528
D18	949.26	37,471	7.10	Development	5	50,538,444	TBD	40.092683	-111.889832
Total	**17,988.56**	**998,366**	**189.08**			**957,710,915**			

*Notes:
1. Estimated based on preliminary bathymetry and island configuration. Estimate will be refined based on revised island bathymetry and engineering.
2. Special Aquatic Sites Present = TBD will be updated based on findings of Utah State University’s Ecology Center and Watershed Sciences Department 2021 study assessing submerged aquatic vegetation (macrophyte communities) within Utah Lake.

4.2 Docks, Boat Ramps and Beaches

LRS proposes to install docks, boat ramps, and beaches associated with development of the containment areas. The location of these facilities will be specifically identified as part of the planning and engineering of the containment area development after the containment areas are constructed and dewatered. The project assumes that the fill volume and area associated with these facilities is included in the area acreage and fill volumes of the containment areas identified in the impact table above. These facilities will be included in the NEPA assessment. The specific structures are anticipated to be approved by the USACE through a General Permit process.

4.3 Causeways

Access to the containment areas will be by boat or by vehicle/ transit via causeways, bridges, and elevated roadways. The area of impact and fill volumes for the causeways are included in the area acreage and fill volumes of the containment areas identified in the impact table above. It is anticipated that approximately 9.5 miles of causeways, bridges, and elevated roadways will be needed. This includes approximately 5.7 miles of eight-lane roadways, 1.6 miles of four-lane roadways, and 2.1 miles of two-lane roadways. Bridges and elevated roadways will be used in ecologically sensitive areas such as wetlands and areas of SAV. Additionally, water circulation and water quality modeling will also be used to confirm bridge and elevated roadway locations to ensure adequate space for effective water circulation and aquatic movement and the appropriate placement of causeway portions constructed on dredged material containments. Studies will also be completed to assess bridge locations and heights to ensure safe navigation.

5 SITE-SPECIFIC EFFECTS

The beneficial and potential adverse environmental effects of the Project are described below and in the attached documents, including the Wetland Delineation Report. The majority of aquatic impacts associated with the Project are related to dredging and the construction of placement areas and causeways, as discussed above. This section addresses the technical evaluation factors in the 404(b)(1) Guidelines (40 CFR Part 230, Subparts C, D, E, F, and H) and the Public-Interest Review factors (33 CFR § 320.4(a)).

5.1 Biological Resources

5.1.1 Migratory Birds

Utah Lake is located on the eastern edge of the Pacific Flyway, an established migratory path used by birds in the spring and fall (USFWS 2021c). Commercial and residential development within the lake has the potential to disrupt the flyway with increased artificial illumination as well as the elevated threat of bird strikes against the glass of new multi-level buildings. As approximately 7% of the current area of analysis adjacent to the lake includes Developed/Urban Landscape, with an anticipated increase as human populations expand, implementation of the action alternative may also attract wildlife species, including possible predators, from surrounding developed habitat.

LRS is working with Project-specific ornithologists and the USFWS to minimize potential impacts to migratory birds. The Project is being developed to increase and improve bird habitat within Utah Lake. The Project will also implement a dark sky ordinance. The dark sky ordinance will regulate outdoor lighting to reduce light pollution and dangerous glare that can come from over lighting areas while also promoting safety, conserving energy, and protecting the environment for wildlife and astronomy.

5.1.1.1 Western Yellow-Billed Cuckoo

The western yellow-billed cuckoo is a federally listed threatened species as well as a Utah State sensitive species. Western, yellow-billed cuckoos migrate to disjunct fragments of habitat within Utah in late May or early June. These remaining fragments of habitat are the result of significant loss and alteration of Utah's riparian habitat. Riparian habitat loss is considered a primary threat to the stability of the population with water development, urban encroachment, and recreational impacts considered as contributing factors to habitat loss. Where infrastructure connects to the shore it has the potential to impact western yellow-billed cuckoo habitat. However, surveys for western yellow-billed cuckoo habitat will be conducted and infrastructure connections will be designed to avoid impacts to the species, where possible. Potential impacts would be addressed as part of the Formal Section 7 coordination with the USFWS.

5.1.2 Fisheries

The June sucker is endemic to Utah Lake with lake-wide distribution extending into portions of its associated tributaries. Historical habitat alterations and water management decisions within Utah Lake and its tributaries have contributed to the decline of the June sucker population, resulting in its listing as an endangered species in 1986. While current management practices have contributed to the species' recovery and its downlisting from endangered to threatened, further development activities in the vicinity of the lake has potential to disrupt this population. LRS is working with the local stakeholders, including a Project-specific Fisheries Technical Advisory Committee (TAC), including members from USFWS, UDWR, JSRIP, URMCC, LRS, SWCA and Geosyntec, to create a long-term solution for the June Sucker, as discussed above. These impacts will be addressed as part of the Formal Section 7 coordination with the USFWS.

5.1.3 Vegetation

Four populations of Ute ladies'-tresses, a federally listed threatened species, are known to occur within the area of analysis along groundwater-fed springs or sub-irrigated meadows. Suitable habitat for Ute ladies'-tresses within the area of analysis is present in the wetland habitats shown in Figure 3. However, these known populations do not occur within the proposed Project footprint. The primary threats to the species are habitat loss from urbanization, infrastructure construction, and hydrology changes (Fertig et al. 2005). Where infrastructure connects to the shore it has the potential to impact Ute ladies'- tresses populations or habitat. However, surveys for Ute ladies'-tresses and Ute ladies'-tresses habitat will be conducted and infrastructure connections will be designed to avoid impacts to the species. Potential impacts would be addressed as part of the Formal Section 7 coordination with the USFWS.

5.2 Wetland Delineation and Stream Identification

Wetland delineation and stream identification surveys were performed for Project areas. Wetlands were delineated using the procedures identified in the USACE 1987 Wetland Delineation Manual (Environmental Laboratory 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual (USACE 2012) for making preliminary jurisdictional wetland determinations. Physical and biological characteristics of USACE Water Type (USACE 2007) and Cowardin classification (Cowardin et al. 1979) were identified and evaluated. Biological characteristics evaluated included the presence of fish, aquatic macroinvertebrates, and vegetation rooted within the ordinary high-water mark. WOTUS identified during the delineations and the anticipated unavoidable project impacts, are listed below:

- Palustrine Emergent (PEM): 152 acres
- Palustrine scrub-shrub (PSS): 9 acres
- Palustrine Forested (PFO): 0 acres

- Freshwater Pond: 1 acre
- Riverine: 1 acre

The unavoidable impacts do not include the dredging footprint. The impacts related to dredging would be considered temporary impacts.

Details of the WOTUS are provided in the attached Wetland Delineation Report (Appendix B).

5.3 Cultural Resources

The greatest potential for project impacts to cultural resources that are eligible for or listed on the NRHP is in causeway tie-in areas. Each of these five areas are located on the lake shore where causeway construction would involve significant new ground disturbance. The paragraphs that follow evaluate potential impacts to cultural resources in each of these areas.

The northeastern-most tie-in area includes the historic Geneva Steel plant. This area is approximately 452 acres in size and roughly 75% has been subject to archaeological survey. These surveys have identified three cultural resource localities including a prehistoric artifact scatter, a segment of the Denver and Rio Grande-Western railroad, and the aforementioned Geneva Steel plant. All three of these previously documented sites are considered eligible for the NRHP. This tie-in area has been highly impacted by industrial development and it is unlikely that additional archaeological survey would find intact cultural resource locations. Direct impacts to known sites could likely be avoided through project engineering to avoid those sites.

A proposed tie-in in the Vineyard area is approximately 545 acres in size. This area has not been subject to substantial archaeological survey, and visual inspection of those survey boundaries suggests that less than 10% of the proposed Vineyard tie-in area has been surveyed. Three prehistoric archaeological sites are known in this area, none of which have been formally evaluated for NRHP eligibility. Similar to the Geneva Steel tie-in area, the Vineyard area has been subject to considerable development. Accordingly, additional archaeological survey is not likely to find intact cultural resource sites. Project engineering could likely avoid the three documented sites as each site is relatively small.

Immediately north of the Provo Airport another proposed tie-in area of approximately 417 acres is proposed. Slightly more than 50% of this area has been surveyed for archaeological sites but these surveys have documented six such localities. Four of these known archaeological sites are extensive prehistoric habitation sites temporally affiliated with the Fremont archaeological culture. Three of these large sites have not been formally evaluated for the NRHP and the fourth is not eligible because of extensive disturbance to the site. The two additional sites are both historic period sites—one a non-significant levee system and the other a historic boathouse and pier that are NRHP eligible. Although the Provo Airport tie-in area has also been subject to considerable modern disturbance from development, its location surrounding the Provo River inlet to Utah Lake would have been a highly attractive location for prehistoric settlement. In relatively undisturbed portions of the Provo Airport tie-in area, it is likely that additional archaeological survey would find undocumented archaeological sites. Once such survey is completed, however, site locations could likely be avoided by project engineering.

A proposed tie-in area along the south shore of Provo Bay includes approximately 940 acres. This area has not been subject to much archaeological survey—a visual estimate suggests that less than 5% of the South Provo Bay tie-in area has been surveyed. This limited survey has documented one locality, a large prehistoric artifact scatter along the lake margin that has been formally listed on the NRHP. The spatial extent of this site follows closely the boundaries of prior survey, and it is very likely that the site extends beyond those currently plotted boundaries. Additional survey of the South Provo Bay area would likely expand the boundary of the known site further along the lake margin and would also likely identify additional undocumented archaeological sites. Because the known cultural resource locality extends along much of the lake shore in this area, and is listed on the NRHP, it is likely that project plans will have a direct impact to this site. Although avoidance of impacts to this site is likely not possible, those impacts can be minimized and/or mitigated with project planning and implementation of appropriately scaled data recovery excavation and construction monitoring of the site.

A large, proposed tie-in area is located along the Utah Lake shore just west of West Mountain. This area is approximately 1,432 acres in size and has not been subject to any prior archaeological survey. Although unsurveyed, existing records show the locations of four known but not formally documented rock imagery sites on the western slopes of West Mountain. The West Mountain tie-in area is relatively remote and has not been substantially affected by modern development. Archaeological surveys conducted in nearby parcels do show the presence of archaeological sites and it is very likely that survey of the West Mountain area would similarly find undocumented cultural resource localities. Because this large area has not been surveyed for cultural resource localities it is difficult to accurately assess project impacts. However, given the size and distribution of sites in nearby areas that have been surveyed it is likely that project engineering could avoid most sites once identified and documented.

Another large, proposed tie-in area is located along the southwestern shore of Utah Lake in the Mosida area. This tie-in area is approximately 2,605 acres and has not been subject to much archaeological survey—less than 5% of the area appears to have been surveyed. One large prehistoric artifact scatter has been documented within the proposed Mosida tie-in area and this site has not been formally evaluated for its NRHP eligibility. Similar to the large site found along the lake margin in the South Provo Bay area, the boundary for the site documented in the Mosida area closely matches the boundary of prior survey. It is very likely that additional survey will extend the boundary of this known site further along the lake margin. The Mosida tie-in area has not been subject to significant disturbance and more extensively surveyed areas surrounding Mosida suggest a moderate density of archaeological sites. Archaeological survey of the Mosida tie-in area would likely identify undocumented cultural resource localities and would also likely extend the boundaries of the single known site. Because the known site follows the lake shore and additional survey will likely extend those boundaries further along the shore, avoidance of impacts to this site are probably not possible. However, those impacts can be minimized and/or mitigated with project planning and implementation of appropriately scaled data recovery excavation and construction monitoring of the site.

The proposed Knolls tie-in area along the western shore of Utah Lake is approximately 527 acres and has not been subject to archaeological survey. Nonetheless, one known cultural resource site is documented within the proposed tie-in area—a segment of a historic road that is not considered NRHP eligible. One known but undocumented rock imagery location is also present within this area. Archaeological survey along the lake shore near the Knolls tie-in area shows the presence of a large prehistoric artifact scatter that extends along much of the surveyed shoreline. Given the widespread presence of this site in nearby areas it is likely that the site is also present along the shoreline of the Knolls tie-in area. The larger area has not been subject to considerable modern development, and it is likely that additional cultural resource sites would be identified during archaeological survey. Should the large shoreline site be present, it would be difficult to fully avoid all impacts of the project. However, those impacts can be minimized and/or mitigated with project planning and implementation of appropriately scaled data recovery excavation and construction monitoring of the site.

Last, a proposed tie-in area of approximately 296 acres is proposed in the Little Cove area. Slightly less than 50% of this area has been subject to previous archaeological inventory. Those inventories within the Little Cove tie-in area have documented one NRHP-eligible prehistoric site with rock imagery, one NRHP-eligible historic telephone line, and one not-eligible historic road segment. Existing records also show the presence of nine known but undocumented rock imagery localities within the Little Cove tie-in area. Because of the relatively high density of known rock imagery locations in the Little Cove tie-in area it is very likely that additional survey would identify undocumented archaeological sites. However, because such sites are expected to be fairly limited in size, careful project engineering is expected to be able to avoid direct impacts to those sites

5.4 404(b)(1) Guidelines Technical Evaluation Factors

5.4.1 Substrate (§ 230.20)

Substrate will be disturbed during the described dredging operations. It should be noted that the sediments are believed to contain elevated nutrients that contribute to the ongoing water quality concerns. Data from sediment samples collected by others indicates that the dredge material is suitable for beneficial reuse. LRS is characterizing the sediments to confirm that they are suitable for the proposed beneficial reuse. The results will dictate the proposed use and management of the dredged material. The dredging limits are still being developed. This section will be updated once the dredge limits are finalized and evaluated in the EIS process.

5.4.2 Suspended Particles/Turbidity (§ 230.21)

The Project will result in temporary, localized increased turbidity within the Project area resulting from dredging operations. The Project will minimize these effects by implementing best management practices (BMPs) and controlled dredging production rates. The dredging limits are still being developed. This section will be updated once the dredge limits are finalized and evaluated in the EIS process. In addition, conservation measures will be developed and implemented during the dredging.

5.4.3 Water (§ 230.22)

The Project will cause a temporary short-term, localized disturbance of water quality resulting from dredging operations. Following the initial disturbance, the Project is expected to have long-term positive effects on water quality within Utah Lake. Additional details will be provided at the completion of the Water Circulation and Water Quality Modeling and will be evaluated during the EIS process.

5.4.4 Current Patterns and Water Circulation (§ 230.23)

Project activities are expected to improve the normal current patterns and water circulation of Utah Lake. LRS has conducted extensive modeling related to Utah Lake's water circulation and the containment areas placements. Additional modeling details will be provided at the completion of the Water Circulation and Water Quality Modeling and will be evaluated during the EIS process.

5.4.5 Normal Water Fluctuations (§ 230.24)

Project activities are not expected to significantly disturb the normal water fluctuations within Utah Lake. Section 3.9 provides details on the water fluctuations. Additional details will be provided at the completion of the Water Circulation and Water Quality Modeling and will be evaluated during the EIS process.

5.4.6 Salinity Gradients (§ 230.25)

The Project will have no effect on salinity gradients.

5.4.7 Threatened and Endangered Species (§ 230.30)

Project impacts to threatened and endangered species are unlikely. Through coordination with the USFWS and other stakeholders, the Project will include an overall habitat improvement for the sensitive species. Refer to Section 3.2 for details on the Threatened and Endangered Species. LRS is working with a Project-specific Fisheries TAC, including members from USFWS, UDWR, JSRIP, URMCC, LRS, SWCA, and Geosyntec. The TAC is working to develop conservation measures while providing guidance to the Project design to minimize impacts and provide enhancements to the aquatic resources, including the June sucker. Potential impacts will be addressed as part of the Formal Section 7 coordination with the USFWS.

5.4.8 Fish, Crustaceans, Mollusks, and Other Aquatic Organisms in Food Web (§ 230.31)

Project activities will temporarily disrupt the life cycle movements of aquatic life indigenous to Utah Lake. Additional details will be provided at the completion of the Water Circulation and Water Quality Modeling. The dredging will be completed in phases to minimize impacts to aquatic organisms. In addition, the containment areas and causeways are being designed to preserve aquatic movement.

Activities in spawning areas during spawning seasons will be avoided to the maximum extent practicable. LRS will coordinate with USFWS, UDWR, JSRIP, and the URMCC regarding sensitive resources.

Additionally, LRS is working with a Project-specific Fisheries TAC, including members from USFWS, UDWR, JSRIP, URMCC, LRS, SWCA and Geosyntec. The TAC is working to develop conservation measures while providing guidance to the Project design to minimize impacts and provide enhancements to the aquatic resources, including the June sucker and other fish species, as well as mollusks.

5.4.9 Other Wildlife (§ 230.32)

Project impacts to other wildlife are unlikely. Refer to Section 3.2 for details on terrestrial wildlife. The Project will implement conservation measures (e.g., biological monitors, phased approach, invasive species control, restoration, etc.) to minimize potential impacts.

5.4.10 Sanctuaries and Refuges (§ 230.40)

No sanctuaries or refuges are present within the Project area.

5.4.11 Wetlands (§ 230.41)

The Project has been designed to avoid and minimize to the maximum extent practicable the destruction and loss of wetlands in accordance with the 404(b)(1) Guidelines. Notwithstanding the size of the Project, it has been carefully designed to cause minimal permanent loss of wetlands; only approximately 0.6% (27,378 acres of mapped wetlands around the Utah Lake fringe with 161.3 acres of unavoidable impacts) of wetlands delineated will result in any permanent wetland loss, and the Project will mitigate these impacts to ensure no net loss. These are preliminary numbers. Project impacts will be defined during the alternative analysis and confirmation of design. Additionally, the Project will remove invasive species, including *Phragmites*, from existing wetlands and restore them with native species, as well as create additional wetlands around the containment areas.

5.4.12 Mud Flats (§ 23.042)

The Project may temporarily affect mud flats during the dredging activities. The dredging limits are still being developed. This section will be updated once the dredge limits are finalized and evaluated in the EIS process.

5.4.13 Vegetated Shallows (§ 230.43)

LRS is planning to complete SAV surveys in May 2022. The Hydroacoustic SAV surveys will provide information on canopy height, percent coverage, and overall biomass of the surveyed areas. The results of the SAV survey will be used to adjust the layout of the project as required and the data will be provided to USACE upon completion. Project impacts will be determined during the alternative analysis and enhanced as part of the Restoration Plan. These potential impacts will be evaluated in the EIS process.

5.4.14 Riffle and Pool Complexes (§ 230.45)

The Project is being designed to avoid tributaries; therefore, impacts to riffle and pool complexes associated with stream hydrology are not anticipated.

5.4.15 Municipal and Private Water Supplies (§ 230.50)

LRS is working with the municipal and private water suppliers to ensure no loss of service. The containment areas will reduce the surface area of the lake by approximately 20% to reduce evaporation and conserve water to increase the water supply for the state. The Project will enhance the natural clarity and quality of the water in Utah Lake by removing nutrient-loaded sediments and reducing turbidity within the lake. The Project will also increase the water storage and water supply functions of Utah Lake and preserve current water rights related to water associated with Utah Lake by reducing the evaporation potential and increasing the water volume in the lake.

5.4.16 Recreational and Commercial Fisheries (§ 230.51)

LRS is working with a Project-specific Fisheries TAC, including members from USFWS, UDWR, JSRIP, URMCC, LRS, SWCA and Geosyntec. The TAC is working to develop conservation measures while providing guidance to the Project design to minimize impacts and provide enhancements to the aquatic resources, including the recreational and commercial fishery.

5.4.17 Water-Related Recreation (§ 230.52)

Improving the recreational use of Utah Lake is one of the key objectives of the Project. These objectives include the following:

- Improve navigability of Utah Lake by increasing water depth and reducing wind and wave action.
- Maximize, enhance, and ensure recreational access and opportunities on Utah Lake by the creation of recreational islands.
- Improve the use of Utah Lake for residents and visitors by enhancing the lake, improving access, and creating additional recreational opportunities.
- Enhance property adjacent to Utah Lake by enhancing the lake and providing access to the lake for recreation and other uses.

5.4.18 Aesthetics (§ 230.53)

The containment areas may potentially impact the aesthetics of Utah Lake and view from multiple viewpoints. LRS is actively determining the Project's effects on aesthetics. This section will be updated once the visual resource assessment is finalized and evaluated in the EIS process.

5.4.19 Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites and Similar Preserves (§ 230.54)

Within the area of analysis, 11 parks and several wildlife management areas are present. No direct impacts to these sites are anticipated. The Project is expected to have a positive effect on these sites resulting from improved water quality and the increased access to Utah Lake and the surrounding areas.

Neither Utah Lake nor the associated waterways are National Wild and Scenic Rivers or rivers officially designated by Congress as a National Wild and Scenic Rivers Act.

5.4.20 General Evaluation of Dredged or Fill Material (§§ 230.60, 230.61)

LRS is planning to initiate sediment sampling and characterization in the spring/summer of 2022, in accordance with 40 CFR § 230.60(b). The results of the characterization will be used in the evaluation of the dredge and fill material, the design of the containment areas, and evaluate the potential beneficial reuse of the sediment.

5.4.21 Actions Concerning the Location of the Discharge (§ 230.70)

The Project will minimize dredge material dewatering discharge impacts by placing dredged material in containment areas located within the lake to maintain lake water levels and preserve the lake's water storage and supply functions. The locations and sizes of the containment areas will be refined based on the volume of material required to be dredged, the results of the sediment characterization, Water Circulation and Water Quality Modeling, and Project engineering.

5.4.22 Actions Concerning the Material to be Discharged (§ 23.071)

The Project includes dredging an estimated 957,710,915 cubic yards of nutrient-loaded sediment from the lake bottom for placement into 34 constructed containment areas totaling approximately 18,000 acres. Some material within the location of the containment areas may be removed and mixed with new dredge material or imported material to make it suitable for development.

5.4.23 Actions Controlling the Material After Discharge (§ 230.72)

The containment areas area being designed to manage the dewatering of dredge material using both active and passive methods. The discharge will be coordinated through the Section 401 permitting process. The Project will minimize the potential impacts of water discharge from the containment areas through the implementation of BMPs and construction of bioretention basins and bioswales developed to capture and clean runoff from the containment areas prior to entering Utah Lake.

5.4.24 Actions Affecting the Method of Dispersion (§ 230.73)

The Project will minimize temporary, localized effects resulting from dredging operations by controlling dredging production rates to maintain current lake levels and implementation of BMPs to minimize and capture turbidity created during dredging.

5.4.25 Actions Related to Technology (§ 230.74)

Appropriate machinery and techniques will be implemented to minimize impacts during Project operations. LRS is committed to evaluating new technology to minimize impacts of the Project and enhance Utah Lake. This would include new technologies for dredging, containment area construction, causeway construction, revegetation, invasive species control, etc.

5.4.26 Actions Affecting Plant and Animal Populations (§ 230.75)

The Project minimizes impacts to aquatic habitat by restoring temporary impacts, as close as practicable. The Project includes mitigation measures to minimize harm to and enhance habitat for threatened and endangered species. In addition, the dredging activities, development of enhanced habitat on and adjacent to the containment areas, wetland restoration, creation of new littoral zones will provide habitat for plant and animal populations. LRS will adhere to applicable guidance recommended by federal or state resource agencies for the protection of aquatic and terrestrial species.

5.4.27 Actions Affecting Human Use (§ 230.76)

The Project will have a both negative and positive effects on human use. Potential negative effects include increased traffic, noise from construction, and limited lake access to work areas. Potential positive effects include improved lake access, creation of additional recreational activities, additional skilled jobs, improved boating navigation and safety, and improved water quality, increased water storage capacity, and water conservation.

5.4.28 Other Actions (§ 230.77)

The Project will implement conservation measure (e.g., biological monitors, phased approach, invasive species control, restoration, etc.) to minimize potential impacts and facilitate additional enhancement opportunities.

5.5 Public Interest Review Factors

Pursuant to 33 CFR § 320.4(a), USACE must conduct a public-interest review that considers the "*probable impacts of the proposed activity and its intended use on the public interest*." This review must balance the "*benefits which reasonably may be expected to accrue from the proposal against its reasonably foreseeable detriments*." This section provides a summary of information relevant to each of the public-interest review factors listed in § 320.4(a) and, where appropriate, the additional policies described in § 320.4(b) through (r).

The following sections will be evaluated and updated as part of the NEPA assessment.

5.5.1 Conservation (§ 320.4(a))

The Project will have a positive (mitigated) effect on conservation. As part of the Project, a Conservation Plan will be developed to protect and enhance the Utah Lake ecology. This Conservation Plan will be developed with review by the Fisheries TAC (as described above).

5.5.2 Economics (§ 320. 4(a))

The Project will have a significant beneficial effect on the local and regional economy resulting from increased economic opportunities and access to Utah Lake and the surrounding areas. In addition, the Project will provide new skilled jobs. A detailed economic analysis will be completed as part of the EIS.

5.5.3 Aesthetics (§ 320. 4(a))

The containment areas may potentially impact the aesthetics of Utah Lake and view from multiple viewpoints. LRS is actively determining the Project's effects on aesthetics. This section will be updated once the visual resource assessment is finalized and evaluated in the EIS process

5.5.4 General Environmental Concerns (§ 320. 4(a))

General environmental concerns will be identified during the EIS process and subsequent evaluations. Identified concerns will be assessed and mitigated, to the greatest extent practicable, through project refinement, design, and engineering.

5.5.5 Wetlands (§ 320. 4(a) & (b))

The Project will have a positive (mitigated) effect on wetlands. The Project includes enhancement, restoration, and compensatory mitigation. The Project will include a Wetland Enhancement and Restoration Plan and a Compensatory Mitigation Plan. The Project has been designed to avoid and minimize the destruction and loss of wetlands. to the maximum extent practicable in accordance with the 404(b)(1) Guidelines.

The Project includes the removal of invasive plants, including *Phragmites*, from Utah Lake and the creation of additional littoral zones with planting and monitoring of SAV communities. Compensatory mitigation will be utilized to offset unavoidable adverse impacts to WOTUS. Compensatory Mitigation will be completed through four methods:

- Enhancement – enhancing existing aquatic resources functions
- Restoration – restoring a previously existing site
- Establishment – creating an entirely new aquatic site
- Preservation – preserving an existing aquatic site

These methods will be fully described in the Compensatory Mitigation Plan.

5.5.6 Historic, Cultural, Scenic, and Recreational Values (§ 320. 4(a) & (e))

The Project will have a positive effect on recreational values resulting from the enhancement of the lake, increased access, and additional recreational activities.

5.5.7 Cultural Resources (§ 320. 4(a) & (e))

Given the distribution and nature of expected significant cultural resource sites across the Project area, avoidance is expected to be able to address most anticipated Project impacts. For those sites that cannot be avoided, a combination of minimization and mitigation measures will be implemented to address direct Project impacts. Refer to Section 5.1 for details on cultural resources.

5.5.8 Tribal Trust (§ 320. 4(a) & (j))

Due to Section 106 requirements, coordination with the Tribes will be completed during the Individual Permit process.

5.5.9 Fish and Wildlife Values (§ 320. 4(a) & (c))

The Project will have short-term minor detrimental effects on fish and wildlife during construction. These short-term effects will be minimized through conservation measures. The Project may have a potential negative effect by providing improved habitat for invasive and predatory fish species. The Project will have a long-term positive effect on desired fish and wildlife values resulting from the increased suitability of Utah Lake and its surrounding areas for fish, shorebirds, waterfowl, and other avian species caused by the enhancement and creation of additional littoral zones throughout the lake. LRS is developing an Aquatic Species Restoration Plan and an Invasive Species Management Plan, in coordination with the Project-specific Fisheries TAC. These plans will specifically address the aquatic habitat enhancements and control of invasive and predatory fish species.

5.5.10 Endangered Species (§ 320. 4(a) & (j))

The Project may affect, but is not likely to adversely affect, threatened and endangered species. Through coordination with the USFWS, UDWR, and other stakeholders, the Project will include conservation measures and overall habitat improvement for sensitive species. Refer to Section 3.2 for details on the threatened and endangered species.

5.5.11 Floodplain Hazards, Values, and Management (§ 320. 4(a) & (l))

The Project will have no negative effect on floodplains and/or water use management. The Project is being designed to maintain the Lake at historic levels. Utah Lake is managed for water storage and delivery for beneficial use (agriculture). The first 8.7 feet of storage below the compromise level is considered active storage (710,000 acre-feet). Dredging will create additional storage.

5.5.12 Land Use (§ 320. 4(a))

The containment areas will be constructed within open water and will not change existing land uses. The Project will have potential long-term effects on land use resulting from the construction of causeways connecting the east and west sides of the lake. The final design of the causeways and containment areas will be detailed through Project engineering.

5.5.13 Navigation (§ 320. 4(a) & (o))

The Project will have positive effects on navigation resulting from the deepening of the lake and reduction of the severity of wave actions.

5.5.14 Shore Erosion and Accretion (§ 320. 4(a))

The Project will have positive effects on shore erosion and accretion resulting from the construction of estuary islands and subsequent reduction of wave action within the lake. This will be detailed through Project engineering.

5.5.15 Water Supply and Conservation (§ 320. 4(a) & (m))

The Project will have a positive effect on water supply and conservation resulting from the reduction in the evaporation, removal of *Phragmites*, and increase in water storage capacity.

5.5.16 Water Quality (§ 320. 4(a) & (d))

Dredging operations will temporarily disturb water quality in localized areas; however, the Project will improve water quality through removal of nutrient loaded sediment, reduction in turbidity, and littoral zone enhancement.

5.5.17 Energy Needs, Energy Conservation and Development (§ 320. 4(a) & (n))

The Project will increase local energy needs; however, the Project will utilize energy efficient and conservation-based technologies. The energy needs, levels of conservation, and development requirements will be assessed as part of the EIS process.

5.5.18 Safety (§ 320. 4(a))

The Project will have no material effect on safety. Health and Safety Plans will be implemented during construction. The general public will be temporarily excluded from specific construction areas for safety purposes.

5.5.19 Food and Fiber Production (§ 320. 4(a))

The Project will have no effect on food and fiber production.

5.5.20 Mineral Needs (§ 320. 4(a))

The project will have no effect on mineral needs.

5.5.21 Consideration of Property Ownership (§ 320. 4(a) & (g))

The Project will have minimal impact to existing private property ownership. Any property will need to be acquired at fair market value for the construction of the raised roadways, bridges, and/or causeways. The dredge placement will convert submerged lakebed, owned by state, to usable containment areas. Some of the containment areas created by the Project will provide public benefit while other areas will become available for private ownership.

5.5.22 Needs and Welfare of the People (§ 320. 4(a))

The Project will have a beneficial effect on the needs and welfare of the people resulting from the improvement in the local water supply, increased access to recreational activities within Utah Lake, economic benefits associated with the development of some containment areas, and affordable housing opportunities provided with the development.

5.5.23 Effects on Limits of the Territorial Sea (§ 320. 4(f))

The Project will have no effect on the territorial sea.

5.5.24 Activities Affecting Coastal Zones (§ 320. 4(h))

The Project will have no effect on coastal zones.

5.5.25 Activities in Marine Sanctuaries (§ 320. 4(h))

The Project will have no effect on marine sanctuaries.

5.5.26 Other Federal, State, or Local Requirements (§ 320. 4(j))

LRS will obtain required federal, state, and local permits or authorizations necessary for construction.

5.5.27 Safety of Impoundment Structures (§ 320. 4(k))

The Project includes the construction and maintenance of permanent containment impoundment structures. These structures are being designed utilizing approved geotechnical and structural engineering standards and methods. Project engineering documents will be provided upon completion.

5.5.28 Environmental Benefits (§ 320. 4(p))

The Project will have positive environmental benefits resulting from the improvement in water quality, water conservation, and enhanced habitat within and adjacent to Utah Lake.

5.6 Mitigation

5.6.1 Section 404 CWA Mitigation (§ 320. 4(r))

In accordance with the CWA, LRS has avoided impacts to jurisdictional WOTUS features to the greatest extent practicable, minimized the resulting impacts that were unavoidable, and will provide compensation for the resulting impacts that were not de minimis, given the Project's purpose and need. Complete avoidance of WOTUS is not possible due to water dependency of the Project. The information in this section is provided in accordance with the application requirements identified in 33 CFR § 325.1(d)(7)48 and to document LRS's compliance with the 404(b)(1) Guidelines and the USACE and EPA's mitigation sequence guidance. Unavoidable losses will be compensated in accordance with 40 CFR § 230.93 to ensure that the Project does not result in a net loss of wetlands.

LRS is working with a Project-specific Fisheries TAC, including members from USFWS, UDWR, JSRIP, URMCC, LRS, SWCA, and Geosyntec. The TAC is working to develop conservation measures and provide guidance to the Project design to minimize impacts to the aquatic resources, including the June sucker. The TAC will also assist with the formal Section 7 Coordination.

5.6.2 Avoidance and Minimization (§ 320. 4(r))

The basic premise of the Section 404 permitting program is that no discharge shall be permitted if:

- A practicable alternative exists that is less damaging to the aquatic environment
- The discharge would cause the nation's waters to be significantly degraded

For a project to be permitted, it must be demonstrated the following, to the extent practicable:

- Steps have been taken to avoid impacts to wetlands and other aquatic resources

- Potential impacts have been minimized
- Compensation will be provided for any remaining unavoidable impacts

The ULRP is a comprehensive plan to restore and enhance Utah Lake. Enhancement of Utah Lake requires dredging the lake to remove nutrient-loaded sediment and facilitate littoral zone restoration. Dredged material must be placed in containment areas located within the lake to maintain lake water levels and preserve the lake's water storage and supply functions. Developing the containment areas for beneficial residential, commercial, mixed use, institutional, recreational, and open space land uses provide the means to fund the Utah Lake restoration and enhancement. Because of this, LRS is assuming the Project is Water Dependent and will include temporary impacts to special aquatic sites. The project has been designed to limit impacts to special aquatic sites where possible. In addition, the dredging and the containment area creation will accomplish the following:

- Improve water quality in Utah Lake by removing nutrient-loaded sediments and reducing turbidity within the lake
- Conserve water resources in and around Utah Lake by reducing the lake evaporation
- Increase the water storage and water supply functions of Utah Lake and preserve current water rights related to water associated with Utah Lake by reducing the evaporation potential and increasing the water volume in the lake
- Improve navigability of Utah Lake by increasing water depth and reducing wind and wave action
- Reduce shore erosion by constructing estuary islands
- Increase the suitability of Utah Lake and its surrounding areas for fish, shorebirds, waterfowl, and other avian species by enhancing and creating additional littoral zones throughout the lake
- Maximize, enhance, and ensure recreational access and opportunities on Utah Lake by creating recreational and development islands, improving water quality, and reducing the danger of waves on the lake
- Improve the use of Utah Lake for residents and visitors by enhancing the lake, improving access, and creating additional recreational opportunities
- Enhance property adjacent to Utah Lake by enhancing the lake and providing access to the lake for recreation and other uses
- Create causeways across the lake that connect the east and west sides of the lake and improve regional transportation

- Alleviate growth and housing constraints along the Wasatch front using environmentally sustainable development practices

In addition, LRS proposes to implement the following mitigation measures:

- Remove invasive plant and animal species, including *Phragmites* and carp, from Utah Lake
- Restore and create additional littoral zone and other plant communities in and around Utah Lake
- Create additional fish habitat within Utah Lake and restore, conserve, and re-establish native fish and other aquatic species in Utah Lake, including June sucker
- Develop bioretention basins and bioswales to capture and clean stormwater runoff from containment areas prior to entering Utah Lake
- Develop biofiltration streams to circulate and clean lake water
- Locate containment areas to provide adequate water circulation throughout the lake
- Create openings and corridors with diverse types of habitat between containment areas for water circulation and aquatic movement
- Establish June sucker within a Phase 1 lake-in-lake proof of concept area to provide redundancy for the threatened species
- Develop and implement aquatic species control plans
- Create additional wetland mitigation areas adjacent to existing wetlands
- Create deposition areas to control sedimentation
- Provide compensatory mitigation, if needed, for temporary and permanent impacts to special aquatic sites, including emergent wetlands and submerged vegetation areas

To further reduce impacts during dredging and construction, LRS proposes to implement BMPs. Some of the BMPs are as follows:

- Phase the Project and implement a lake-in-lake proof of concept to facilitate adaptive management strategies
- Control dredging production rates to maintain historic lake levels during dredging operations
- Implement BMPs during dredging operations to minimize and capture turbidity created during dredging
- Implement BMPs during dredging operations to protect fish from entrainment
- Provide archeological monitors during construction to avoid impacts to cultural resources

- Provide biological monitors during construction to avoid impacts to biological resources

5.6.3 Cultural Compensatory Mitigation (§ 320. 4(r))

Resolution of anticipated impacts to significant cultural resource localities that are listed on or eligible for the NRHP follows one or more of three general categories—avoidance, minimization of impacts, or mitigation of impacts. Of the three, avoidance is generally preferred. Avoidance of direct impacts to NRHP-eligible cultural resources is achieved by designing project impacts like access road construction to fall outside of documented site boundaries. Given the distribution and nature of expected significant cultural resource sites across the entire project area, avoidance is expected to be able to address most anticipated Project impacts.

For those sites that simply cannot be fully avoided, a combination of minimization and mitigation measures can effectively address anticipated direct impacts. For most archaeological sites that are important for the historical data that they contain, such minimization and mitigation involve clearly identifying which portions of the site will be directly impacted by project plans, recovering the important information found at the site within those direct impact areas, and monitoring active construction to ensure that those activities do not inadvertently impact additional portions of the site. For historical sites that are important because of their association with important events or significant historical persons, a typical mitigation measure involves preparing a detailed historical context and presentation of that context to a broader public audience.

6 ALTERNATIVES ANALYSIS

NEPA requires federal agencies to consider reasonable alternatives to the proposed action. "*Reasonable alternatives must be those that are feasible and such feasibility must focus on the accomplishment of the underlying purpose and need (of the applicant or the public) that would be satisfied by the proposed Federal action (permit issuance)*."

Consistent with NEPA requirements, a detailed evaluation of a range of reasonable alternatives will be developed and evaluated by LRS, cooperating and other governmental resource agencies, affected landowners, the public, and USACE staff. USACE, as the lead agency, will review the no-action alternative and viable alternative that could meet the Project purpose.

The CWA requires that the location of discharges authorized under Section 404 be determined through the application of guidelines developed by USACE and EPA. The guidelines required by Section 404(b), which are set forth at 40 CFR Part 230, require that an applicant demonstrate that the proposed discharge of dredged or fill material is the least environmentally damaging practicable alternative.

The 404(b)(1) guidelines allow an alternative to be rejected when it has impacts to the aquatic ecosystem, including wetlands and streams, that are similar to or greater than impacts under the preferred alternative. The guidelines also allow an alternative to be rejected if it has "*other significant adverse environmental consequences*." Such environmental consequences encompass a full range of resources including, for example, effects on threatened or endangered species, effects on cultural resources, and impacts on viewshed, air quality, or the human environment. The 404(b)(1) guidelines also allow rejection of alternatives that are not practicable. An alternative is practicable if it is "*available and capable of being done after taking into consideration cost, existing technology, and logistics, in light of overall project purposes*."

7 PROJECT DESIGN LAYOUT

Appendix D contains the general island layouts, as described in Section 4.1. The containment areas will be developed as multiple islands to ensure water circulation and aquatic movement throughout the lake. LRS acknowledges the containment areas will evolve in shape and size based on the alternative analysis, water circulation modeling, agency and stakeholder input, and final engineering design.

8 LIST OF ADJACENT PROPERTY OWNERS

The list of adjacent property owners is provided in Appendix E. The list was obtained from the Utah County GIS Property Notification Map. The private properties listed in this report are adjacent to the Project boundary along the perimeter of Utah Lake. This list will be provided in a separate excel label file, as appropriate.

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