PROVO RIVER DELTA RESTORATION PROJECT
Final Environmental Impact Statement
Volume I: Chapters 1–5





April 2015

UTAH RECLAMATION MITIGATION AND CONSERVATION COMMISSION

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

CENTRAL UTAH WATER CONSERVANCY DISTRICT

JUNE SUCKER RECOVERY IMPLEMENTATION PROGRAM

UTAH RECLAMATION
MITIGATION
AND CONSERVATION
COMMISSION

230 South 500 East, #230, Salt Lake City, UT 84102
Phone: (801) 524-3146 – Fax: (801) 524-3148

Dear Reader,

April 2015

Attached is the Final Environmental Impact Statement (EIS) for the Provo River Delta Restoration Project (PRDRP). The proposed project would restore a naturally functioning river-lake interface essential for recruitment of June sucker (*Chasmistes liorus*), an endangered fish species that exists naturally only in Utah Lake and its tributaries. In addition to fulfilling environmental commitments associated with water development projects in Utah and contributing to recovery of an endangered species, the project is intended to help improve water quality on the lower Provo River and to provide enhancements for public recreation in Utah County. Alternative B has been identified as the preferred alternative because it would minimize the amount of private lands that would need to be acquired for the project while still providing adequate space for a naturally functioning river delta and sufficient habitat enhancement for achieving the need for the project.

The agencies preparing the Final EIS are the Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission), the Central Utah Water Conservancy District, and the Central Utah Project Completion Act (CUPCA) Office of the U.S. Department of the Interior, collectively referred to as the Joint Lead Agencies.

The Final EIS, Executive Summary and Technical Reports can be viewed or downloaded from the project website www.ProvoRiverDelta.us or by requesting a copy on CD. Paper copies are available for public review at the Provo City Library, Salt Lake City Main Public Library or any of the Joint Lead Agency offices. After a period of not less than 30-days from the date of publication of the Notice of Availability of the Final EIS in the *Federal Register*, anticipated to be approximately April 10, 2015, the authorizing officials for the CUPCA Office and the Mitigation Commission may respectively issue a Record of Decision (ROD) as to which alternative to implement, if any. The ROD(s) or hyperlink to the document(s) will be mailed to our entire mailing list. The ROD(s) will also be made available on the project website.

On behalf of the Joint Lead Agencies, I thank you for your interest in the project.

Sincerely,

Michael C. Weland
Executive Director
Utah Reclamation Mitigation and Conservation Commission

PROVO RIVER DELTA RESTORATION PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

Utah Reclamation Mitigation and Conservation Commission

**U.S. Department of the Interior –
Central Utah Project Completion Act Office**

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April 2015

Cover Sheet
Provo River Delta Restoration Project
Final Environmental Impact Statement

Joint Lead Agencies
Utah Reclamation Mitigation and Conservation Commission

U.S. Department of the Interior - Central Utah Project Completion Act Office

Central Utah Water Conservancy District

Cooperating Agencies
U.S. Fish and Wildlife Service
U.S. Army Corps of Engineers
U.S. Bureau of Reclamation
Federal Aviation Administration
State of Utah
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Abstract

This Environmental Impact Statement has been prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA), as amended, the Council on Environmental Quality Regulations at 40 CFR 1502.25, and environmental review requirements under the Endangered Species Act (16 USC 1531 et seq.), the National Historic Preservation Act (16 USC 470 et seq.), and Section 404 of the Clean Water Act (33 USC 1344 et seq.). It will serve as the compliance document for Clean Water Act Section 404, Section 7 of the Endangered Species Act, Fish and Wildlife Coordination Act, and contracts, agreements and permits that would be required for construction and operation of the Provo River Delta Restoration Project.

The Provo River Delta Restoration Project is needed to facilitate recovery of June sucker (*Chasmistes liorus*) in Utah Lake by restoring habitat conditions essential for spawning, hatching, larval transport, rearing, and recruitment. June sucker occur naturally only in Utah Lake and its tributaries and is listed as endangered under the Endangered Species Act (16 USC 1531 et seq.). Three action alternatives are considered, any of which would restore a more natural river/lake interface of the lower Provo River and Utah Lake and reestablish essential rearing habitat for June sucker. This rearing habitat would support juvenile June sucker until they are capable of surviving in the larger open water environment of Utah Lake. Under any of the three action alternatives, the lower Provo River channel would be split so that the main flow would be directed into a restored river delta area, promoting the development of a diverse, vegetated aquatic environment capable of supporting young-of-year and juvenile June sucker and other aquatic life. This natural area would also provide a variety of public recreation opportunities.

A portion of the river's flow would always be directed into the existing lower Provo River channel, which would be retained in place under any action alternative in order to continue to support existing recreational uses and aesthetic values of the existing river corridor. Two options are considered for the existing Provo River channel. Under Option 1, the existing river channel would remain open to Utah Lake, allowing for fluctuating water levels at various times of the year. Under Option 2, a small dam would be constructed at the downstream end of the channel near Utah Lake State Park. This dam would maintain the water level in the existing channel at a relatively constant elevation year round. Under both options, a minimum flow of 10 cubic feet per second (cfs) and up to 50 cfs would be supplied to the existing channel. Additionally, an aeration system would be constructed in the existing channel to improve water quality and to better support aquatic life and aesthetics, particularly during the hot summer months.

PROVO RIVER DELTA RESTORATION PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

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CHAPTER 1: PURPOSE AND NEED

This chapter describes the purposes of and need for the Provo River Delta Restoration Project (proposed action), which has been identified as an essential action needed to recover the June sucker (*Chasmistes liorus*). Relevant background information supporting the purpose and need is discussed in this chapter, along with permits, authorizations, and agreements that would be required in order to implement the project. Related and ongoing actions are also described.

1.1 Project Overview

The June sucker is an endangered fish species that exists naturally only in Utah Lake and spawns naturally in the lower Provo River, a Utah Lake tributary. The fish is named for the timing of its annual spawning migration, which typically occurs sometime around June. June sucker was listed as an endangered species on April 30, 1986 (51 FR 10857). The lower 4.9 miles of the Provo River, from Utah Lake upstream to the Tanner Race Diversion Dam, is designated as critical habitat for the June sucker. Under the Endangered Species Act (ESA), critical habitat is an area essential to the species' conservation that requires special management and protection. Figure 1-1 illustrates the location of the Provo River in relation to Utah Lake and the portion of the river that is designated as critical habitat. The proposed action would modify the lower 2 miles of the designated critical habitat reach by relocating and reconstructing the lower Provo River and its connection to Utah Lake.

Under the National Environmental Policy Act of 1969 (NEPA) (42 USC § 4321 et seq.), an Environmental Impact Statement (EIS) must be prepared for major federal actions with the potential to significantly impact the environment. This project represents a major federal action involving environmental effects and, therefore, an EIS is being prepared.

1.1.1 Joint Lead Agencies

The Joint Lead Agencies (JLAs) preparing this EIS are:

- Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission),
- Central Utah Water Conservancy District (CUWCD), and
- U.S. Department of the Interior—Central Utah Project Completion Act Office (Interior).

1.1.2 Proposed Action and the Preferred Alternative

With the proposed action, the JLAs would restore habitat in the lower Provo River and its interface with Utah Lake that is essential for spawning, hatching, larval transport, survival, rearing, and recruitment of the June sucker population on a self-sustaining basis.

Alternatives for meeting the project needs were carefully considered and evaluated, including consideration of all Utah Lake tributaries and alternative geographic locations. The JLAs actively engaged cooperating agencies, other governmental entities, the public, property owners, and other stakeholders in developing alternatives advanced for detailed analysis in this EIS. Details regarding these efforts are summarized in Chapters 2 and 4 and are documented in the project administrative record. A list of supporting technical reports and related documents is provided in Section 1.3.7. Reports are available on the project website, www.provoriverdelta.us, or may be obtained by contacting the Mitigation Commission.

The proposed action would involve diverting the main flow of the lower Provo River from its currently constrained channel into a broader floodplain area where a delta ecosystem would be restored, providing the diverse habitat types that are necessary for supporting all life stages of June sucker. Three distinct action alternatives were advanced for detailed analysis in Chapter 2, these are labeled Alternatives A, B, and C. Any of these alternatives would require acquisition of private lands to the north of the existing river channel near Utah Lake within a portion of the study area shown in Figure 1-1. The alternative preferred by the JLAs is Alternative B. This alternative minimizes the amount of lands that would need to be acquired while still providing enough habitat enhancement area for meeting the project need. This is further discussed in Chapter 2, and all of the action alternatives being evaluated are illustrated on maps included with Chapter 2 and the executive summary.

The property where the existing river channel occurs is owned by Utah County and several private land owners. Two options for the existing channel were advanced for detailed analysis. The first of these would leave the channel open to Utah Lake, allowing for fluctuating water levels at various times of the year as the level of Utah Lake fluctuates. The second option would maintain the existing channel at a relatively constant elevation by constructing a small dam at the downstream end of the channel near Utah Lake State Park. The existing channel would be preserved in its current location and configuration with a guaranteed flow of 10–50 cubic feet per second and would be managed for continuation of existing uses. Maps illustrating these options and more details are provided in Chapter 2, as are discussions of other options that were considered but not carried forward.

The proposed action is intended to specifically address the lack of natural recruitment by June sucker in Utah Lake. It responds directly to recovery criteria of the June Sucker Recovery Plan (USFWS 1999a) and aids in accomplishing the goals of the June Sucker Recovery Implementation Program (JSRIP) to achieve sufficient progress towards the recovery of the June sucker (CUWCD et al. 2002).

1.1.3 Cooperating Agencies

In the NEPA process, a cooperating agency has the responsibility to assist the JLAs by participating in the NEPA process at the earliest possible time, participating in the scoping process, assisting in developing information and preparing environmental analyses for the EIS related to the cooperating agency's special expertise or jurisdiction, and making staff support available at the lead agency's request to enhance the lead agency's interdisciplinary capabilities (40 CFR 1501.6).

Serving as a cooperating agency does not constitute endorsement or approval of the project or alternatives evaluated in an EIS, nor does it relieve an agency of any other duties or responsibilities it may have under local, state or federal law. Rather, a cooperating agency helps to identify relevant issues early in the planning process and helps to verify the data and information used in the impact evaluations.

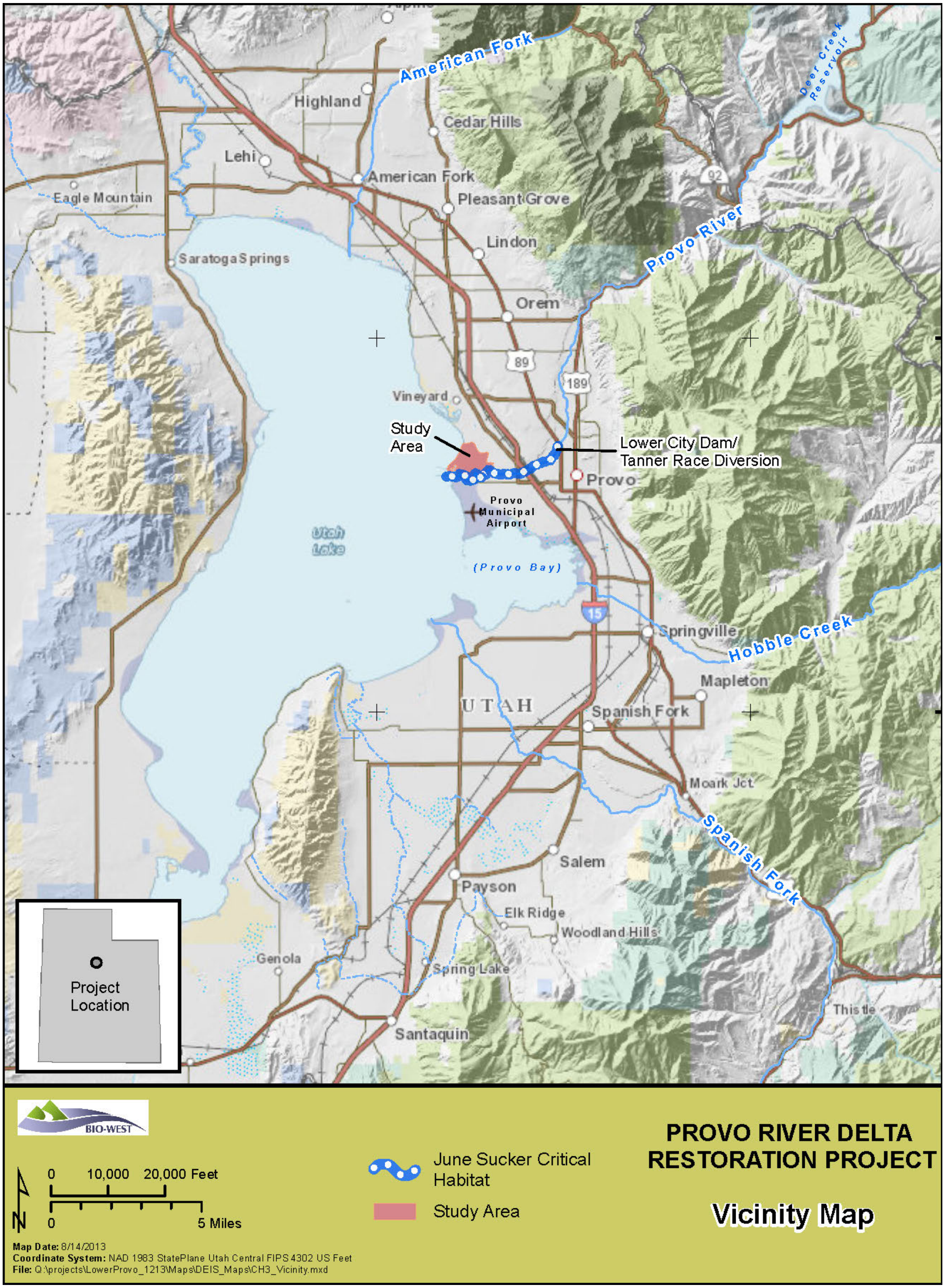

Figure 1-1. Vicinity map.

Cooperating agencies for preparation of this EIS are as follows:

- U.S. Fish and Wildlife Service (USFWS),
- U.S. Army Corps of Engineers (Corps),
- U.S. Bureau of Reclamation (Reclamation),
- Federal Aviation Administration (FAA),
- State of Utah,
- Provo City, and
- Utah County.

1.2 Purpose and Need

An EIS must include a brief statement of "the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action" (40 CFR 1502.13). As presented by Schmidt (1988), a need is the lack of something requisite, desirable, or useful, or a condition requiring supply or relief. All alternatives analyzed in detail in an EIS must meet the need(s) for the project. Purposes, on the other hand, are goals, or ends to be attained. Thus a purpose can be seen as a goal to be attained while seeking to satisfy an underlying requisite need. A statement of underlying purpose and need will thus actually have two parts: a requisite *need* and associated desirable *purposes*, where the purposes are the goals or ends to be attained while seeking to satisfy an underlying requisite need (Schmidt 1988, 1993).

1.2.1 What is the need for the project?

The proposed action is needed to facilitate recovery of June sucker in Utah Lake by restoring habitat conditions essential for spawning, hatching, larval transport, survival, rearing, and recruitment of June sucker on a self-sustaining basis.

1.2.2 What are the purposes of the project?

The purposes of the proposed action are as follows:

- Implement the specific criteria of the June Sucker Recovery Plan to restore a naturally functioning Provo River delta ecosystem essential for recruitment of June Sucker.
- Provide recreational improvements and opportunities compatible with the habitat restoration project.
- Adopt flow regime targets for the lower Provo River and provide delivery of supplemental water to the lower Provo River, including additional conserved water.[1]

[1] See Section 1.3.8 and Chapter 2, Section 2.6.2.

The need and specific purposes of the proposed action have been carefully considered by the JLAs during the process of developing this EIS and through consultation with cooperating agencies and other stakeholders. Subsequent sections of this chapter provide details and background information regarding these efforts.

1.3 Basis for the Purpose and Need of the Proposed Action

Recovery of the endangered June sucker is the driving force behind this project. The following question-and-answer discussions provide an overview and background of June Sucker recovery efforts and explain the need for the proposed action.

1.3.1 Why was the June sucker listed as an endangered species?

The June Sucker Recovery Plan (USFWS 1999a) identified three primary reasons for listing the June sucker as an endangered species:

- its localized distribution,
- failure to recruit new adult fish, and
- threats to its continued survival.

When the June Sucker Recovery Plan was completed, the estimated wild spawning population was only 300 individuals (Keleher et al. 1998). Historical reports suggest the June sucker population numbered in the millions. Through the mid-1800s, the fish served as an important source of food and fertilizer for Native Americans and early white settlers (Carter 2003). The recovery plan attributed the subsequent decline of June sucker to:

- extended drought during the 1930s,
- habitat alteration through dewatering,
- channelization of tributary streams and degrading water quality,
- competition and predation by nonnative species,
- overharvest through fishing, and
- killing of adults during the spawning run.

1.3.2 What are the obstacles to natural recruitment of June sucker?

In brief, almost all juvenile June sucker die before they reach adulthood because the existing lower reaches of Utah Lake tributaries lack the physical habitat, food production, appropriate temperatures, and water quality conditions necessary to support the growth and survival of young June sucker. Additionally, the majority of Utah Lake lacks the vegetative cover necessary for young June suckers to escape from predators.

June sucker spend the majority of their life cycle in Utah Lake, but utilize tributary streams for spawning, with the Provo River being the largest tributary and most heavily used site for spawning. Adult fish broadcast eggs over areas of suitable gravel and cobble substrate and return to Utah Lake shortly after spawning. June sucker eggs hatch after about 7–10 days of incubation (depending on water temperature). Following another 7–10 days of further growth and development, larval fish emerge from the stream bed and drift downstream in the river current to the river-lake interface. Shallow, productive, warm water habitat combined with vegetated areas that provide cover from predators provides optimal rearing conditions for larval and juvenile lake suckers (Cooperman and Markle 2004). Vegetative cover necessary to provide ideal rearing conditions is generally lacking from Utah Lake and the lower reaches of its tributaries.

Much of the known information regarding June sucker spawning and hatching comes from monitoring efforts in the lower Provo River, which was designated as "critical habitat" when the species was listed as endangered in 1986. Each spring, adult fish are observed spawning, and significant numbers of recently hatched larvae are subsequently observed drifting downstream. However, these larval fish generally do not survive longer than about 20 days after hatching (Ellsworth et al. 2010). Juvenile June sucker introduced from hatcheries into Utah Lake at about 8 inches or greater have survived and have been observed in the spawning run as adults (UDWR 2012). The ability of hatchery fish stocked as juveniles to survive, grow, and reach sexual maturity in the Utah Lake system adds to the evidence that the habitat utilized after hatching but before sub-adulthood is the limiting factor during the June sucker life cycle. Consequently, improving habitat conditions for early life stages has been identified as a high priority objective.

1.3.3 How did historic conditions provide better June sucker habitat?

Historically, a broad delta and floodplain (vegetated with emergent marsh wetlands, oxbow wetlands, wet meadows, cottonwood and willow dominated riparian areas, etc.) existed at the lower Provo River/Utah Lake interface. The typical cross section of the river corridor would have looked like the upper half of Figure 1-2. Similar conditions would have existed in other Utah Lake tributaries as well, such as the Spanish Fork and the American Fork Rivers. With human settlement, these rivers were typically confined to narrow channels with a levee or fill material on each side of the channel to prevent flooding of adjacent property. Now the typical river cross section looks like the lower half of Figure 1-2. Inadvertently, this modification has also greatly reduced habitat value for fish and other aquatic life.

Additionally, in a normally functioning river-lake interface, or delta ecosystem, the river zone is characterized by a meandering channel across a broad floodplain. As a river approaches a body of water (a lake or ocean), it slows down and bedload and suspended sediments drop out of the flow. As these sediments accumulate over time, the river begins to braid into a series of distributary channels, as illustrated by a typical delta plain area (Figure 1-3). Sediment accumulation causes the threaded channels to shift position over time, providing a diversity of fish habitat types including shallow and warmer areas off the main channel, and features such as abandoned channels, backwaters, and oxbow wetlands. These off-channel areas provide food resources for larval fish as well as refuge from predatory fish. In the case of historic Utah Lake tributaries, these off-channel habitat zones would have been critical to June sucker survival and recruitment to more developed life stages (USFWS 1999a).

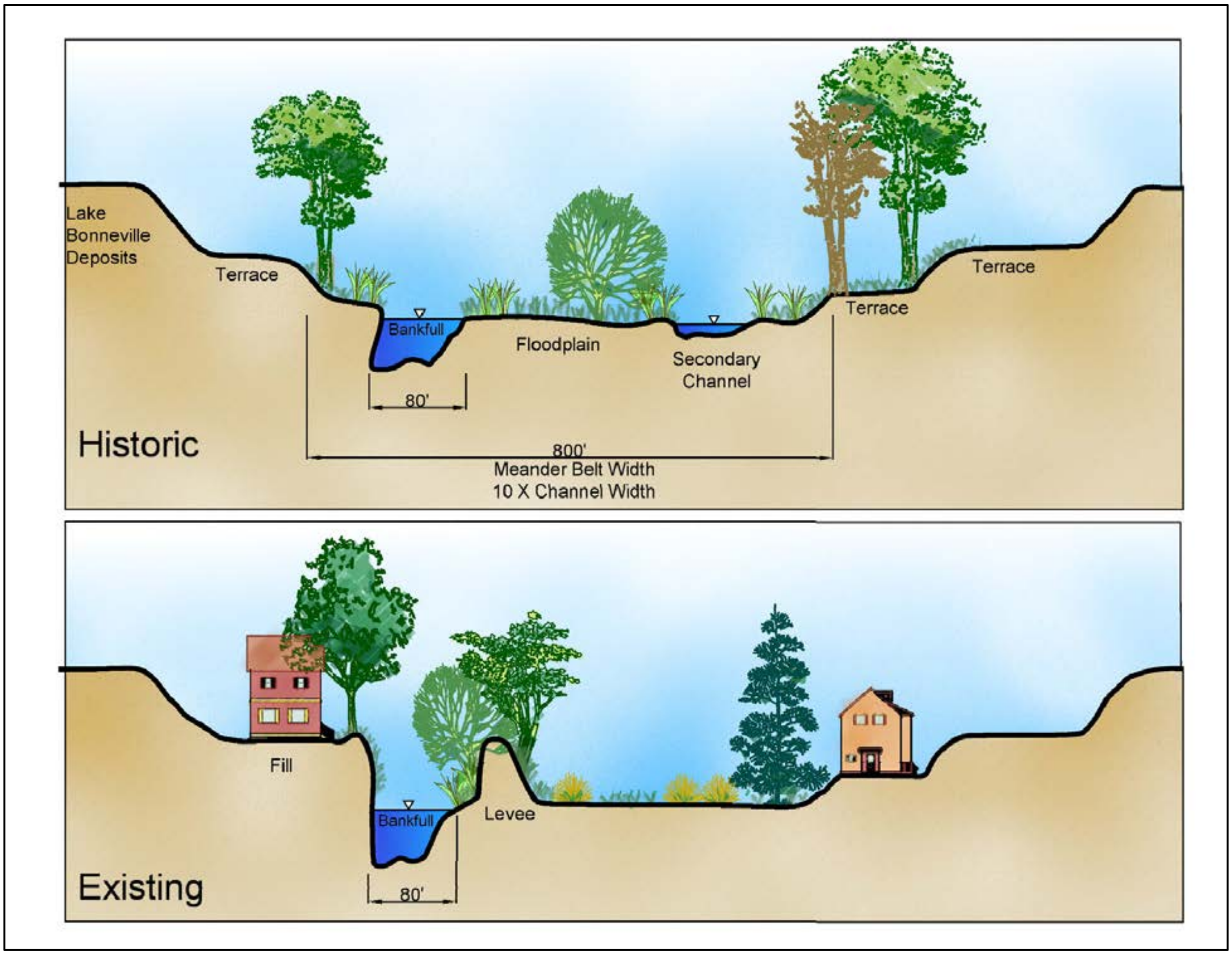

Figure 1-2. Schematic cross sections comparing historic channel and riparian corridor/floodplain to existing levee-constrained channel.

More broadly, various biological studies have documented the significance of such delta habitats to aquatic ecosystems and fish populations (Killgore and Baker 1996; Sommer et al. 2001; Belk et al. 2004; Cooperman and Markle 2004; Kaemingk et al. 2007; Albrecht et al. 2010a, 2010b; Burdick and Brown 2010; Erdman and Hendrixson 2010; Kappenman et al. 2010). Collectively, these studies demonstrate that when larval fish are able to access shallow, warm, productive habitats, their likelihood of successfully recruiting to the adult population will be greatly improved. Delta habitats provide unique conditions that can support large numbers of species and life stages, presumptively through habitat diversity. Furthermore, abundance of young fish can reasonably be expected to be greater with a larger spatial extent of such habitats. Modeling studies (Belk et al. 2004) indicate that June sucker population numbers may be particularly sensitive to abundance and survivorship levels of young fish (less than 1 year old). These modeling results suggest that restoring rearing habitat would provide gains in terms of population growth and ultimate species recovery.

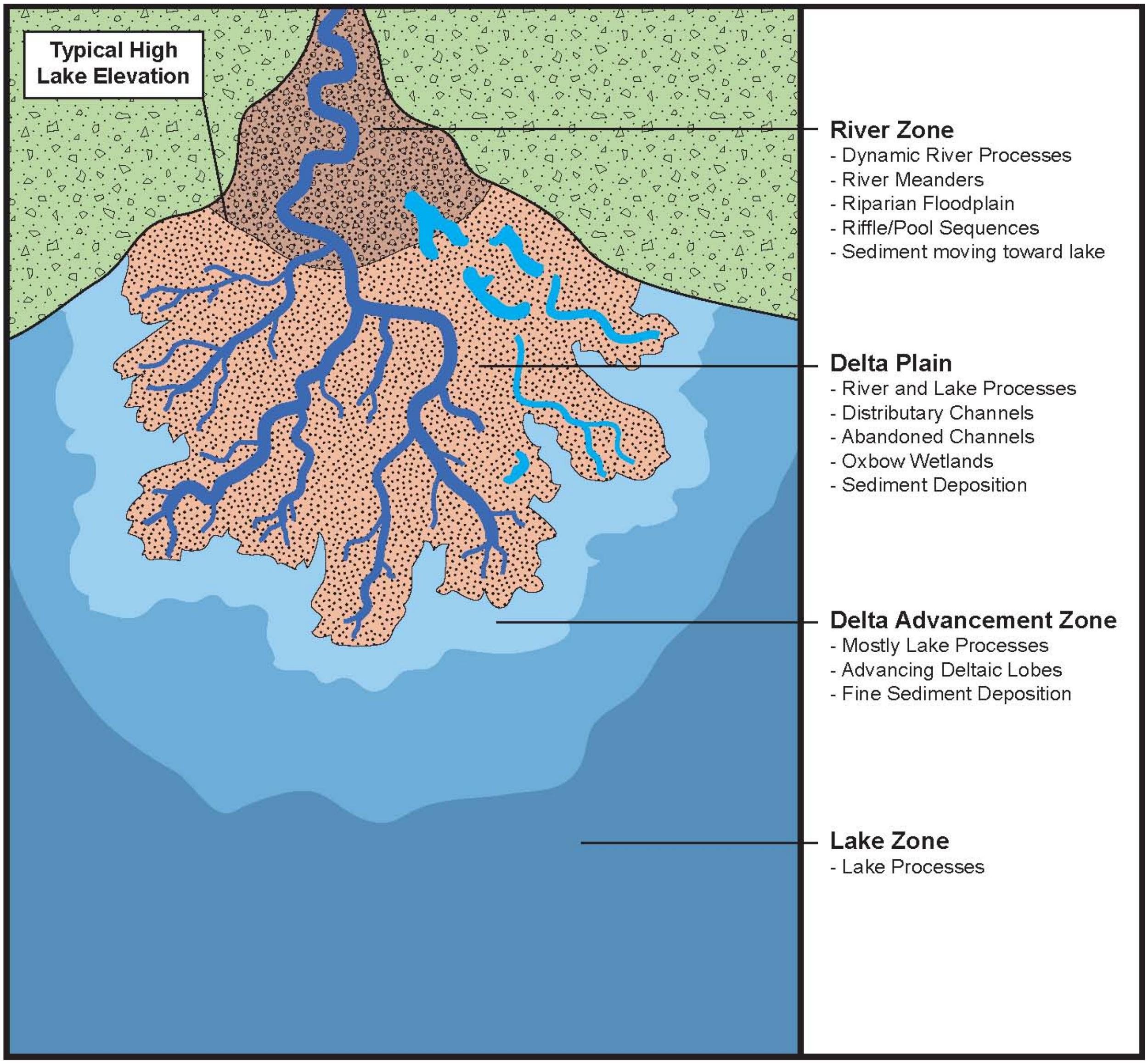

Figure 1-3. Schematic drawing of typical river delta zones.

Greater details regarding the historic Provo River delta and the minimum dimensions used to develop alternatives for the current project are discussed in the Alternatives Development Technical Memorandum (URMCC 2011).

1.3.4 How are efforts to recover June sucker being pursued?

Measures identified in the June Sucker Recovery Plan (USFWS 1999a) are intended to lead to downlisting and then delisting (or “recovery”) of the June sucker under the ESA. The ESA mandates that federal agencies must consult with the USFWS on any action that may affect an endangered species or adversely modify designated critical habitat (16 USC § 1536). Partly as a result of consultations on federally funded water development projects, the JSRIP was established to coordinate interagency recovery actions for June sucker while concurrently allowing water development and operations to continue. Sections 1.3.7 and 1.3.8 provide more detail on how the current project is related to water development and growth in Utah.

The USFWS prepared a programmatic Environmental Assessment (EA) (66 FR 56840, November 13, 2001) related to the decision to form the JSRIP. The programmatic EA acknowledged that implementing specific actions of the June Sucker Recovery Plan "…would be subject to compliance with federal environmental laws, including NEPA, prior to implementation." This EIS addresses some of the measures of the June Sucker Recovery Plan.

1.3.5 Which criteria of the recovery plan does the proposed action address?

The June Sucker Recovery Plan (USFWS 1999a) identified seven recovery criteria for "delisting" the June sucker from *endangered* status to not listed status. Those criteria—with bold text indicating criteria that are directly relevant to the proposed action—are as follows:

1. **Provo River flows essential for June sucker spawning and recruitment are protected;**
2. **habitat in the Provo River and Utah Lake has been enhanced and/or established to provide for the continued existence of all life stages;**
3. nonnative species which present a significant threat to the continued existence of June sucker are reduced or eliminated from Utah Lake;
4. **increasing self-sustaining spawning run of wild June sucker resulting in significant recruitment over ten years has been re-established in the Provo River**;
5. establishment of a second self-sustaining, protected, refugia population of June sucker within the Utah Lake Basin;
6. establishment of an additional self-sustaining spawning run of June sucker in Utah Lake. **This will require adequate protection of instream flows and available habitat, as well as successful recruitment to the spawning run of June sucker naturally produced in the Lake; and**
7. removal of other threats to the continued existence of June sucker including those associated with the required physical, chemical and biological environment of Utah Lake necessary for survival of the species. Final delisting criteria will be determined after an analysis to determine quantified objectives is completed including a definition of a self-sustaining June sucker population.

In order to achieve recovery, successful spawning and natural recruitment of June sucker from Provo River and one additional Utah Lake tributary is needed (in addition to other criteria). This means that June sucker are able to reproduce, the offspring are able to survive and mature to adulthood, and then return to a tributary stream to spawn, thus completing their life cycle requirements. The required "additional tributary" has been determined by the JSRIP to be Hobble Creek, and efforts to restore it and provide instream flows are already in place or ongoing. This EIS describes the potential impacts of implementing the project to restore or create those necessary habitat conditions on the lower Provo River and its delta at Utah Lake and to deliver additional supplemental instream flow water to the lower Provo River for June sucker recovery.

1.3.6 What other June sucker recovery efforts are being pursued?

The JSRIP (through its partners) has implemented numerous projects and conducted a variety of studies since the program was formed in 2002. A listing of studies and NEPA documentation and years they were completed includes the following:

- Feasibility Analysis of Establishing an Additional Spawning Location to Benefit the Endangered June Sucker, 2002;
- Property Transfer and Improvements of Red Butte Dam and Reservoir, 2003;
- Warm Water Interim Hatchery Facility EA and Finding of No Significant Impact (FONSI), 2004;
- Hobble Creek Stream Restoration Project EA and FONSI, 2008;
- Fort Field Diversion Dam Reconstruction Project EA and FONSI, 2008;
- Removal and Control of Nonnative Carp in Utah Lake to Support June Sucker Recovery EA and FONSI, 2010; and
- East Hobble Creek Restoration EA and FONSI, 2013.

Each of these projects was developed to accomplish a specific action needed to help recover June sucker. The EA for Property Transfer and Improvements of Red Butte Dam and Reservoir allowed for rebuilding Red Butte Dam so it could serve as the site for a refuge population of June sucker and resolve issues relating to ownership of the reservoir. Hatchery facilities have been constructed and improved greatly to produce hatchery-reared June sucker for stocking into Utah Lake. Hobble Creek restoration efforts are fulfilling the recovery criteria of establishing a second spawning run of June sucker in a Utah Lake tributary. The Fort Field Diversion Dam on lower Provo River was reconstructed to eliminate a migration barrier to June sucker on their annual spawning migration. Nonnative fish control in Utah Lake is underway through the carp removal program, started in 2010.

1.3.7 How is the proposed action related to water development and growth in Utah?

In 1982 the USFWS published a notice in the Federal Register indicating that it would review the status of the June sucker and requesting information related to the species. Reclamation initiated endangered species consultation with the USFWS, the Utah Division of Wildlife Resources, and the CUWCD in 1983. In addition to three interagency meetings, several technical meetings were held with agency specialists. As a result of endangered species consultation, Reclamation contracted with the Utah Division of Wildlife Resources to study the instream flow needs of the

June sucker as a basis for determining project impacts and mitigation. The study was completed in 1986 (Radant et al 1987).

Reclamation re-opened Section 7 consultation with the USFWS in 1985 because of proposed modifications to the Central Utah Project (CUP) Bonneville Unit's Municipal and Industrial System (M&I System) and the proposed listing of the June sucker as an endangered species. Reclamation completed an EA of the impact of the M&I System on the proposed endangered June sucker. The EA, which concluded there were no adverse impacts, was sent to the USFWS as part of the official request for endangered species consultation.

On April 30, 1986, June sucker was officially listed as endangered. The USFWS informed Reclamation that it would withhold its determination on the effects of the M&I System on that species pending further analysis of data gathered by Reclamation and Utah Division of Wildlife Resources. On October 8, 1986, Reclamation submitted a supplement to the biological assessment, which again concluded no effect on the June sucker.

On December 11, 1986, the USFWS concurred with Reclamation, and issued its own determination of no effect but requesting that enhancement opportunities be considered. As quoted from the memorandum to Reclamation's Regional Director from the USFWS Endangered Species Office Field Supervisor:

> The rather significant reduction in spring discharges could have negative impacts on the June sucker which are not apparent with our current level of knowledge. Therefore, it is important that the alterations associated with the project be monitored to assure that our current conclusions are in fact correct and borne out through observation before and with the project in place.

Late in 1986 the Utah Division of Wildlife Resources completed a study started in 1983 on instream flow needs of the June sucker (Radant et al 1987).

The following excerpt is from the 1999 Diamond Fork Final Supplement to the 1984 Final EIS, (CUWCD 1999) and refers to the proposed action:

> ...with the recommended plan and alternative A there would be fewer impacts to terrestrial and aquatic resources than those described in the Final EIS. Therefore, there would be no adverse impacts on ... June sucker... On January 21, 1987, the Service concurred in the "no effect" determination for alternative A.

The 1994 Final EA for the Olmsted Diversion and Intake Structure Replacement Project, Bonneville Unit, CUP (Reclamation 1994), states the following:

> There are no special concern, threatened, or endangered fish species present in the project influence area. Migration blockage on the lower Provo River, and no change in river flows would result in no effect to the June sucker, which inhabits Utah Lake or the lower Provo River. The federally-listed endangered June sucker, which occurs in Utah Lake, migrates into the Provo River to spawn in June,

> followed by several months of juvenile rearing. The diversion and falls at the Columbia Lane Bridge (located approximately 10.7 miles downstream of the diversion dam construction area) restrict this species' distribution in the Provo River to reaches well downstream of the project area. Use of best management practices would minimize siltation and turbidity. Construction activities would occur during noncritical months for the June sucker. At the June 15, 1993, meeting with the FWS, they agreed that the Proposed Project would have no effect on June sucker.

In a letter dated July 26, 1993, the USFWS concurred in the assessment conclusion that there would be no effect on listed species (USFWS 1993).

The 1994 Biological Opinion for the Provo River Project (USFWS 1994) stated that " the Reasonable and Prudent Alternative (RPA) for June sucker was "primarily based upon the establishment and protection of flows in the Provo River to ensure annual river flushing, support adult spawning activities, and maintain high quality egg and larval habitat conditions." The RPA called for a range of research flows and associated studies over a 3-year period (1995–97) and reinitiation of consultation:

> At the end of the 3-year study, when data are available to determine June sucker flow needs, Reclamation will reinitiate consultation for the Project . . . This new consultation, using the study results, will define the size of the permanent block of water to be acquired and delivered by Reclamation for June sucker needs.

The Central Utah Project Completion Act (CUPCA) was passed in 1992 as part of Public Law 102-575. The CUPCA legislation transferred responsibilities for the Bonneville Unit of the CUP from Reclamation to the CUWCD; however, Reclamation still has a responsibility to provide water for the June sucker under the 1994 Biological Opinion on the Provo River Project.

The following summarizes the RPAs identified in the USFWS Biological Opinion on the Effects of Operation of the Provo River Project:

1. Reclamation will identify, acquire, and permanently store a block of water to augment Provo River flows during June sucker spawning and rearing activities, the volume of which will be determined from 1995–1997 studies as identified in the Biological Opinion.

2. Reclamation will ensure that the Provo River Water Users Association's operation of Deer Creek Reservoir, especially during periods of importing the Weber River and Duchesne River water to Utah Lake, are provided as necessary to ensure activities leading up to or during importation do not adversely alter the timing, magnitude, and/or duration of June sucker research flows.

3. Establish a permanent water quality monitoring station within critical habitat. This station would be monitored by Reclamation personnel immediately prior to and during June sucker occupation of the Provo River to determine whether suitable water quality exists for adult and larval June sucker riverine needs. As necessary to protect June sucker, flow-release adjustments would subsequently be accomplished by Reclamation to enhance water quality and quantity conditions.

4. Reclamation will actively cooperate with the USFWS and other members of the Provo River Resource Team, or a subteam thereof, to successfully implement the above activities. This team would meet at least twice a year to specifically discuss June sucker needs, water-year scenarios, options to assist recovery efforts, and activities to implement this RPA. Reclamation and the USFWS would be team co-leads to ensure timely meetings, discussions, and actions.

The CUPCA was enacted October 30, 1992, to provide for the successful completion of the CUP, the largest water development undertaken in Utah. The CUPCA included an increase in authorized funding for the CUP as well as requirements for mitigating impacts to fish, wildlife, and recreation resources. Several Environmental Impact Statements have been completed for various components of the CUPCA-approved water system. Records of Decision for two of these—*1999 Final Supplement to the Final Environmental Impact Statement for the Diamond Fork System* (CUWCD 1999) and the *2004 Utah Lake Drainage Basin Water Delivery System Final Environmental Impact Statement* (CUWCD 2004)—included specific commitments to June sucker recovery. These commitments and their respective completion status are described in Table 1-1.

Among other recovery actions for June sucker listed above, in its August 24, 1999 Biological Opinion issued on the 1999 *Diamond Fork Final Supplement to the Final Environmental Impact Statement*, the USFWS was specific in its recommendation as to how the JLAs should provide habitat development for June sucker:

> The JLAs, in cooperation with the FWS and the June sucker Technical Workgroup, should determine the feasibility of restoring the lower Provo River to obtain past habitat characteristics and complexity. The lower Provo River historically had a complex delta system, which provided braided, slow, meandering channels. This delta system provided low velocity habitat as a refuge and rearing habitat for larval and juvenile June sucker. Re-establishment of the delta system may provide habitat needed by larval and juvenile June sucker to obtain the size needed to reduce predation by nonnative fishes. (USFWS 1999b)

Ultimately, the JLAs and USFWS concurred that making a commitment to implement such a project, which would require the preparation of additional NEPA analysis, was problematic to adopt as a commitment in the Records of Decision for the Diamond Fork System. The JLAs instead made the commitment to "…participate in the development of a Recovery Implementation Program [RIP] for June sucker" and that "…future development of the Bonneville Unit of the CUP will be contingent on the RIP making sufficient progress towards recovery of June sucker" (CUWCD 1999).

Table 1-1. Mitigation commitments for June sucker recovery from previous Environmental Impact Statements.

MITIGATION COMMITMENT	SOURCE	COMPLETION STATUS
The Joint Lead Agencies (JLAs) will identify, acquire and permanently provide a block of water for flows in the lower Provo River through critical habitat, in perpetuity, for June sucker.	Final Supplement to the Final Environmental Impact Statement for the Diamond Fork System (CUWCD 1999)	Ongoing
The Central Utah Water Conservancy District (CUWCD), in cooperation with the other Provo River water users, the U.S. Fish and Wildlife Service and other members of the June Sucker Flow Work Group, will agree on operational scenarios that mimic dry, moderate, and wet years. The CUWCD, with the support of the JLAs and Provo River water users, will apply operational scenarios to the annual Provo River operation to benefit June sucker.	CUWCD 1999	Ongoing, and as part of the proposed action in this EIS
The JLAs will participate in the development of a Recovery Implementation Program (RIP) for June sucker.	CUWCD 1999	Complete and ongoing
The JLAs, in cooperation with the State of Utah and the U.S. Fish and Wildlife Service, will work toward establishment of a refugium (*sic*) in Red Butte Reservoir for June sucker.	CUWCD 1999	Complete
Any future development of the Bonneville Unit of the CUP will be contingent on the RIP making sufficient progress towards recovery of June sucker.	CUWCD 1999	Ongoing
Provide 12,165 acre-feet[2] of water to be released in a pattern based on annual decisions made in coordination with the June Sucker Flow Work Group from Central Utah Project Reservoirs to the lower Provo River for June sucker spawning and rearing flows.	Utah Lake Drainage Basin Water Delivery System [ULS] Environmental Impact Statement (CUWCD 2004)	Upon completion of the ULS
The Utah Reclamation Mitigation and Conservation Commission and the CUWCD will continue to acquire water shares from irrigation companies to provide flows in the lower Provo River to meet a 75 cubic feet per second (cfs) target flow.	The Central Utah Project Completion Act Section 303(c)(4) established a minimum flow of 75 cfs as a target for the lower Provo River.	Ongoing

[2] The originally committed amount of 12,165 acre-feet has grown to 13,879 acre-feet already conserved, including 714 acre-feet acquired with funding authorized under Section 302(a) of CUPCA for acquisition of Provo River water rights.

Table 1-1. Continued.

MITIGATION COMMITMENT	SOURCE	COMPLETION STATUS
Provide 3,300 acre-feet[3] of irrigation company shares of water to flow unregulated to partially meet the 75 cfs target flow in the lower Provo River.	CUWCD 2004	Upon completion of the ULS
An annual average of 16,000 acre-feet of Bonneville Unit water could be delivered to the lower Provo River through the Spanish Fork-Provo Reservoir Canal (SFPRC) Pipeline, when water is needed in Utah Lake for exchange to Jordanelle Reservoir. Timing and pattern of the release would be in coordination with the June Sucker Flow Work Group. [4]	CUWCD 2004	Upon completion of the ULS
An annual average of 12,037 acre-feet of water, of which 4,000 acre-feet will be available annually for June sucker spawning and rearing in Hobble Creek, could be released out of Central Utah Project Reservoirs through the Mapleton-Springville Lateral Pipeline or the SFPRC Pipeline to Hobble Creek and Utah Lake when water is needed for exchange to Jordanelle Reservoir. Timing and pattern of the release would be coordinated with the June Sucker Flow Work Group.	CUWCD 2004	Upon completion of the ULS
The JLAs, in cooperation with the June Sucker RIP and USFWS, [shall initiate] a study to determine the feasibility of providing fish passage or removing the Fort Field Diversion Dam on the lower Provo River for June sucker spawning and rearing.	CUWCD 2004	Fish passage is completed

1.3.8 What water supplies are available to support June sucker in the Provo River?

Several of the mitigation commitments listed in Table 1-1 involve delivery of water in the Provo River for the benefit of June sucker. In this EIS, the term "supplemental water" is generically used to refer to water from several supplies that can be used to provide instream flows. The three main types of water commonly referred to in this EIS as supplemental water, along with a brief explanation of each, follows.

[3] 2,586 acre-feet (minus conveyance losses) were acquired from mutual water companies; 714 acre-feet of this commitment was achieved through Mitigation Commission participation in a Section 207 water conservation project using funding authorized under Section 302(a) of CUPCA.

[4] In emergency conditions, operational changes may be required such that coordination will occur after-the-fact.

Exchange Water

Once complete, the Bonneville Unit's Utah Lake Drainage Basin Water Delivery System (ULS) will provide an average 101,900 acre-feet that will be supplied annually from Strawberry Reservoir: 30,000 acre-feet of M&I water under contract to Salt Lake County; 31,590 acre-feet of M&I water under contract to southern Utah County; and 40,310 acre-feet, minus conveyance losses, would be delivered from Strawberry Reservoir to Utah Lake for exchange to Jordanelle Reservoir under the M&I system.

Of the 40,310 acre-feet, on an average annual basis about 16,273 acre-feet would be released down the Spanish Fork River during the winter months (after serving as winter instream flow in Sixth Water and Diamond Fork Creeks), an average of 16,000 acre-feet would be conveyed through new pipelines to the lower Provo River to assist in meeting instream flows (Table 1-2), and an average of about 8,037 acre-feet would be conveyed to Hobble Creek to assist with the recovery of the June sucker. The average annual amount of 16,000 acre-feet and 8,037 acre-feet that would be exchanged to Jordanelle Reservoir via delivery to the Provo River and Hobble Creek for instream flows to Utah Lake could vary substantially from year to year. The range for the Provo River could vary from 0 to 34,601 acre-feet, and Hobble Creek could vary from 0 to 33,500 acre-feet. This trans-basin exchange follows requirements of Bonneville Unit water rights and the State Engineer's Utah Lake Interim Water Distribution Plan (UDWRT 1992).

Conserved Water

Water conserved under Section 207 of CUPCA can be turned over to the Secretary of the Interior to be used for instream flows. Since the ULS EIS was completed in 2004, the water conservation program of the CUP (known as the CUPCA Section 207 projects) has exceeded anticipated quantities (CUWCD 2004). The originally committed amount of 12,165 acre-feet has increased to 13,879 acre-feet of permanently conserved water. The conserved water would be available each year to assist in meeting target flows for June sucker (Chapter 2, Section 2.6.2 provides additional detail regarding target flows). However, as conserved water originates from the Bonneville Unit M&I water supply, it is subject to the same shortages as other M&I uses.

Potentially, an additional 4,500 acre-feet of conserved water has been identified for possible use in the Provo River and/or Hobble Creek, bringing the total (for Provo River) up to 18,379 acre-feet of conserved water available annually to supplement flows in the lower Provo River (Table 1-2). In the current EIS, the JLAs evaluate the potential use of up to 4,500 additional acre-feet of conserved water combined with the baseline conditions for this reach of the Provo River. Some or all of the 4,500 acre-feet of additional conserved water may be carried to the Provo River through the Spanish Fork–Provo Reservoir Canal Pipeline (SFPRC) pipeline or to Hobble Creek from the SFPRC or Mapleton–Springville Lateral pipelines on a space-available basis.

Acquired Water

Water can be acquired through purchase or lease for use as instream flow water. Under Section 302(a) of CUPCA, the Mitigation Commission and CUWCD were authorized to acquire water rights for the purpose of establishing instream flows in the lower Provo River. When the ULS EIS was completed in 2004, up to 3,300 acre-feet (under a full water supply) had been acquired under the Section 302(a) program. Most (2,586 acre-feet minus conveyance losses) had been purchased as water shares in mutual water companies, and a portion (714 acre-feet) was acquired

Table 1-2. Supplemental water that may be used in the Provo River to support instream flows and June Sucker.

SOURCES	ACRE-FEET OF WATER
Exchange Water	
Bonneville Unit water delivered to the lower Provo River through the Spanish Fork-Provo Reservoir Canal (SFPRC) Pipeline, when water is needed in Utah Lake for exchange to Jordanelle Reservoir	16,000 average annual (0–34,601 range)
Section 207 Projects [a]	
Pleasant Grove	500
Lindon	500
Alpine	875
Highland	1,000
Timpanogos[b]	1,004
Central Utah Water Conservancy District water for Upper East Union Conservation Project	1,000
Pleasant Grove II	1,000
Provo Reservoir Canal Enclosure Project	8,000
Subtotal, Prior Section 207 Projects	**13,879**
Future South Utah County Projects [c]	4,500
Total, Section 207 available water	**18,379**
Acquired Water Shares	
Various Utah County irrigation companies	2,586

[a] Water available from the conservation program of the Central Utah Project Completion Act (CUPCA Section 207) projects. Conserved water is available annually, subject to the same shortages as the Bonneville Unit municipal and industrial water supply.
[b] Includes 714 acre-feet purchased by the Mitigation Commission using Section 302(a) funds
[c] Anticipated Section 207 water to become available with completion of south Utah County projects.

through Mitigation Commission participation in a Section 207 water conservation project with Section 302(a) funds. No additional water shares or water rights have been acquired since that time.

Capacity Constraints and Shortages

Water deliveries through the previously described systems are constrained by actual capacity of the delivery facilities, system shutdowns for periodic maintenance needs, and are also subject to shortages under water rights and water contracts.

1.3.9 Where is more information available?

The JLAs developed a number of technical reports leading up to and in support of the NEPA process for the proposed action. Table 1-3 provides a list of reports that are directly related to this project (note that this is not an exhaustive list of all environmental documents and technical reports related to June sucker recovery, only those that are directly relevant to the proposed action NEPA process). The technical reports prepared specifically for the current NEPA project are available from the project website www.provoriverdelta.us, and other publications may be obtained by contacting the Mitigation Commission.

Table 1-3. **Technical reports and other related documents for the proposed project.**

DOCUMENT TITLE	AGENCIES/ AUTHORS	YEAR	PURPOSE/DESCRIPTION
Water Quality Technical Memorandum (URMCC 2015a)	JLAs	2015	Describes current water quality conditions in the lower Provo River and criteria for evaluating project effects.
Existing Bird Communities and Bird-Aircraft Strike Risk Assessment (URMCC 2015b)	Joint Lead Agencies (JLAs)[a]	2015	Summarizes existing data and surveys of bird populations in and adjacent to the study area and Provo Airport. Assesses potential for the project to change bird-aircraft strike risk.
Wetland Functional Assessment Memorandum (BIO-WEST 2015)	BIO-WEST, Inc.	2014	Describes current and predicted functional ratings for study area wetlands (see Chapter 3, Section 3.5.6, for a summary).
Riparian Vegetation Technical Memorandum (URMCC 2013)	JLAs	2013	Describes the existing Provo River channel riparian forest and surface/ groundwater elevations and develops criteria for evaluating project effects.
Hydraulic Modeling (HEC RAS) Report (Allred 2013)	Allred Restoration, Inc.	2013	Describes existing and post-project water elevations in the Provo River under various flooding scenarios.
Class III Cultural Resource Inventory for the Provo River Delta Restoration Project, Utah County, Utah	Logan Simpson Design, Inc.	2013	Inventory of known cultural resource sites and recommendations.
Alternatives Development Technical Memorandum (URMCC 2011)	JLAs	2011	Describes the processes of developing and evaluating potential alternatives for addressing the purpose and need.
Final Supplement to the Diamond Fork System Environmental Impact Statement (EIS) (CUWCD 1999)	JLAs	1999	Final supplemental EIS for completion of features of the Diamond Fork water delivery system authorized by the Central Utah Project Completion Act.
Final Supplement to the Diamond Fork System Environmental Impact Statement (EIS) (CUWCD 1999)	JLAs	1999	Final supplemental EIS for completion of features of the Diamond Fork water delivery system authorized by the Central Utah Project Completion Act (CUPCA).
Provo River Diversion Dams Evaluation Final Report (URMCC 2001)	URMCC	2001	Evaluation of diversion structures on the lower Provo River in terms of impacts to fish migration, hydrology, sediment transport, and ability to support riparian vegetation.
Feasibility Analysis of Establishing an Additional Spawning Location to Benefit the Endangered June Sucker (Stamp et al. 2002)	Utah Department of Natural Resources	2002	Evaluation of Utah Lake tributaries to determine feasibility of establishing a secondary spawning run.
Utah Lake Drainage Basin Water Delivery System (ULS) – Final EIS and Record of Decision (CUWCD 2004)	JLAs	2004 and 2005	EIS document for completion of the ULS water delivery system authorized by CUPCA.
Lower Provo River Ecosystem Flow Recommendations Final Report (Stamp et al. 2008)	URMCC	2008	Summarizes prior data, reports, and recommendations regarding instream flow targets for the lower Provo River.
Lower Hobble Creek Ecosystem Flow Recommendations	JSRIP[b]	2009	Provided recommendations regarding instream flow targets.

[a] Central Utah Water Conservancy District, Utah Reclamation Mitigation and Conservation Commission, and the U.S. Department of the Interior.
[b] June Sucker Recovery Implementation Program.

1.4 Issues and Areas of Controversy

1.4.1 Relevant Issues Identified in Scoping

Under regulations for implementing NEPA, agencies must determine the issues to be analyzed in depth and identify and eliminate from detailed study the issues that are not significant (40 CFR 1501.7). The JLAs conducted numerous scoping activities to determine relevant issues; these efforts are described in detail in Chapter 4 of this EIS.

Through scoping, relevant issues to be evaluated in detail included potential for the proposed action to result in changes or impacts to the following:

- groundwater and surface water flows;
- flooding potential;
- water quality in the lower Provo River and Utah Lake;
- water rights;
- wetland resource types and functions;
- fisheries, wildlife, and special status species;
- introduction or spread of invasive species;
- land ownership and use;
- agriculture and agriculture-related activities;
- compatibility with adjacent land uses, transportation planning, Provo Airport, and public utilities;
- recreational uses of the existing river channel and associated businesses;
- cultural resources; and
- public health and safety.

1.4.2 Controversial Issue Resolution

Understanding the importance of the lower Provo River to the community, the JLAs engaged key stakeholders early on and throughout the process to help define the range of alternatives and potential ways of enhancing the recreational values and opportunities afforded by the project. A Technical Assistance Team met on multiple occasions and helped to determine a broad range of project alternatives and options for the proposed action, including options for the existing Provo River channel.

Through subsequent public involvement efforts, several key issues emerged that required additional consideration. These included the following:

- effects to existing lower Provo River recreation uses,
- potential water quality effects to the existing channel,
- property acquisition and effects to agricultural land use,
- mosquito abatement, and
- bird-aircraft strike risk.

Existing Provo River Recreation

Even though a broad range of potential options were proposed for the future of the existing river corridor, a perception emerged that the project was proposing to "shut down" or "close" the lower Provo River. There were also concerns that changes in the flow of the existing channel would negatively affect mature trees that provide shade for the Provo River Parkway trail, and there were concerns that existing recreation uses and recreation businesses that utilize the river corridor would be adversely affected.

Responding to these concerns, the JLAs undertook a detailed investigation of riparian vegetation to evaluate potential effects to mature tree stands. In consultation with partners, the JLAs also made a commitment to a minimum flow and flow regime for the existing river channel, which would be retained in its current location with any action alternative (Chapter 2, Section 2.5). Coordination occurred with Utah Lake State Park managers and local business owners to keep them informed of these efforts and to solicit their input.

Following release of the Draft EIS, the JLAs met with representatives of Provo City and Utah County to determine additional recreation facilities and long-term ownership and management of facilities that would be constructed as part of the proposed project. In response to comments from Provo City, an additional new parking area and trailhead were added to the project near the existing river channel. Also in response to Provo City comments, an additional trail segment to the Utah Lake shoreline was added as a component of Alternatives A and B. In response to public comments, an unpaved trail that would be appropriate for equestrian use was also added. Provo City and Utah County agreed that the equestrian trail would be an asset and could be integrated into their plans for recreation facilities in the area. Provo City and Utah County were also agreeable to assuming long-term ownership and management of trails and parking areas that would be constructed within their respective jurisdictions.

Provo River Water Quality

Water quality in the existing channel has been a concern for Provo City and other users of the river and trail system since before the project was proposed. Although water quality in the existing channel is currently impaired during extreme low flow conditions in the summer, the frequency and duration of poor water quality conditions would increase in the existing channel following flow diversions into the newly constructed Provo River and delta area. The existing river channel is heavily used for recreation including biking, jogging, walking, running, and roller-blading on the Provo River Parkway Trail, and fishing and canoeing in the river. A commercial ropes course and a campground are also located adjacent to the river in this reach. The quality of the riverside recreational experience could suffer if further degraded water quality were to lead to more frequent unsightly algae blooms and/or unpleasant odors. Furthermore, the fishery could be impacted if dissolved oxygen concentrations were to drop below lethal levels for a longer duration during the heat of the summer than it currently does.

Responding to these concerns, the JLAs undertook a detailed investigation of existing water quality in the lower Provo River. A resulting technical memorandum (URMCC 2015a) describes the current water quality conditions along the existing lower Provo River channel-Utah Lake interface, including quality effects of interactions between Utah Lake levels, Provo River discharge, and both daily and seasonal air temperature cycles. The JLAs also made a commitment to a minimum flow and flow regime for the existing river channel, and incorporated artificial aeration as a measure to improve water quality conditions in the existing river channel which would be retained in its current location with any action alternative (Chapter 2, Section 2.5). The aeration method and features are described in more detail in Chapter 2 (Section 2.6.3).

Following release of the Draft EIS, the JLAs responded to comments from the U.S. Environmental Protection Agency by conducting additional studies regarding sediment oxygen demand to further understand causes of existing water quality problems in the lower Provo River and the feasibility of relying on aeration in the lower Provo River to maintain State water quality standards for dissolved oxygen. These studies supported the feasibility of the proposed aeration method.

Property Acquisition and Effects on Agricultural Land Use

Landowners and local citizens value lands near the Provo River-Utah Lake interface for their agricultural character and heritage. Landowners suggested alternatives, including use of existing canals and alternate project locations. All suggestions were considered; however, it was determined that many would fall short of meeting the project need. Through multiple meetings with landowners, revisions were made to one of the project alternatives that would reduce the level of effects to existing land uses and most owners from what had been proposed to date while still having sufficient habitat creation to meet the project need. That revised alternative is presented in the Draft and Final EIS as Alternative B, the Preferred Alternative.

Mosquito Abatement

In scoping, concern was expressed that the project would increase abundance of mosquitoes. The JLAs coordinated with the Utah County Health Department to complete a baseline assessment of mosquito production in the study area and to develop a mosquito abatement plan that would be implemented with any of the action alternatives.

Bird-Aircraft Strike Risk

Provo City identified a concern that the project would attract more birds to the area and would increase the bird-aircraft strike risk at Provo Airport. During meetings with Provo City and the Federal Aviation Administration (FAA), the JLAs learned that Provo City had plans to conduct a Wildlife Hazard Assessment for Provo Airport in 2013. As a result of these meetings, the JLAs invited FAA to become a cooperating agency and review the portions of the EIS that evaluate bird-aircraft strike risks at Provo Airport. Several meetings were held with Provo City, FAA, and U.S. Department of Agriculture (USDA) Wildlife Services to coordinate studies and share information regarding existing and predicted bird communities, their risk to aircraft, and potential mitigation measures. A detailed technical report was prepared supporting the analysis provided in the Draft EIS, and the technical report was updated with additional information and analysis in support of the Final EIS (URMCC 2015b). Following release of the Draft EIS, representatives of FAA, USDA Wildlife Services, Provo City, and the Utah Valley University Aviation Sciences program worked with the JLAs to develop a Memorandum of Agreement detailing the arrangements for a mitigation and monitoring program that would be implemented with the proposed action.

As previously mentioned, all technical reports supporting these evaluations are available from the project website, www.provoriverdelta.us, or may be obtained by contacting the Mitigation Commission. Chapter 4 includes more information about consultation and coordination activities that occurred throughout the EIS process.

1.5 Decision to Be Made

Based on the analysis in this Final EIS, and comments received during the public comment period, the responsible officials will determine which action alternative, if any, should be implemented. The JLAs may also select components from the various alternatives that have been evaluated in detail. The selected alternative will be identified at the time the federal agencies issue their Records of Decision (ROD).

This EIS is intended to satisfy public involvement and disclosure requirements of the NEPA process and to serve as the compliance document for Clean Water Act Section 404 permitting, compliance with Section 7 of the ESA, coordination requirements of the Fish and Wildlife Coordination Act, and compliance with Section 106 of the National Historic Preservation Act.

1.6 Required Permits, Authorizations, and Agreements

Table 1-4 lists required permits, approvals, and agreements that would be necessary for implementing the proposed action.

Table 1-4. Required permits, approvals, and agreements.

ENTITY	PERMIT/APPROVAL/AGREEMENT	REQUIRED FOR
Central Utah Water Conservancy District (CUWCD)	Operation, Maintenance, and Replacement Agreement between JSRIP and CUWCD	Facility to divert water between existing Provo River channel and new Provo River delta
Occupational Safety and Health Administration	Construction permit	Worker safety and health
Private Landowners	Land purchase contracts	Acquisition of property needed for project implementation
Provo City	Operation, Maintenance, and Replacement Agreement between JSRIP and Provo City	Aeration facilities for existing Provo River channel

Table 1-4. Continued.

ENTITY	PERMIT/APPROVAL/AGREEMENT[5]	REQUIRED FOR
Provo City	Operation, Maintenance, and Replacement Agreement between JSRIP and Provo City	Management of recreation sites along existing Provo River channel
Provo City (Public Works)	Construction permit	Utility construction within Provo City limits
	Agreement	Wetlands mitigation area
	Agreement (including Joint Lead Agencies, Federal Aviation Administration, USDA Wildlife Services, others)	Monitoring and mitigation of wildlife (birds) safety hazards at Provo Airport
U.S. Army Corps of Engineers	Section 404, Clean Water Act, 33 USC 1341 (individual permit or Nationwide Permit 27)	Discharge of dredge/fill materials into waters of the United States, including wetlands; impacts on aquatic ecosystems
U.S. Bureau of Reclamation	Construction access permit	Construction of project on Reclamation lands
U.S. Fish and Wildlife Service	Section 7 Consultation, Biological Opinion (Endangered Species Act, 16 USC 1531-1544)	Compliance with Endangered Species Act of 1973
	Fish and Wildlife Coordination Act, 16 USC 661-667	Documenting that fish and wildlife resources receive adequate consideration through Fish and Wildlife Coordination Act Planning Aid Report
Utah County	Grading permit	Excavation and fill activities
	Road encroachment	Activities within county rights-of-way
	Transportation permit	Transport of overloads on county road rights-of-way
	Agreement	Remove/replace trails and facilities for recreation; relocate portion of Boat Harbor Drive
	Implementation Agreement	Mosquito Monitoring and Control
Utah County [and/or Private Contractors]	Implementation Agreement	Vegetation Management/ Noxious Weed Control
Utah County [Planning]	Use permit	Activities where use is conditional in a particular zone
Utah County [Public Works]	Operation, Maintenance, and Replacement Agreement between USA, State of Utah and Utah County	Recreational facilities in delta restoration area
Utah Department of Natural Resources	Agreement between USA and State of Utah	Land management of restored Provo River delta area
Utah Department of Public Safety – Utah Highway Patrol	Transportation permit (Utah Code Annotated Section 2712155)	Transporting overloads

[5] See section 2.6 for more detailed discussion of management and operation of project features and land area.

Table 1-4. Continued.

ENTITY	PERMIT/APPROVAL/AGREEMENT[6]	REQUIRED FOR
Utah Division of Air Quality	Construction permit	Permit to gauge emissions during construction and to approve fugitive dust control measures
Utah Division of Forestry Fire and State Lands	Construction access permit	Access/construction on State-owned lands
Utah Division of Water Quality	General construction activity stormwater permit, UPDES	Stormwater discharges associated with construction activity
	401 Certification (Clean Water Act, 33 USC 1341)	Discharge into waters and wetlands
	Utah Pollutant Discharge Elimination System (UPDES) Permit (Section 402 Clean Water Act)	Construction projects that disturb more than 1 acre of land must obtain a UPDES permit and prepare a Stormwater Pollution Prevention Plan to minimize impacts to water quality
Utah Division of Water Rights	Stream channel alteration permit (Utah Code Annotated Section 73-3-29)	Change in river or stream
Utah Division of Wildlife Resources	Concurrence	Fish and Wildlife Coordination Act Planning Aid Report
Utah State Historic Preservation Office	Section 106 Consultation (National Historic Preservation Act, 16 USC 470), Programmatic Agreement between SHPO, JLAs, U.S. Army Corps of Engineers and with Utah Statewide Archaeological Society and Utah Public Lands Coordination Office as Consulting Parties National Historic Landmarks Program (36 CFR 65)	Historic, architectural, archaeological or cultural characteristics of properties that meet National Register of Historic Places criteria
	Cultural resource use permit (Utah Code Annotated Section 631825)	Surveys or disturbance to archaeological or paleontological sites on state lands

1.7 Interrelated Projects

The following projects/programs are anticipated to be implemented or in development within the general location and time frame of the proposed action that is evaluated in this EIS. Project ownership is indicated in parentheses.

- Provo Lakeview Parkway and Trail (Provo City)
- Fort Field Diversion Dam Reconstruction (JLAs)

[6] See section 2.6 for more detailed discussion of management and operation of project features and land area.

- Hobble Creek Restoration, East and West projects (JSRIP)
- Removal and Control of Nonnative Carp in Utah Lake (JSRIP)
- Utah Lake phragmites control efforts (Utah County, Utah Lake Commission, Utah Division of Forestry, Fire, and State Lands)
- Provo City Airport Wildlife Hazard Assessment and Wildlife Hazard Management Plan (Provo City)
- Provo Westside Connector and associated wetland mitigation in Provo Bay (Provo City)
- Provo City Wetland Mitigation Site (Provo City)
- Utah Lake Wetlands Preserve (Mitigation Commission)
- Utah Lake Drainage Basin Water Delivery System (JLAs)

These planned/ongoing projects and efforts are considered as appropriate in the evaluations of cumulative effects in Chapter 3, along with other relevant past projects.

PROVO RIVER DELTA RESTORATION PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT

Chapter 2: Alternatives

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Note: Figures for Chapter 2 are included in Appendix A, as referenced throughout the chapter.

CHAPTER 2: ALTERNATIVES

In this chapter, the Joint Lead Agencies (JLAs) provide detailed descriptions of the action alternatives and the No-Action Alternative, including a summary of environmental impacts (40 CFR 1502.14). The JLAs also present a discussion of the process through which alternatives were identified and developed for detailed analysis in this Final Environmental Impact Statement (Final EIS), including explanations of why some alternatives considered were not advanced for detailed analysis.

The alternatives descriptions and maps are intended to provide a feasibility-level design. Some slight changes in exact channel pattern and profiles are expected, along with additional construction and revegetation details in the final design. Additional field-fit modifications would also be expected during implementation. These design changes would be based on best professional judgment during the final design and implementation phases of the project and are not expected to change the impact analysis of this EIS.

2.1 Chapter Organization

There are three action alternatives evaluated in detail in this EIS for reestablishing a delta ecosystem at the mouth of Provo River—Alternatives A, B, and C. Distinguishing features of these alternatives are described in Sections 2.2, 2.3, and 2.4 of this chapter, respectively. Large-format figures illustrating alternatives are provided in Appendix A.

Two options for the existing river channel are also carried forward for detailed analysis; these options are described in Section 2.5. Either of the two existing river channel options could be paired with any of the three delta-restoration action alternatives. Diversion structures associated with either option would be designed and built as part of the project, and operated by Central Utah Water Conservancy District (CUWCD) for the June Sucker Recovery Implementation Program (JSRIP).

Features that the action alternatives have in common are described in Section 2.6. The No-Action Alternative is described in Section 2.7. Alternatives considered but not advanced are described in Section 2.9, along with reasons why these alternatives were dismissed.

This chapter also provides a summary comparison of the alternatives (Section 2.8) and a summary of environmental commitments (Section 2.10).

2.2 Alternative A

With Alternative A the main flow of the Provo River would be directed into a restored river delta area as shown in Appendix A, Figure A-1. Alternative A was designed to maximize the available rearing and spawning habitat for June sucker (*Chasmistes liorus*) north of Boat Harbor Drive. The acquisition boundary for Alternative A encompasses 507.3 acres. A diversion dam would be constructed in the Provo River (jurisdiction waters of the United States) and a new channel constructed to divert flow from the existing channel into the delta. A new outlet dam would be constructed in the lower portion of Provo River/Utah Lake under Option 2. Alternative A would require small amounts of fill to be placed in wetlands associated with partially filling undesirable drainage ditches.

2.2.1 New Provo River Channel and Delta Area

A diversion structure would be constructed at a location approximately 900 feet downstream of the existing Lakeshore Drive Bridge; Figure A-2 in Appendix A provides a close-up view of this vicinity. The structure would be designed in consultation and coordination with the CUWCD and the U.S. Bureau of Reclamation (Reclamation). The majority of the total river flow would be diverted into the restored delta area, but the diversion structure would include a mechanism to supply a flow of 10–50 cubic feet per second (cfs) to the existing river channel, which would be kept in place and maintained for existing and enhanced recreational opportunities (see Section 2.5 for additional details regarding existing channel options and Sections 2.6.2 regarding management of flows and 2.6.3 regarding enhancement of existing channel water quality).

From the diversion point, a meandering river channel would be excavated until it crosses the 4,491-foot contour. The first 400 feet of the new channel would remain confined similar to the existing channel, facilitating the potential construction of a future bridge crossing for a new roadway that has been proposed by Provo City, known as the Provo Lakeview Parkway and Trail. Over the next 2,200 feet, the channel would primarily be single-threaded with an average streambed slope of approximately 0.2 percent. An 800-foot-wide floodplain is included in the preliminary design and land-acquisition boundary. This space would allow room for the channel to migrate over time, creating a floodplain with a natural mosaic of riparian forests, open water, oxbows, emergent wetlands, and grassed uplands. The meandering channel would enhance spawning habitat for June sucker by allowing development and maintenance of a complex series of pools and riffles.

At about the 4,491-foot contour, the river would begin to divide into a distributary pattern. This very flat and broad portion of the project area would be influenced by both river and lake processes. Some initial channels and oxbow/pool features would be excavated within this zone. Other features that are common to naturally formed delta environments—such as abandoned channels, oxbow wetlands, and natural dikes—would be expected to form over time, adding to the desired habitat complexity of the project area. Portions of the existing Skipper Bay dike would be lowered to the elevations indicated in Figure A-1. This would allow Utah Lake to inundate the project area and would retain water at a slightly higher elevation than the lake as the lake recedes to lower elevations, enhancing habitat value for rearing June sucker.

To prevent surface water from intruding south of the project area, a new berm would be constructed north of Boat Harbor Drive. At the southeast end of the project area, the berm would tie into the existing north levee and trail on the northwest side of the Provo River at an elevation of approximately 4,498 feet (Figure A-2). The berm would descend in elevation, approximately 0.2 to 0.3 percent for 1,000 to 1,500 feet, to match the drop of the Provo River until it reached an elevation of 4,495 feet. The berm would continue west at an elevation of 4,495 feet until it tied in with the Skipper Bay dike trail near Utah Lake State Park. For analysis purposes, a berm with a base 30–70 feet wide was assumed; actual dimensions and structural characteristics of the berm would be determined in final design. The preliminary design for the berm illustrated in Figure A-1 meanders away from Boat Harbor Drive periodically, creating pockets of land between the road and the berm that could be planted with trees and other desirable vegetation. This vegetated buffer would provide shade for a new trail that would be constructed on the berm. To the east and northeast of the property acquisition boundary, an existing topographic rise would prevent surface water from intruding beyond the project area under normal, high-lake elevations.

2.2.2 Boat Harbor Drive Realignment

With Alternative A, a portion of Boat Harbor Drive would be rerouted in the right-of-way illustrated in Figure A-1 and in the close-up view in Figure A-2. This alignment is consistent with Provo City and Utah County design standards. The alignment has been routed to avoid existing wetlands and to minimize the number of privately owned land parcels that would be affected. The preliminary design includes a bridge over the existing river channel. The bridge would allow trails on both sides of the existing river channel to be routed underneath the realigned road. The easternmost portion of the existing Boat Harbor Drive would be retained as a dead-end access road, providing access from Lakeshore Drive to a Provo City pump facility on the north side of the road and an existing recreational trailhead on the south side.

2.2.3 Recreation Components

Alternative A would be paired with one of the two options for the existing channel that are described in Section 2.5. With either option, existing trails along the Provo River would be retained. A new pedestrian bridge would be constructed for the trail on the north side of the channel to cross over the new river channel.

New Parking Areas/Trailheads

An existing parking lot on the north side of the existing channel known as Alligator Park would be expanded with Alternative A. New parking and river access would also be built to the north of Boat Harbor Drive at a location to the west of the existing Alligator Park. A new parking area and trailhead would also be constructed on the south side of the existing river channel, near where the realigned Boat Harbor Drive would intersect with Lakeshore Drive.

Trails

Approximately 1 mile of new trail would be constructed on the new berm constructed north of Boat Harbor Drive. This trail would connect to the existing Provo River Trail on the east end and to the Provo River trail on the west end, creating a new loop for trail users. A viewing tower is proposed at the end of the remaining portion of the Skipper Bay dike trail. Additionally, the berm/trail segment would also incorporate a separate unpaved pathway intended for equestrian use. Width of the pathway would vary depending on location, but would be a minimum of 2 feet wide along the entire length. At least one of the proposed parking areas would include space to accommodate several horse trailers, as well as essential equestrian features such as a hitching rail. Equestrian use of other existing or proposed connecting trails (e.g., Skipper Bay dike trail, Provo River Parkway, Provo Lakeview Parkway and Trail) would be decided by Utah County or Provo City, depending on jurisdiction of respective trail segments.

A right-of-way would be designated for construction of a short east-west trail segment on the north end of the study area (Appendix A, Figure A-1). This segment (approximately 1,658 feet in length) would be developed in concert with Provo City's planned Provo Lakeview Parkway and Trail. It would likely be developed as an unpaved trail to the Utah Lake shoreline at the northwest corner of the proposed project's property acquisition boundary. Wetland impact avoidance would be necessary for developing the trail segment, including a possible bridge or boardwalk structure for an undetermined portion of the trail length. A second viewing tower would be constructed at the west end of the trail. However, this trail segment and viewing tower would not be built under Alternative A in the absence of Provo City's connecting trail associated with the proposed parkway.

2.3 Alternative B – The Preferred Alternative

Alternative B (illustrated in Appendix A, Figure A-3) has been designated by the JLAs as the preferred alternative. It was developed and then revised with substantial involvement from study area landowners and other stakeholders. It was designed to reduce the amount of private land that would be acquired, especially the higher-value agricultural lands to the south, while still meeting June sucker spawning and rearing habitat improvement needs. Alternative B also meets screening criteria (URMCC 2011) for the riparian channel meander width and delta width that would sufficiently meet the need for June sucker spawning and rearing habitat improvements. The Alternative B acquisition boundary encompasses 310.3 acres. A berm would be constructed along a portion of the south property acquisition boundary to prevent lake inundation and river channel migration onto the agricultural lands that would not be acquired. A diversion dam would be constructed in the Provo River (Jurisdictional Waters of the U.S.) and a new channel constructed to direct the majority of the river's flow into the new delta. Small amounts of fill would be placed in wetlands under Alternative B to construct the berm and partially fill undesirable drainage ditches.

2.3.1 New Provo River Channel and Delta Area

With Alternative B, the majority of the Provo River flow would be routed northwestward of the existing channel into a restored river delta area. A diversion structure would be designed in consultation and coordination with the CUWCD and Reclamation. Figure A-4 (Appendix A) provides a close-up view of the diversion structure vicinity and realignment of a portion of Boat Harbor Drive. The majority of the total river flow would be directed into the restored delta area, but the diversion structure would include a mechanism to supply a flow of 10–50 cfs to the existing river channel, which would be kept in place and maintained for existing and enhanced recreational opportunities (see Section 2.5 for additional details regarding existing channel options and Sections 2.6.2 regarding management of flows and 2.6.3 regarding enhancement of existing channel water quality).

From the diversion point, a meandering river channel would be excavated until it crosses the 4,489-feet contour. The first 750 feet of the new channel would remain confined similar to the existing channel, facilitating the potential construction of a future bridge crossing for a new roadway that has been proposed by Provo City, known as the Provo Lakeview Parkway and Trail. Over the next 1,610 feet the channel would primarily be single-threaded with an average streambed slope of approximately 0.3 percent. Maintaining the single channel for this length would be necessary with Alternative B for the purpose of avoiding impacts to some areas where Ute ladies'-tresses (*Spiranthes diluvialis*) have been identified. Ute ladies'-tresses is a species of orchid listed as threatened under the Endangered Species Act; Chapter 3 includes an impact assessment. An 800-foot-wide floodplain is included in the preliminary design and land-acquisition boundary. This space would allow room for the channel to migrate over time, creating a floodplain with a natural mosaic of riparian forests, open water, oxbows, emergent wetlands, and grassed uplands. The meandering channel would enhance spawning habitat for June sucker by allowing development and maintenance of a complex series of pools and riffles.

At about the 4,489-foot contour, the river would begin to divide into a distributary pattern. This very flat and broad portion of the project area would be influenced by both river and lake processes. Some initial channels and oxbow/pool features would be excavated within this zone. Other features that are common to naturally formed delta environments—such as abandoned channels, oxbow wetlands, and natural dikes—would be expected to form over time, adding to the desired habitat complexity of the project area.

To prevent surface water from intruding south of the project area, a new berm would be constructed along the south acquisition boundary for Alternative B. At the southeast end of the project area, the berm would tie into the existing north levee and trail on the northwest side of the Provo River at an elevation of approximately 4,498 feet (Figure A-3). The berm would descend in elevation, approximately 0.2–0.3 percent for 1,000–1,500 feet, to match the drop of the Provo River until it reached an elevation of 4,495 feet. The berm would continue west at an elevation of 4,495 until it tied in with the Skipper Bay dike and trail north of Utah Lake State Park. For analysis purposes, a berm with 3:1 side slopes and a base 30-70 feet wide was evaluated; the actual dimensions and structural characteristics of the berm would be determined in final design. To the east and northeast of the property acquisition boundary (shown in Figure A-3), an existing topographic rise would prevent surface water from intruding beyond the project area under normal, high-lake elevations.

2.3.2 Boat Harbor Drive Realignment

With Alternative B, a portion of Boat Harbor Drive would be rerouted in the right-of-way illustrated in Figure A-3 and in the close-up view in Figure A-4. The preliminary design is consistent with Provo City and Utah County design standards. The alignment has been routed to avoid existing wetlands and to minimize the number of privately owned land parcels that would be affected. A new bridge over the existing channel would allow existing trails on each side of the existing river channel to be routed underneath the realigned road. The eastern most portion of the existing Boat Harbor Drive would be retained as a dead-end access road, providing access from Lakeshore Drive to a Provo City pump facility on the north side of the road and an existing recreational trailhead on the south side.

2.3.3 Recreation Components

Alternative B would be paired with one of the existing channel options (Section 2.5), which would retain and enhance existing recreation uses. Existing trails along the Provo River would be retained. A new pedestrian bridge would be constructed across the new channel alignment near the diversion point.

<u>New Parking Areas/Trailheads</u>

A new parking area and trailhead would be constructed on the south side of the existing river channel, near where the realigned Boat Harbor Drive would intersect with Lakeshore Drive. Additionally, a new parking area providing access to the restored river delta area would be constructed as illustrated in Figure A-3. This access would require an easement for a portion of an existing private property access road. A portion of this property access road would also be realigned along a portion of the berm, as illustrated in Figure A-3. Under Alternative B, no property acquisition would occur in the vicinity of Alligator Park, so this existing facility would not be improved as a component of the proposed project.

Trails

Approximately 1.2 miles of new trail would be constructed on the new berm. This trail would connect to the existing Provo River Trail on the east end with a trail segment adjacent to the realigned portion of Boat Harbor Drive. On the west end the new trail would connect to the remaining portion of the Skipper Bay dike trail, creating a complete loop for trail users with inclusion of an existing connection between trails along a small segment of 4200 West Street. A viewing tower is proposed at the end of the remaining portion of the Skipper Bay dike trail.

Additionally, the berm trail segment would also incorporate a separate unpaved pathway intended for equestrian use. Width of the pathway would vary depending on location, but would be a minimum of 2 feet wide along the entire length. At least one of the proposed parking areas would include space to accommodate several horse trailers, as well as essential equestrian features such as a hitching rail.

A right-of-way would be designated for construction of a short east-west trail segment on the north end of the study area (Appendix A, Figure A-3). This segment (approximately 1,658 feet in length) would be developed in concert with Provo City's planned Provo Lakeview Parkway and Trail. It would likely be developed as an unpaved trail to the Utah Lake shoreline at the northwest corner of the proposed project's property acquisition boundary. Wetland impact avoidance would be necessary for developing the trail segment, including a possible bridge or boardwalk structure for an undetermined portion of the trail length. A second viewing tower would be constructed at the west end of the trail. However, this trail segment and viewing tower would not be built under Alternative B in the absence of Provo City's connecting trail associated with the proposed parkway.

2.4 Alternative C

Alternative C (illustrated in Appendix A, Figure A-5) was designed to exclude existing peat wetlands located on the east and north sides of the project area from the restoration project, while still meeting June sucker spawning and rearing habitat improvement needs for the project by using lands to the south of these wetlands. The Alternative C acquisition boundary encompasses 298.3 acres. A berm would be constructed to an elevation of 4,495 feet along the north property acquisition boundary to prevent lake inundation and river channel migration onto the existing peat soils (emergent marsh and wet meadow wetlands) and the other lands that would not be acquired. A berm along Boat Harbor Drive would also be necessary to prevent surface water from intruding south of the property acquisition area. This berm along Boat Harbor Drive would be the same design as described for Alternative A. A diversion dam would be constructed in the Provo River (Jurisdictional Waters of the U.S.) and a new channel constructed to divert flow from the existing channel into the delta. A new outlet dam would be constructed in the lower portion of Provo River/Utah Lake under Option 2. Alternative C would require fill to be placed in wetlands associated with the north berm and to partially fill undesirable drainage ditches.

2.4.1 New Provo River Channel and Delta Area

With Alternative C, the majority of the Provo River flow would be directed into a restored river delta area in a similar manner as described and illustrated for Alternative A. However, the delta would be restricted to primarily occur on the existing upland agricultural fields located on the southern portion of the study area.

2.4.2 Boat Harbor Drive Realignment

Alternative C includes the same conceptual realignment of a portion of Boat Harbor Drive as Alternative A. This is illustrated in Figure A-5 and in the close-up view in Figure A-2. This alignment is consistent with the Provo City and Utah County design standards. The alignment has been routed to avoid existing wetlands and to minimize the number of privately owned land parcels that would be affected. The preliminary design includes a bridge over the existing river channel. This bridge would allow existing trails on both sides of the existing river channel to be routed underneath the realigned road. The easternmost portion of the existing Boat Harbor Drive would be retained as a dead-end access road, providing access from Lakeshore Drive to a Provo City pump facility on the north side of the road and an existing recreational trailhead on the south side.

2.4.3 Recreation Components

Alternative C would be paired with one of the two options for the existing channel that are described in Section 2.5. With either option, existing trails along the Provo River would be retained. A new pedestrian bridge would be constructed for the trail on the north side of the channel to cross over the new river channel.

New Parking Areas/Trailheads

An existing parking lot along the existing Provo River Trail known as Alligator Park would be expanded. A new parking and river access would be added at a location north of Boat Harbor Drive and to the west of the existing Alligator Park, same as under Alternative A, and a new parking area and trailhead would be constructed on the south side of the existing river channel, near where the realigned Boat Harbor Drive would intersect with Lakeshore Drive.

Trails

Approximately 2.2 miles of new trail would be constructed on the new berms located parallel to Boat Harbor Drive and along the northern property acquisition boundary. Trees would be planted on the south side of the Boat Harbor Drive berm to provide shading for those using the trail. The new trail along Boat Harbor Drive would connect to the existing Provo River Trail on the east end and to the remaining portion of the Skipper Bay dike trail on the west end, creating a new loop for trail users. A viewing tower is proposed at the end of the remaining portion of the Skipper Bay dike trail. The trail on the northern berm would terminate at the existing end of the Skipper Bay dike. Additionally, the berm/trail segments would also incorporate a separate unpaved pathway intended for equestrian use. Width of the pathway would vary depending on location, but would be a minimum of 2 feet wide along the entire length. At least one of the proposed parking areas would include space to accommodate several horse trailers, as well as essential equestrian features such as a hitching rail. Equestrian use of other existing or proposed connecting trails (e.g., Skipper Bay dike trail, Provo River Parkway, Provo Lakeview Parkway and Trail) would be decided by Utah County or Provo City, depending on jurisdiction of respective trail segments. An existing picnic table and shade structure on the end of Skipper Bay dike could be retained at that location with the new berm trail. A second viewing tower is proposed for this location.

Under Alternative A or B, a trail right-of-way is included to provide a trail connection from Provo City's proposed Provo Lakeview Parkway and Trail to the Utah Lake shoreline; however, under Alternative C no property acquisition would occur in the vicinity of the proposed trail. Therefore, Alternative C does not include this trail segment, although Alternative C would provide access to the same shoreline area by way of the proposed northern berm trail.

2.5 Existing Provo River Channel Options

Any of the action alternatives would direct the majority of the Provo River flow to an area north of the existing lower Provo River channel, as described in Sections 2.2, 2.3, and 2.4. However, the existing river channel would be kept in place and managed for recreational, aesthetic, and fishery uses. The existing channel would always be provided with a portion of the total river flow as described in Section 2.5.1. A riparian wet meadow with small channel feature would be constructed immediately downstream of the delta diversion structure to better accommodate the new 10–50 cfs flow regime. Any additional alterations to the existing channel would be detailed during the final design and included in the Section 404 and stream alteration permit application process. Two options for the existing river channel were advanced for detailed analysis in this EIS; Section 2.9.2 describes other options that were considered but not carried forward. Figure A-6 in Appendix A illustrates the two options for the existing river channel, and Figure A-7 compares typical channel cross sections for the two options.

Under either Option 1 or Option 2, the JLAs would construct and install an aeration system in the existing lower Provo River channel. The aeration system would improve water quality by increasing dissolved oxygen (DO) concentrations. The aeration system would be intended for year-round use initially to oxygenate the bottom sediments and improve conditions for beneficial microbes, which will reduce the muck layer that is currently on the channel bottom, and then will be operated as needed to maintain State water quality standards for DO. In particular, this system would be expected to improve water quality during the hot summer months compared to existing conditions.

During the planning process for the project, Provo City requested consideration of ways to temporarily provide higher water surface elevations in the existing channel in order to allow the City to examine the south levee under high water conditions. Under either Option 1 or Option 2, the JLAs would coordinate with Provo City during final design and construction of the existing channel to provide opportunities to periodically and temporarily raise water levels for the purpose of testing the structural integrity of the south levee for operation and maintenance purposes. Strategies will be sought to raise water levels in the existing channel where possible without flooding adjacent properties or impacting other uses/users of the existing Provo River corridor.

2.5.1 Flow to Support Existing River Channel Options

As previously mentioned, under any of the action alternatives a flow of 10–50 cfs would be provided to the existing channel. This flow would support either of the two existing river channel options. To meet this commitment, the JLAs have proposed the flow regime illustrated in Table 2-1 for allocation of the available flow at any given time.

2.5.2 Option 1: Fluctuating Water Elevations Open to Utah Lake

Under Option 1, the mouth of the existing channel would be left as-is and the channel provided with a year-round flow. Flows released to the existing river channel from the diversion structure would vary from 10 cfs up to 50 cfs (Table 2-1).

A portion of the existing channel from the new diversion structure downstream to the existing fish weir (about 1,000 feet in length) would become a narrower channel, and a denser riparian vegetation community would likely develop through this reach. This feature is shown in Appendix A, Figures A-2 and A-4 as a riparian wet meadow with small channel feature. Downstream of this point, the channel would look similar to existing conditions during most summer low-flow periods.

The trail on the north side of the existing channel would remain intact and mostly unchanged—an underpass beneath the realigned portion of Boat Harbor Drive and a new pedestrian bridge over the newly aligned river channel would be constructed to maintain and enhance the trail. Ownership of lands surrounding the existing channel would not be expected to change as a result of the project, except for the location of the diversion dam and the new Boat Harbor Drive crossing location. Boating access from Provo River to Utah Lake would not be modified as a result of the project under Option 1 and boating use regulations would remain the responsibility of Utah County and the Utah Division of State Parks and Recreation.

2.5.3 Option 2: Managed Water Elevation Separate from Utah Lake

With Option 2, a small dam or weir would be constructed across the Provo River channel near Utah Lake, approximately 600 feet downstream of Center Street Bridge, near an existing walking bridge that crosses the river to the south from Utah Lake State Park. This dam would allow for a stable water elevation of approximately 4,489 to 4,490 feet in the existing channel, creating a linear “pond” between this dam and the upstream diversion structure that diverts the main channel into the new river delta area. The same 10 to 50 cfs flow as provided in Option 1 would be delivered to this existing channel pond. The dam/weir would include an outlet to release this flow to Utah Lake. It would also include facilities to allow pumping of the water into Utah Lake if/when Utah Lake elevation exceeds 4,490 feet, negating the option of gravity flow.

The trail on the north side of the existing channel would remain intact and mostly unchanged, with the same underpass and bridge as Option 1 to maintain and enhance the trail. Ownership of lands surrounding the channel would not change as a result of the project except for the locations of the diversion structure, the dam/weir near the mouth of the lake, and the Boat Harbor Drive crossing. Boating access locations would not be modified as a result of the project, but direct boat access to Utah Lake from the existing river channel would be blocked and would require a short portage over the dam or weir. Boating use regulations for the channel would remain the responsibility of Utah County and the Utah Division of State Parks and Recreation.

Table 2-1. Allocation of Provo River Flow to river delta (Alternative A, B, or C) and existing channel (Option 1 or 2).

TOTAL AVAILABLE FLOW (CUBIC FEET PER SECOND)	FLOW ALLOCATED TO NEW RIVER CHANNEL/RIVER DELTA (CUBIC FEET PER SECOND)	FLOW ALLOCATED TO EXISTING CHANNEL (CUBIC FEET PER SECOND)
10	0	10
20	10	10
30	20	10
40	30	10
50	40	10
60	50	10
70	60	10
80	70	10
90	80	10
100	90	10
110	99	11
120	108	12
130	117	13
140	126	14
150	135	15
160	144	16
170	153	17
180	162	18
190	171	19
200	180	20
300	270	30
400	360	40
500	450	50
600	550	50
700	650	50
800	750	50
900	850	50
1,000	950	50
1,100	1,050	50
1,200	1,150	50
1,300	1,250	50
1,400	1,350	50
1,500	1,450	50
1,600	1,550	50
1,700	1,650	50
1,800	1,750	50
Greater than 1,800	Flow - 50	50

Potential variations could be incorporated with this option with respect to identifying the most preferable water elevation for the pond (probably somewhere between 4,489 and 4,490 feet), and possibly to create multiple ponds from the existing river channel. A number of excellent, detailed suggestions were provided during the public scoping process regarding this option relative to creating a fishery and other recreation ideas. If this option is selected, during final design and with input from local users and adjacent landowners, these variations could be incorporated.

2.6 Features Common to the Action Alternatives

To ensure the operational integrity and viability of the project, there are some features that would be common to any of the three action alternatives. Other design elements that the action alternatives have in common were developed in response to comments by participants in the scoping process, including interested agencies, stakeholders, and the general public.

2.6.1 Stream Channel and River Delta Features

The stream channel conditions in the lower Provo River and its interface with Utah Lake are of critical importance to the success of the proposed action, and are thus an area of specific focus under any action alternative. The channelized, diked, dredged condition of the existing channel greatly limits suitable rearing habitat for larval and juvenile June sucker and increases the susceptibility of young June sucker to predation (URMCC 2011). All of the action alternatives would create a more naturally functioning stream channel and delta ecosystem, and would be designed to provide habitats essential for successful June sucker spawning, hatching, larval transport, rearing, and recruitment.

Under any of the action alternatives, the Provo River would be conveyed through the project area to Utah Lake and the existing channel would no longer be the main flow conveyance. Upstream of the project area, the physical Provo River stream channel conditions would not be modified as a result of this project. However, related JSRIP projects would seek to modify existing irrigation diversion structures on the Provo River that limit fish passage. In 2009 modification of the Fort Field Diversion was completed for this purpose.

Within the project area, any of the action alternatives would change the plan form, cross-sectional, and longitudinal shape of the new lower Provo River channel as it approaches and enters Utah Lake. Under any of the action alternatives, channel slope would decrease downstream of the point where significant channel braiding begins. The multi-threaded channel design would promote the development of complex habitats suitable as rearing habitat for June sucker. The channels and excavated floodplain ponds would also allow for more gradual mixing of river water and lake water, which would help prevent the steep thermal gradient that occurs where the existing diked Provo River channel enters Utah Lake. This portion of the project area would be influenced by both lake and riverine processes. Comparable features would be constructed under any of the three action alternatives, but the overall width available for dynamic delta processes would vary by alternative (Table 2-2).

Table 2-2. Stream channel and delta feature characteristics by alternative.

FEATURE	BASELINE CONDITIONS	ACTION ALTERNATIVES		
		A	B	C
Riverine channel length (feet) (existing or enhanced spawning habitat within the study area portion of the lower Provo River)	2,180 [a]	2,600	2,360	2,600
Channel slope (riverine section)	0.3%	0.2%	0.3%	0.2%
Width of floodplain/riparian corridor in spawning reach (feet)	100	800	800	800
Relative width available for dynamic delta processes [b] (feet)	100	5,225	3,030	3,285

[a] A portion of the existing river channel upstream of the Utah Division of Wildlife Resources fish weir meets the criteria for spawning habitat.
[b] For the action alternatives, width available for dynamic delta processes was determined by measuring the width perpendicular to the central channel thread alignment at the point midway between the start of braiding and Skipper Bay dike; for existing conditions, it is the approximate average width between levees on either side of the existing channel.

All delta restoration alternatives include geomorphic features that are common to river delta environments, including a distributary channel form with alternating bars, mid-channel bars, and mouth bars. Other features that are common to naturally formed delta environments include abandoned channels, oxbow wetlands, and natural dikes. (Natural dikes form along the margins of rivers when suspended sediment settles out of the water onto the floodplain during annual high flow events. Natural dikes are generally relatively low and wide, and should not be confused with constructed dikes, which are created by humans and generally intended to prevent overbank flow.) These natural features would be expected to form in the project area over time and would add to the habitat complexity desired for meeting the needs of all June sucker life stages on a self-sustaining basis.

The approximate elevation of Skipper Bay dike is presently about 4,493 feet on the south near Boat Harbor Drive dipping down to approximately 4,491 feet on the north end. Under any of the action alternatives, the portion of dike included in the project would be removed or lowered to 4,487.5 feet for most of the dike length and would be excavated another 6 inches to 4,487 feet in three or four locations to allow channels of water to continue to flow to the lake when the lake is lower than that elevation. Reducing the dike height in this manner would allow Utah Lake to inundate the project area when lake elevations are higher than 4,487 feet, which occurs at least part of the year nearly every year. The remaining portion of Skipper Bay dike would serve the purpose of “perching” water in the river delta area above the bed of the lake. This would help retain water in the delta area at a slightly higher elevation than the lake only during times when the lake is low, which would enhance habitat value for June sucker and other fishes. This “spit” is an anticipated natural shoreline feature of the lake at Skipper Bay. A similar feature exists for Provo Bay, allowing water in that bay to sit at a slightly higher elevation than the main body of the lake.

2.6.2 Management of Provo River Instream Flows

Any of the action alternatives would include three aspects that would affect the hydrology in the Provo River that were not specifically analyzed in the Utah Lake Drainage Basin Water Delivery System (ULS) Final Environmental Impact Statement (CUWCD 2004). Those aspects are:

- adopting seasonal flow regime targets identified in the **Lower Provo River Ecosystem Flow Recommendations Report** (Stamp et al. 2008);
- delivering up to an additional 4,500 acre-feet of conserved water, on a space-available basis, under the Utah Lake Drainage Basin Water Delivery System (ULS) Project to Provo River to help meet the target flow regime recommendations; and
- dividing the flow so that the first 10 cfs and up to 50 cfs is delivered to the existing lower Provo River channel to help maintain aesthetics, water quality, and recreational values.

Adoption of Lower Provo River Ecosystem Flow Recommendations

The Record of Decision for the ULS EIS included commitments for delivering an annual supply of 12,165 acre-feet of conserved water to the lower Provo River, in addition to delivery of an average of 16,000 acre-feet (range from 0 to 34,601 acre-feet) of exchange water and up to 3,300 acre-feet of purchased water, for a total annual average delivery of 31,465 acre-feet of supplemental water to Provo River to support June sucker recovery and other instream uses[1]. As discussed in Section 1.3.8, the 4,500 acre-feet of additional conserved water could be incorporated into the total supplemental water supply available for the lower Provo River to help meet target flows. Under any of the three action alternatives, the supplemental water would be allocated toward flow regime targets recommended in the *Lower Provo River Ecosystem Flow Recommendations Final Report* (Stamp et al. 2008).

The Flow Recommendations Report provides seasonal flow recommendations and specific target release patterns for average, wet, and dry years by season as shown in Figure A-8 (Appendix A). Flow regimes are intended to be adaptive, but efforts would be made on an ongoing basis to coordinate the use of all supplemental water sources to achieve target flows. The amount of water added to Provo River in any given year would vary depending on weather conditions, local water use, amounts available, need for delivery of exchange water, and delivery system capacity availability. Additionally, the JLAs understand that additional biological monitoring and research is ongoing and may improve understanding of June sucker use of the lower Provo River and the restored delta habitat beyond what is currently known.

[1] The initial amount of 12,165 acre-feet of conserved water committed under the ULS EIS was exceeded, reaching 13,879 acre-feet. That amount includes 714 acre-feet conserved with funding from the Mitigation Commission under Section 302(a) of CUPCA; thereby the amount of acquired water is actually 2,586 acre-feet (minus conveyance losses) and not 3,300 acre-feet. See Section 1.3.8 and Table 1-2 for a current description and accounting of supplemental water supply quantities available.

A general discussion of the flow recommendations (Stamp et al. 2008) that would be adopted with any of the action alternatives is as follows:

- Winter (January–March) flow recommendations assume that the natural (existing) flows of Provo River are generally already meeting the target flow recommendations and that supplemental water deliveries would generally not be required during this time period. These assumptions are based on the fact that irrigation diversions are not active during these months. Exchange water deliveries to Provo River in excess of the flow targets may be required during this period.

- Summer (July–September) target flow recommendations attempt to mimic natural hydrologic conditions and are primarily based on what would be needed to protect water quality and water temperature for fisheries in both the existing channel and the new delta area. The existing summer flows are heavily influenced by irrigation water diversions. Conserved water would generally be needed to meet summer target flows. Exchange water deliveries to Provo River (as described in Chapter 1, Section 1.3.8) may be available to aid in meeting the target flow recommendations during this time period. Conserved water would likely most often be used to meet instream flow targets during this period.

- Autumn (October–December) target flow recommendations assume that the natural flows of Provo River are generally already meeting the target flows. Conserved water deliveries would generally not be required during this time period except during some years, particularly in the first couple of weeks in October when irrigation use is often continuing. Exchange water deliveries to Provo River may be available to aid in meeting target flow recommendations during this time period.

- Spring (April–June) flow target regimes illustrated in Figure A-8 (Appendix A) were developed to better reflect a natural springtime rise and fall that would support June sucker spawning and larval transport. For the receding phase of the moderate- and wet-year hydrographs, a multi-day period of flows in the 300 cfs range is included. Flows in this range have been found to provide effective transport of larval June sucker from their hatching sites to the mouth of the existing Provo River (Wilson and Thompson 2001). This "larval drift" component is not included in the dry year flow recommendation because there is typically not enough water available under dry conditions to hold flows at that level. Strictly from a June sucker recovery standpoint, the emphasis in dry years may be appropriately placed on maintaining base flows for ecological sustenance purposes instead of providing spawning and recruitment flows from supplies of stored water. It is likely that under natural habitat and hydrologic conditions, spawning and recruitment did not successfully occur every year and it does not appear necessary for June sucker recovery. However, the dry year hydrograph may hold flows within the range found optimal for June sucker spawning (150–200 cfs) for several days if water is available. This type of decision would be made annually, based on the recommendation of the JSRIP and the June Sucker Flow Work Group.

To reiterate, these are target flows that would need to be adapted to actual conditions on a year-by-year basis. There are times when exchange water would need to be delivered to Utah Lake that would be in excess of the nonirrigation season target flows for the Provo River. During those times the exchange water may be delivered to Utah Lake via the Spanish Fork River, Hobble Creek, or the Provo River. Supplemental water would not be added to high spring runoff flows if there were a risk of flooding along the Provo River (generally flows that exceed 1,800 cfs). The peaks of the target flow regimes are below the 10-year flood value of 1,722 cfs. Conversely, analysis shows that there are times (generally during the peak irrigation season) that delivery capacity is fully utilized with contracted water deliveries and thus would not be available for full delivery of the target supplemental flows.

Each year the June Sucker Flow Work Group meets to discuss the flow outlook for the upcoming water year. The Flow Workgroup is a multi-agency group comprised of water users and stakeholders in the Provo River and Hobble Creek drainages. This group meets as needed to coordinate flow patterns. The Flow Work Group is a subcommittee of the JSRIP and advises the broader JSRIP group regarding the upcoming water year.

With implementation of one of the action alternatives, the JSRIP would discuss the needs of the June sucker, taking into account the target flow recommendations, available water supplies, and respective commitments for delivery of water to the Provo River and Hobble Creek. Based on these factors the JSRIP would recommend a flow pattern to the U.S. Department of the Interior. There may be years when exchange water is available to assist with meeting the flow regime targets. On these years, the Flow Work Group would be advised by CUWCD on anticipated exchange flows. Emergency conditions may necessitate immediate flow changes. The Flow Work Group would be notified of these changes as soon as possible.

Use of Additional Conserved Water

Under any of the action alternatives, the previously discussed 4,500 acre-feet of additional conserved water could be used in the Provo River, in Hobble Creek, or in both, depending upon the annual recommendation of the Flow Work Group, system capacity constraints, water shortages, and other factors. If used in the Provo River, this water may be incorporated into the total supplemental water supply available to the lower Provo River or may be used to help support the commitment to provide 10–50 cfs to the existing river channel (see Section 2.5.1).

2.6.3 Enhancement of Existing Channel Water Quality

Poor water quality conditions may develop in the lower Provo River channel under baseline and predicted future conditions. These conditions usually occur during late summer but can occur any time temperatures are high, water flows are low, and nutrient levels in the water are high. Due to growth of algae and plants, followed by respiration of aquatic animals and algae and plants (at night) plus decomposition of dead and decaying organic matter as part of the natural nutrient cycling of the river, the water can become so deficient in oxygen that the water may not support aquatic life (fish), which can in turn lead to or exacerbate objectionable odor concerns. Aeration of such waters improves water quality by supplying the deficient oxygen, promoting aerobic rather than anaerobic decomposition processes, rescuing the free carbon dioxide and eliminating much of the hydrogen sulfide and other odorous constituents present. Aeration can also increase oxygen levels and therefore improve beneficial microbial activity in organic sediments. Microbial activity can significantly reduce the amount of organic material and muck on the channel bottom.

Aeration is the process by which the area of contact between water and air is increased, either by natural methods or by mechanical devices. In the more limited context of water works practice, aeration refers specifically to use of mechanical devices or procedures to circulate air through, mix with, or dissolve in water. In this limited sense aeration is defined as a method of treatment rather than merely a modification of natural conditions. The terms "natural aeration" or "reaeration" are used to represent nonmechanical procedures or slower aeration of large bodies of water under natural conditions.

Aeration is one of the most elemental techniques frequently employed in the improvement of the physical and chemical characteristics of water. Many different methods of water aeration have been and can be applied in process systems under controlled conditions. Aeration can be accomplished by mechanical aerators or underwater air diffusers. Mechanical aerators agitate water to produce liquid to air contact, while underwater diffusers introduce air bubbles from a depth to achieve oxygen transfer and mixing. Surface agitators often look very impressive; however, their influence over the oxygen levels in the system can be rather localized to the area surrounding the equipment.

Bubble type or diffuser aeration systems are more commonly used in environmental applications than mechanical aerators because of their low maintenance, high reliability, safety, flexibility, and higher oxygen transfer efficiency. In this arrangement, atmospheric air is transferred under water and released through diffusers. Bubbles of air then rise to the surface. During this process, two main things occur: the oxygen transfer takes place, whereby the oxygen becomes dissolved in the water; but also, the force of the rising gas bubbles carries water molecules towards the surface, causing a stirring or mixing effect. The mixing effect leads to "natural aeration" or "reaeration" of the water from the bottom of the river, as it comes in contact with the surface. In some instances, the mixing effect of the aeration system can be more important than the oxygen transfer from the compressed air injected into the water column directly, as toxic gases (CO_2, ammonia, etc.) are also liberated at the water/air interface. Diffusers are designed to deliver either coarse (approximately 4-6 mm), medium (approximately 2-3 mm), or fine (approximately 1 mm) air bubbles.

The design of an aeration system is a complex process, which includes selection and sizing of system components. The oxygen demand of any water body is never fixed or constant but varies depending on various factors and conditions. The aeration system would be designed to be able to deliver variable air flow, saving energy to meet the aeration demand. Aeration system optimization first requires a full evaluation of project objectives and an aeration system design focused to meet project objectives. Optimization also requires a properly operated and maintained aeration system. The details of the aeration system for the existing Provo River channel would be determined during final design, following selection of a proposed action alternative, if any, and a channel option.

2.6.4 Accommodation of Provo City Transportation Planning

The preliminary designs for all of the action alternatives have accommodated Provo City's preferred alignment for the Provo Lakeview Parkway and Trail. This preferred alignment was provided by Provo City and is illustrated on Figures A-1 through A-5 (Appendix A). The JLAs met with Provo City staff periodically throughout the EIS process to discuss designs for project alternatives to accommodate the future transportation facility. Design requirements for modifications to Boat Harbor Drive were also discussed and accommodated in proposed alignments for action alternatives.

2.6.5 Typical Construction Procedures

Construction under any of the action alternatives would include the excavation of a distributary channel network for the Provo River, reduction in height of portions of the Skipper Bay dike, and the construction of new berms along property acquisition boundaries wherever this would be necessary to contain surface flow. Any of the action alternatives would also require relocation of a portion of Boat Harbor Drive, as previously discussed for each alternative.

Equipment that would likely be used during construction would be consistent with equipment that is typically used in earth excavation and grading operations, including small numbers of: backhoes, compactors, dozers, excavators, loaders, graders, scrapers, and dump trucks. Additional equipment for bridge and road construction would also be used for realignment of a portion of Boat Harbor Drive. Construction impacts would be minimized to the extent practicable, particularly to protect adjacent land uses, local flora and fauna, wetlands, and water quality. Mitigation measures for avoiding and minimizing construction impacts are listed at the end of this chapter.

Channel excavations, side channels, and oxbows would likely be constructed first, followed by construction of berms and realignment of Boat Harbor Drive. Salvageable materials from excavation would be used in project construction wherever possible and if not salvageable would be removed from the site. Excavation of portions of the existing Skipper Bay dike would need to be constructed in conjunction with development of the Provo River diversion structure. Skipper Bay dike would be excavated during a time of year when Utah Lake is lower than 4,487 feet. If Option 2 is selected for the existing Provo River channel, then the dam structure at the channel outlet would be constructed after the upstream diversion structure is operational. New recreation features, including parking areas, trails, and viewing towers, would likely be constructed last after river and habitat restoration construction activity is finished.

2.6.6 Operation and Maintenance

Management Objectives

The delta restoration project is supported by the JSRIP program. It is anticipated that ongoing management and maintenance funding for this project would be provided through annual commitments of funds from the JSRIP.

The JSRIP, in cooperation with the appropriate government representatives and stakeholders, would develop a detailed management plan that specifies the habitat developments, their management, and the public uses that would be permitted. The primary management objective would be to restore and maintain habitat essential to June sucker natural recruitment. Ongoing monitoring of habitat function and quality would be necessary for project success. The JSRIP would develop operating agreements with appropriate entities to identify areas of responsibility and authority, specify costs of management and commit funding to support ongoing development, operation and maintenance, and management of the project area.

Operating Agreements and Resource-Specific Management Plans

The JSRIP would develop operating agreements with appropriate entities as needed for technical and management assistance. Such operating agreements would identify areas of responsibility and authority, specify costs, and commit funding. Operating agreements for the proposed action would include but not be limited to agreements for control of noxious weeds and mosquito abatement, and operation, maintenance and replacement of: the aeration system for the existing Provo River channel, the diversion facility to split flows between the existing river channel and the new river channel and restored delta, the parking areas and recreation facilities, and the delta management area. A vegetation management plan (Appendix B) and a mosquito management plan (Appendix C) have been developed in consultation with appropriate entities as part of this EIS.

A preliminary list of anticipated operation and maintenance agreements and the entities with whom the JSRIP is most likely to enter in to an agreement with for those services is given in Table 2-3, along with a brief discussion of each. Also see Chapter 1, Section 1.6 regarding other required permits, authorizations, and agreements.

Table 2-3. Required operation and maintenance agreements.

ENTITY	OPERATING AGREEMENT	REQUIRED FOR
Provo City	Operation, Maintenance, and Replacement Agreement between JSRIP and Provo City	Aeration facilities for existing Provo River channel
Central Utah Water Conservancy District	Operation, Maintenance, and Replacement Agreement between JSRIP and CUWCD	Facility to divert water between existing Provo River channel and new Provo River delta
Provo City or Utah County Public Works	Operation, Maintenance, and Replacement Agreement between USA, State of Utah and Utah County or Provo City	Management of recreation sites along existing Provo River channel
Utah County Public Works	Operation, Maintenance, and Replacement Agreement between USA, State of Utah and Utah County	Recreational facilities in delta restoration area; Realignment of Boat Harbor Drive
Utah Department of Natural Resources	Agreement between USA and State of Utah	Land management of restored Provo River delta area
Utah County	Implementation Agreement	Mosquito Monitoring and Control
Utah County (and/or Private Contractors)	Implementation Agreement	Vegetation Management/ Noxious Weed Control
Provo City, Federal Aviation Administration, USDA Wildlife Services, and possibly third-party contractors	Memorandum of Agreement with USA; funding instrument(s) with Provo City Airport and/or other parties	Monitoring and movement study and adaptive bird-aircraft strike risk mitigation program

Aeration Facilities
As described in Section 2.6.3, the proposed project would incorporate measures to enhance late summer water quality conditions of the lower Provo River in the reach of the existing river channel that would be downstream of the diversion to the restored river channel and delta by installing an aeration system to increase DO levels in the water. The aeration system would be designed and constructed to be as low-maintenance as possible, however some maintenance, repair and eventual replacement would be required. The JSRIP would propose to enter into a multi-year agreement for Provo City or other local entity to provide those services. The aeration facilities would be able to utilize electrical power available to the Bonneville Unit of the Central Utah Project at a rate available to participating projects under the Colorado River Storage Project, which will help keep operating costs reasonable. Energy costs are estimated to be around $2,500 annually for operating the aeration system for 3 months of the year.

Provo River Diversion Facility
As described in Section 2.5, the proposed project would require a diversion on the left bank of the new Provo River channel that would be capable of accurately and safely diverting and delivering flows to the restored Provo River and delta, as well as flows ranging from 10 cfs to 50 cfs from the main Provo River channel into the existing lower Provo River channel that would remain after the river would be relocated to the north and restored to a delta environment. For effective and efficient management, this facility would be designed and constructed so it could be metered (have its flow rate measured) accurately and in real-time, and operated remotely by the responsible entity. The data from the meters and gauges would be telemetered to publicly-available websites for near real-time access. The JSRIP would propose to enter into a multi-year agreement for CUWCD to provide those services on a contributed or reimbursable basis.

Recreational Facilities
As described in Section 2.5, under the proposed project the majority of existing recreational features and opportunities along the existing lower Provo River channel and corridor would be retained or improved. As described in Sections 2.2, 2.3, and 2.4, the proposed project would provide a number of additional or enhanced recreational opportunities, such as extended pedestrian and bicycling trails, an unpaved trail intended for equestrian use, additional trailhead/parking areas, expanded parking, and depending on the option selected for the existing channel, improved access to the river for small watercraft and fishing. Several of these activities would be supported by developed facilities that would be initially constructed as part of the proposed project but would require ongoing operations, maintenance and repair or replacement. Following construction of the proposed recreation facilities, the JLAs anticipate transferring long-term ownership and management of trails and parking areas to Utah County and/or Provo City, depending on jurisdiction of areas where the respective facilities would be located.

Land Management of Restored Provo River Delta Area and Other Acquired Lands
As described in Sections 2.2, 2.3, and 2.4, to implement the proposed project the federal government would acquire land from private landowners so that all lands incorporated into the restored delta area would be federal, State, or local-government owned lands committed to the project. The United States would enter into a management contract with a local entity, most likely the State of Utah, to manage its lands for the long-term objectives of the proposed project. Specific terms and conditions of the contract would be developed at the completion of the

construction phase of the proposed project, consistent with the project's purpose, needs, goals, and objectives described in this Final EIS.

Public Access and Allowed Recreation Activities

Public access to the restored delta area would be allowed for uses related to and compatible with wetland-wildlife resources, as specified in the management plan. Allowable recreation uses would likely include fishing, hunting, environmental education, pedestrian use, other nonmotorized use, and wildlife observation. Allowed uses of trails, trailheads, and parking areas would be determined by Utah County or Provo City according to their respective jurisdictions, rules, and ordinances. It would also continue to be incumbent on the County and City to determine allowed uses and management of other existing and planned trails within their respective jurisdictions that the proposed project's recreation trails, trailheads, and parking facilities would connect into (e.g., Provo River Parkway Trail, the airport dike trail, and the proposed Provo Lakeview Parkway and Trail). Hunting and fishing would be regulated by the Utah Division of Wildlife Resources (UDWR) and boating access and restrictions would be regulated by Utah Division of State Parks and Recreation.

Prohibited uses would include off-road motorized vehicle use. Access to the project area would be either via existing city or county roads, or via new accesses constructed as part of this project or as part of future transportation corridor projects undertaken by others. Internal access would primarily be by footpaths, although administrative uses within the project area may require limited motorized and/or mechanized travel. Additional parking areas and trail heads would be constructed at strategic locations (some proposed locations have been identified on the maps for each alternative included in this chapter, though modifications may be necessary in final design).

Restrictions to public access may be necessary in some areas or times of year to meet wetland-wildlife management goals or aviation safety requirements of the nearby Provo Airport. Restrictions could consist of complete area closure for short periods of time if necessary to haze or control birds determined to constitute a flight safety hazard. Seasonal closures may also be necessary to protect June sucker during spawning, or other seasonally sensitive periods. In those instances, necessary access restrictions could be imposed by the United States Department of Agriculture Wildlife Services (USDA Wildlife Services), Provo City Airport, Utah Division of Wildlife Resources (UDWR) and/or the U.S. Fish and Wildlife Service (USFWS) in accordance with their legal authorities and obligations.

2.7 No-Action Alternative

Consideration of a No-Action Alternative is required in regulations for implementing the National Environmental Policy Act (NEPA) (40 CFR 1502.14). This alternative considers the consequences of taking "no action" with respect to the purpose and need of the proposed action. Under the No-Action Alternative, the planned project would not be implemented, but remaining actions in the June Sucker Recovery Plan (USFWS 1999a) and JSRIP would proceed as planned, subject to NEPA compliance as appropriate. The underlying need for the project described in Chapter 1 would not be achieved and the commitment to restore the Provo River delta as a necessary step toward delisting would remain. Lands would not be acquired for the proposed action.

2.7.1 Provo River Channel

Under the No-Action Alternative, the main flow of the Provo River would not be diverted from its present course. The straightened, levied condition of the existing lower Provo River channel would be expected to remain unchanged.

2.7.2 Boat Harbor Drive

Under No-Action, the JLAs would not have any reason to implement modifications to Boat Harbor Drive. This Utah County roadway would remain in place and be upgraded to Provo City design standards as improvements are made by either the County or the City.

2.7.3 Recreation Components

Under No-Action, the JLAs would not have any reason to implement the construction of recreation facilities in the project area. Provo City or Utah County may implement components of their respective land use plans, including trail facility additions, upgrades, and maintenance. Existing river channel recreation opportunities would likely remain similar to what they are currently for the reasonably foreseeable future.

2.8 Summary Comparison of Design Features and Impacts

This section provides a comparison of design features and impacts of project alternatives and existing channel options. Impacts are evaluated in detail in Chapter 3. Section 2.8.1 provides a summary comparing the impacts of the three action alternatives and the No-Action Alternative; Section 2.8.2 provides a summary comparing the impacts of the two existing channel options and No-Action.

2.8.1 Project Alternatives Summary

Table 2-4 presents a comparison of the three project alternatives and the No-Action Alternative, including design features that are described in this chapter as well as environmental and socioeconomic impacts that are evaluated in detail in Chapter 3.

Table 2-4. Project alternative design features and impact assessment summary.

FEATURES/IMPACT INDICATORS	NO-ACTION	PROJECT ACTION ALTERNATIVES		
		A	B	C
Design Features				
Property acquisition boundary (acres)	None	507.3	310.3	298.3
Length of new berm (feet)	None	5,306	5,229	11,780
Riverine channel length (existing or enhanced spawning habitat within the study area portion of the lower Provo River, in feet)	2,180	2,600	2,360	2,600
Channel slope (riverine section)	0.3%	0.2%	0.3%	0.2%
Width of floodplain/riparian corridor in spawning reach (feet)	100	800	800	800

Table 2-4. Continued.

FEATURES/IMPACT INDICATORS	NO-ACTION	PROJECT ACTION ALTERNATIVES		
		A	B	C
Design Features (Continued)				
Relative width available for dynamic delta processes (feet)	100	5,225	3,030	3,285
Up to 4,500 acre feet of additional conserved water annually for delivery to Provo River for instream flows for June sucker	Not available	Available		
Consultation with June Sucker Recovery Implementation Program and Flow Workgroup to coordinate target flow regimes according to *Lower Provo River Ecosystem Flow Recommendations Final Report* (Stamp et al. 2008), on adaptive basis.	No change	Adopt flow report and adaptive approach		
Hydrology and Flood Risk				
Change in 100-year water surface elevations in the Provo River- immediately below Lakeshore Drive Bridge. Modeled Parameters: Provo River = 2,700 cubic feet per second (cfs) Utah Lake = 4,489.045 feet	Existing flood elevation is 4,500.51 feet.	-0.07 foot (negligible positive effect)	-1.16 feet (positive effect)	-0.07 foot (negligible positive effect)
Change in 100-year water surface elevations in the Provo River- near Alligator Park. Modeled Parameters: Provo River = 2,700 cfs Utah Lake = 4,489.045 feet	Existing flood elevation is 4,493.24 feet.	-1.05 feet (positive effect)	-2.68 feet (positive effect)	-1.05 feet (positive effect)
Change in consumptive use and evaporation	No change	339 acre-feet (20% increase)	190 acre-feet (11% increase)	224 acre-feet (13% increase)
Water Rights				
Water right acquisition and accommodation	No effects	Some water rights acquired with property acquisition; accommodation for adjacent property water rights to be determined in final design.		
Water Quality				
Wetland and riparian floodplain acres that filter sediments and pollutants	31.4 acres	443.7 acres	265.2 acres	253.8 acres
Utah Lake phosphorous load reductions	No change	-5.2 tons/year	-5.1 tons/year	-5.1 tons/year
Metals	Utah Lake and Provo River not impaired.	Reduced loads to Utah Lake.		
Cumulative water-quality improvement	No improvement	Nutrient uptake with wetlands at the river/lake interface.		

Table 2-4. Continued.

FEATURES/IMPACT INDICATORS	NO-ACTION	PROJECT ACTION ALTERNATIVES		
		A	B	C
Wetlands				
Wetlands filled and converted to uplands (acres)	None	0	0.5	1.6
Wetland converted to deep water ponds (acres)	None	1.1	3.6	0
Net wetland gain (acres)	None	+174.6	+25.2	+154.9
Wetland functional unit gain (percent)	No change	+146%	+64%	+99%
Other Waters of the U.S.				
Diversion structure(s)	None	Approximately 2,250 cubic yards of fill placed below the Ordinary High Water Mark (OHWM) over approximately 0.20 acre in the Provo River associated with new delta diversion structure (Option 1 or 2). With Option 2, an additional 4,000 cubic yards of fill placed below the OHWM over an additional 0.20 acre in the Provo River/Utah Lake associated with lower "outlet" dam.		
New Boat Harbor Drive Crossing and Riparian Wet Meadow with Small Channel	None	Approximately 556 cubic yards of fill placed below the OHWM over approximately 0.17 acre in the Provo River immediately downstream of the delta diversion structure to accommodate the new 10–50 cfs flow regime.	Approximately 1,340 cubic yards of fill placed below the OHWM over approximately 0.41 acre in the Provo River immediately downstream of the delta diversion structure to accommodate the new 10–50 cfs flow regime.	Same as Alternative A
Fill removal	None	Approximately 7,676 cubic yards of fill removed below the OHWM in Utah Lake associated with partial removal of Skipper Bay dike.	Approximately 6,382 cubic yards of fill removed below the OHWM in Utah Lake associated with partial removal of Skipper Bay dike.	Approximately 7,367 cubic yards of fill removed below the OHWM in Utah Lake associated with partial removal of Skipper Bay dike.
Existing Channel Vegetation Community				
Net riparian forests gain (acres)	None	+36.6	+19.4	+27.3

Table 2-4. Continued.

FEATURES/IMPACT INDICATORS	NO-ACTION	PROJECT ACTION ALTERNATIVES		
		A	B	C
Fisheries				
New aquatic habitat conversion or creation (acres)	None	+481.5	+325.2	+313.9
Species supported	No change	Native and nonnative warmwater species benefit; angling opportunity increases.		
Wildlife				
Wetland and riparian woodland habitat gain (acres)	No change	+181.1	+23.7	+168.1
Upland habitat loss (acres)	No change	-229.2	-69.3	-208.0
State-listed special status species	Not affected	No significant effects		
Threatened and Endangered Species				
June Sucker	No effect	Possible negative impacts from predation to a small number of drifting larvae and young fish that are entrained into the existing channel. Significant direct and cumulative benefits for June sucker in the lower Provo River (critical habitat reach) and Utah Lake by restoring a naturally functioning river delta to the Utah Lake-Provo River interface. Spawning habitat would also be improved in a portion of the lower Provo River. These enhancements would contribute directly toward achieving criteria of the recovery plan and would contribute substantially toward downlisting and eventual delisting of the species.		
Ute Ladies'-tresses	No effect	Possible short-term negative impacts if existing occurrences cannot be avoided during construction or if occurrences are inundated, submerged, or the hydrology is altered sufficiently to render the habitat less suitable or unsuitable. However, the restoration of a more natural hydrologic regime in the project implementation area would be considered beneficial to the species in the long-term because natural flood events are important for creating new habitat and for reducing the cover of competing vegetation.		
Yellow-billed Cuckoo	No effect	Avoid short-term impacts by conducting vegetation clearing outside of the typical nesting/brood-rearing period or performing a nest clearance survey prior to disturbance. Over the long-term the project is expected to have positive effects for the species by supporting a net gain in riparian forest and improvement in habitat quality.		

Table 2-4. Continued.

FEATURES/IMPACT INDICATORS	NO-ACTION	PROJECT ACTION ALTERNATIVES		
		A	B	C
Land Use				
Compatibility with local and regional land use and transportation planning	No change	The proposed action is compatible with Utah County and Provo City planning and the Utah Lake Master Plan. Ongoing coordination with Utah County, Provo City, the Utah Lake Commission, the Federal Aviation Administration, and other entities would be necessary as land uses surrounding the project implementation area change over time.		
Agriculture and Farmlands				
Lands primarily used for grazing (existing and acquired for the project) (acres)	516.7	-413.0	-284.5	-209.5
Lands primarily used for crops (acres)	90.6	-79.4	-18.2	-74.3
Lands in agricultural structures (acres)	5.2	-5.2	-1.4	-3.9
Farmland Conversion Impact Rating (significant impact rating = 160 or higher)	No change	127.9	121.9	130.9
Noxious Species				
Noxious weeds, including phragmites	No change	Potential for invasion following construction; ongoing management required.		
Utilities				
Natural gas pipeline present in study area	No change	Need to determine avoidance and mitigation measures in final design.		
Socioeconomic Impacts				
Regional socioeconomic effects	No impact	Temporary construction employment, less than significant regional effects.		
Private property acquisition (acres)	None	417.8	221.4	248.6
Environmental justice	No change	Would not have disproportionate effects or unequal distribution of benefits.		
Recreation Resources				
Length of new paved trail (feet)	None	5,306	6,365	11,780
Dike/paved trail removal (feet)	None	3,454	2,872	3,315
Net increase in paved trail (feet)	No change	+1,852	+3,493	+8,465
Unpaved trail intended for equestrian use on all new berm trail segments parallel to paved trail	Not included	Included	Included	Included
Unpaved trail segment from planned Provo Lakeview Parkway and Trail to Utah Lake shoreline (approximate length: 1,660 feet)	Not included	Included	Included	Not included
Change in other facilities/opportunities	No change	Additional parking, river access, fishing opportunity, nonmotorized boating, trail loop created, viewing towers.		

Table 2-4. Continued.

FEATURES/IMPACT INDICATORS	NO-ACTION	PROJECT ACTION ALTERNATIVES		
		A	B	C
Public Health and Safety				
Mosquito abatement	No change	Potential to increase mosquito production; ongoing coordination with Utah County mosquito abatement required.		
Bird-aircraft strike risk – impact evaluation	No impact	Slight decrease in total bird abundance and potential corresponding decrease in strike risk. Potential increase in strike risk associated with some species.	Decrease in total bird abundance and potential corresponding decrease in strike risk. Potential increase in strike risk associated with some species.	Increase in total bird abundance and potential corresponding increase in strike risk. Potential increase in strike risk associated with some species.
Bird-aircraft strike risk – monitoring and mitigation commitments	Not included	The JLAs will commit to conducting a bird monitoring and movement study and mitigate any increased bird-aircraft strike risk caused by the proposed project. The Mitigation Commission will execute an agreement or contract to conduct the baseline monitoring/movement study and mitigation efforts. The JLAs will endeavor to execute an Memorandum of Agreement among Provo City, Provo Airport, USDA Wildlife Services, and the FAA to establish cooperation and coordination among the parties for implementing the monitoring and mitigation efforts.		
Cultural Resources				
Cultural Resources	No effect	It is probable that historically-eligible buried prehistoric sites are located within the project implementation area for any action alternative. There is a probability that one or more of these sites would be inadvertently discovered during ground disturbing activities associated with any of the three action alternatives. A Programmatic Agreement has been developed in consultation with the Utah State Historic Preservation Office and the Consulting Parties and represents a commitment on the part of the JLAs to mitigate for the effects of the undertaking.		
Energy and Climate Change				
Energy and Climate Change	No impact	No significant impacts		
Commitment of Resources				
Irreversible and Irretrievable Commitment of Resources	No impact	No significant impacts		

2.8.2 Existing Channel Options Summary

Table 2-5 presents a summary of existing channel design features and impacts.

Table 2-5. Existing channel option design features and impact assessment summary.

FEATURES/INDICATORS	NO-ACTION	OPTION 1	OPTION 2
Flow range (cubic feet per second [cfs])	0–1,800 (typical)	10–50	10–50
Water quality	Recent measurements of dissolved oxygen are at times below State standard.	Extreme low flows during the hot summer months during dry years would be improved with a minimum flow of 10 cfs. Debris, suspended and bedload sediment, and pollutants associated with runoff events would be redirected into the new channel and delta. Limited opportunity to make improvements to the bed and banks that could improve water quality and recreation. Aeration would improve dissolved oxygen, reduce algal blooms, improve aesthetics, improve fishery.	Extreme low flows during the hot summer months during dry years would be improved with a minimum flow of 10 cfs. Debris, suspended and bedload sediment, and pollutants associated with runoff events would be redirected into the new channel and delta. Greater opportunity (with permanent dam structure) to make improvements to the bed and banks that could improve water quality and recreation. Aeration would improve dissolved oxygen, reduce algal blooms, improve aesthetics, improve fishery.
Existing channel riparian forest	No impact	Minimal loss (approximately 0.23 acre) of riparian vegetation for construction of delta diversion dam in existing channel.	Minimal loss (approximately 0.46 acre) of riparian vegetation for construction of delta diversion dam and outlet dam in existing channel.
Fishery	No change; existing water quality at times does not support fish. Most common species at present (brown trout) is a cold water species.	With improving summer water quality (dissolved oxygen levels) the habitat and environmental conditions would become more suitable for brown trout, as well as warmwater fishes (e.g., channel catfish, white bass, bluegill, largemouth bass), but would also likely provide excellent habitat for common carp at times and given open connection to the lake.	Opportunity to actively manage as a fishery and potential to exclude carp. With improvements in summer water quality and dissolved oxygen levels, maintenance of a trout fishery might be possible.
Wildlife	No change	No significant impacts	No significant impacts

Table 2-5. Continued.

FEATURES/INDICATORS	NO-ACTION	OPTION 1	OPTION 2
Socioeconomic	Water quality may negatively affect existing channel and private recreation businesses associated with the channel.	Opportunity to improve water quality over existing conditions; potential positive impact for existing channel and private recreation businesses associated with the channel.	Opportunity to improve water quality over existing conditions and manage the water elevation in the channel; potential positive impact for existing channel and private recreation businesses associated with the channel.
Recreation opportunity changes	No impact	Improved parking/access to existing channel; would not change any of the recreational resources associated with the existing channel currently in place.	Improved parking/access to existing channel; opportunity to maintain a constant water elevation in the channel, but boats would not be able to reach Utah Lake directly from the existing channel (portage would be necessary).

2.9 Alternatives Considered but Not Advanced

In an EIS, federal agencies must "rigorously explore and objectively evaluate all reasonable alternatives to the proposed action," and must devote "substantial treatment to each alternative considered in detail," (40 CFR 1502.14). "Screening" is the process whereby concepts are narrowed down to the range of reasonable alternatives that will be analyzed in detail in the EIS. For the alternatives "which were eliminated from detailed study," agencies must "briefly discuss the reasons for their having been eliminated."

For the current project, numerous alternative concepts and potential geographic locations were evaluated through an extensive process. Early in this process the JLAs involved agencies, the public, and stakeholder groups to help identify potential alternatives as well as issues to be evaluated. A detailed technical memorandum was completed to summarize the details of these activities. As a component of this, an extensive effort was made to determine the riverine floodplain width and delta size necessary for meeting the project needs. That geomorphic study is included with the Alternatives Development Technical Memorandum (URMCC 2011), which is available on the project website, www.provoriverdelta.us, or by contacting the Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission).

Section 2.9.1 summarizes project concepts that were considered but eliminated from detailed consideration. Section 2.9.2 describes options for the existing Provo River channel that were eliminated from detailed consideration.

2.9.1 Project Alternatives Eliminated from Detailed Consideration

After thorough review and screening as documented in the Alternatives Development Technical Memorandum (URMCC 2011), the following concepts for project alternatives were eliminated from detailed consideration. Chapter 4 (Section 4.4.4) also provides some background regarding interactions of the alternatives that were carried forward and how these were modified based on public and stakeholder input.

Create Habitat in an Area North of Provo Airport and South of Utah Lake State Park

Concept: The idea of this alternative was to create rearing habitat between existing developed areas at Provo Airport and Utah Lake State Park. This was one of the first concepts considered by the JLAs in preliminary feasibility assessments for the project.

Determination: After developing a preliminary design, it became apparent that this location would not meet the need for the proposed action. This alternative would not provide habitat sufficient for achieving a self-sustaining population of June sucker because there would not be sufficient geographic area available for supporting sufficient numbers of June sucker through all life stages of the species. From a cost and logistical standpoint, it would be infeasible to obtain lands from the Provo Airport or Utah Lake State Park to increase the size of the rearing habitat area.

Create Habitat between Boat Harbor Drive and the Existing Provo River Channel

Concept: This alternative would involve utilizing the existing channel of the Provo River with habitat improvements in the lands immediately north of the existing channel and south of Boat Harbor Drive.

Determination: This alternative would not be able to provide habitat sufficient for a self-sustaining population of June sucker because there would be insufficient geographic area available where the necessary life cycles of June sucker could occur or survive in sufficient numbers to be self-sustaining. In particular, this alternative would fail to provide adequate spawning habitat, would not aid in hatching and larval transport, and would not provide the missing rearing habitat required for a self-sustaining population.

Divert the River South and into Provo Bay

Concept: This alternative would divert the Provo River southward at a location west of U.S. Interstate 15 (I-15) somewhere near the Fort Field Diversion. The river would be routed south into Provo Bay, creating more spawning habitat in the Provo River, and increasing and improving rearing habitat where the river would interface with Provo Bay. Complex habitats providing for a variety of June sucker life stages would be created and maintained. Recreational use of the area could be encouraged through a variety of means.

Determination: With this alternative, there would be adequate geographic area and adequate slope to enhance existing spawning habitat and to restore a naturally functioning delta ecosystem. Therefore, this concept would potentially meet the project need and was further developed to evaluate its potential.

To minimize and avoid potential impacts, the hypothetical path for this alternative was routed through areas with the least amount of existing development. Even so, this alternative would have required the relocation of at least 134 homes, 6 businesses, and a 15-acre park. Existing transportation infrastructure would need to be altered to the extent that several roads would likely be closed or turned into cul-de-sacs, and three major bridge structures totaling 3,795 feet would have been required. In addition, nine potential hazardous waste sites would be disturbed, existing bus routes and stops would be removed, and 3.7 acres of a known archeological site would be impacted. Impacts to structures would likely have included a number of properties eligible for the National Register of Historic Places in accordance with Section 106 of the National Historic Preservation Act. In addition, analysis also indicated that this alternative could impact a minority population with regard to Executive Order 12898 (Environmental Justice). Discussions with Provo City and Utah County representatives indicated that the alternative would be contrary to longstanding planning for the area.

Thus, from myriad logistical standpoints including regulatory requirements (i.e., Section 106, Environmental Justice), broad land use changes, infrastructure requirements, community impacts, and extraordinary costs, it was determined that this alternative would be neither reasonable nor practicable for meeting the project need.

Improve Habitat Quality within the Existing River Channel

Concept: This was suggested as a way to minimize land acquisition. The alternative would involve creating artificial in-stream habitat structures to provide cover and structure for June sucker larvae and young-of-year fish.

Determination: Although actions could be taken to improve the existing river channel habitat quality marginally, this concept would not remedy the water temperature and productivity issues that currently exist in the lower Provo River, which are similar to those found in a large canal. Presence of levees on both sides of the channel and periodic dredging prevent the river from overflowing its banks during high flows. These levees serve the purpose of protecting existing development from flooding but also eliminates the possibility of creating the type of dynamic river delta habitat that would be capable of supporting all of the life stages of June sucker on a self-sustaining basis.

Use a Different Utah Lake Tributary

Concept: This alternative would use a tributary other than the Provo River for creating habitat, such as the American Fork River, the Spanish Fork River, or Mill Race Creek.

Determination: Through the detailed screening process described in the Alternatives Development Technical Memorandum (URMCC 2011), the JLAs determined this concept could potentially restore a naturally functioning delta ecosystem but would not create enough spawning and rearing habitat to result in a sustainable population of June sucker in Utah Lake in the absence of a restored Provo River delta. The JLAs also determined that implementing a restoration project on another Utah Lake tributary as an alternative for the proposed action would not fulfill the responsibilities and commitments of the JLAs under Central Utah Project Completion Act (CUPCA) and the JSRIP (see Chapter 1, Section 1.3.7).

Every documented guidance from the USFWS and the June Sucker Recovery Team since the June sucker was listed as endangered in 1986 has emphasized the need for successful recruitment from the Provo River spawning run to recover the June sucker. The June Sucker Recovery Plan (USFWS 1999a) requires improvement of Provo River and Utah Lake habitats to support a self-sustaining June sucker population. While restoring a delta ecosystem on a tributary other than

Provo River may also be of some benefit to June sucker and the Utah Lake ecosystem, it would not meet the June Sucker Recovery Plan criteria to recover the June sucker by restoring suitable habitat conditions in the Provo River and its interface with Utah Lake.

Additionally, a feasibility study was conducted in 2002 (Stamp et al. 2002) to evaluate the potential of every tributary to Utah Lake for June sucker spawning and rearing. This was completed to help determine an appropriate location for a secondary spawning run, another criteria of June sucker recovery (see Chapter 1, Section 1.3.6). Historically, June sucker most likely spawned in multiple tributaries to Utah Lake, but alterations associated with flow withdrawals, diversion structures, and channelization have greatly limited or precluded access to suitable spawning habitat in tributaries other than the Provo River. Ultimately the Hobble Creek restoration project was successfully implemented in 2009 to serve as a location for establishing a secondary spawning run of June sucker. That study eliminated all other tributaries except Spanish Fork River and American Fork River from detailed consideration due to one or more of the following factors: lack of stream flows during most of the year including during June sucker transport and rearing periods; inadequate or incorrect substrate for spawning; low potential to create or restore spawning habitat; no interface with Utah Lake; constraints by adjacent developments; poor water quality. The other tributaries also have little or no documented history of June sucker use.

Regarding American Fork and Spanish Fork rivers, these tributaries often lack water altogether during the June sucker spawning period. Spanish Fork River is used heavily for irrigation. Gage records indicate that June flows on Spanish Fork are less than 5 cfs about 50 percent of the time (Stamp et al. 2002). In 2002, when the feasibility study was completed, the Spanish Fork River was still under consideration as a potential stream to have instream flows restored under the Utah Lake System of the Central Utah Project (CUP). Subsequently, the decision was made to not deliver instream flow water and/or exchange water to Utah Lake via the Spanish Fork River, but to utilize Provo River and Hobble Creek for that purpose (CUWCD 2004). Numerous irrigation diversions withdraw water from the American Fork River, which often dewaters the river during the summer months and sometimes dewaters the lower river during the spring spawning period. In three out of five years during the 2002–2006 monitoring period, the UDWR was unable to complete surveys for June sucker on the American Fork River because the river was either dry or too shallow (UDWR 2003, 2004, 2005a, 2006, 2007). No instream flow protections are known to have been established for the lower portions of either of these tributaries; therefore, there is little assurance that water would consistently be available each year to support June sucker spawning and recruitment.

Even in its current, altered condition, the section of the lower Provo River designated as critical habitat provides the greatest, though limited, habitat suitable for spawning in the Utah Lake system. As the site of the primary June sucker spawning run, Provo River has been the focus of extensive recovery measures for decades. To this end, significant funds have been spent to acquire water and manage flows for spawning and larval transport in the lower Provo River, to conduct studies on spawning and rearing habitat requirements to guide flow recommendations, on removal of fish passage barriers in the critical habitat reach, and other measures.

For more than 20 years, efforts have been underway to secure water rights to maintain year-round instream flows to the lower Provo River. To date, more than 13,000 acre-feet of water have been acquired annually on a permanent basis for lower Provo River streamflows under Section 207 of the CUPCA. These flows have been used almost exclusively to benefit June sucker spawning and larval transport. Efforts to acquire additional instream water rights remain ongoing. The ULS project, as authorized by the CUPCA, includes an environmental commitment to supplement Provo River stream flows to assist with June sucker and ecosystem recovery. When operational and under full water delivery conditions, the ULS project is projected to deliver on average approximately 16,000 acre-feet of exchange water annually to Utah Lake via the Provo River (CUWCD 2004). In addition, about 13,879 acre-feet of conserved water and up to 2,586 acre-feet of acquired water will be dedicated annually specifically for flows in the lower Provo River to benefit June sucker. Efforts through the water conservation program (authorized in Section 207 of CUPCA) to acquire additional instream water are ongoing. It is anticipated that up to 4,500 acre-feet of additional conserved water may be available annually for controlled release in direct support of June sucker spawning and larval transport in the Provo River as described in Chapter 1, Section 1.3.8.

In summary, restoration of the lower Provo River and its interface with Utah Lake is essential to the recovery of June sucker and is the most important area in which to focus recovery efforts because of the following:

- the lower Provo River serves as the primary June sucker spawning location and is the only Utah Lake tributary where successful reproduction (as evidenced by larval June sucker being transported downstream) has been observed each year since the 1980s[2] (Ellsworth et al. 2010);

- the lower Provo River is protected as critical habitat under the Endangered Species Act (ESA);

- efforts to secure instream flows on the lower Provo River have been successfully underway for 20 years;

- other tributaries to Utah Lake are much smaller and have more factors limiting June sucker recovery than the Provo River; and

- significant funds have been expended and are committed to future expenditure for studies, habitat improvements, and the securing and provision of water to the lower Provo River because of its identified importance for June sucker as a result of prior Section 7 ESA consultation on projects affecting the Utah Lake Drainage Basin.

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[2] The establishment of a secondary spawning location in Hobble Creek is another element of the overall June sucker recovery effort (see Chapter 1, Sections 1.3.5 and 1.3.6).

Pursuit of a different tributary to restore spawning and rearing conditions to recover June sucker would not replace the need to restore suitable spawning and rearing conditions in the Provo River. Although restoring a delta ecosystem on another tributary might be additive in its effects and might be a desirable endeavor in the future under the JSRIP, the JLAs recognize the restoration of the Provo River at its interface with Utah Lake as a required and essential step toward recovery of this endangered species.

Use Mona Reservoir and Currant Creek

Concept: This suggestion was to use Mona Reservoir and Currant Creek to create habitat, either as an alternative to the proposed action, or as a "test" project.

Determination: The JLAs determined that this alternative would not meet the project need. Experimental efforts to introduce June sucker into Mona Reservoir as a refuge population have been undertaken by JSRIP partners. However, Mona Reservoir and Currant Creek have no documented historical June sucker use and would not contribute to a self-sustaining population of June sucker in Utah Lake, as required in the Recovery Plan. In terms of having a "test" project, the JSRIP has already undertaken a project involving the restoration of river-lake interface area, which occurred on Hobble Creek, a tributary of Utah Lake, in 2009. While much smaller in scale, the project involved many of the same goals and design features that are proposed for the Provo River delta and is considered a successful test of the overall concept. The Hobble Creek project represents a smaller example of how restoration activities would provide greater benefits if they are of appropriate magnitude at the Provo River/Utah Lake interface.

Use Strategies/Actions Other Than Habitat Creation

Concept: It was suggested that the JLAs could implement other components of the JSRIP as an alternative to the proposed action or could pursue other actions such as reducing predatory fish populations in Utah Lake.

Determination: Singly or in combination, other such actions would not meet the project need. The JSRIP involves a variety of efforts to achieve recovery of June sucker; however, those needs are in addition to the need for restoring a delta ecosystem at the lower Provo River at Utah Lake. As such, they do not represent alternatives to the proposed action, but are separate and required efforts in achieving the goal of June sucker recovery. Chapter 1 (Section 1.3.6) describes some of the other actions that are being pursued. Other recovery program objectives are included in the No-Action Alternative because those actions would be pursued with or without the proposed action.

Improve Habitat in Provo Bay

Concept: It was suggested that improving habitat in Provo Bay may meet June sucker recovery needs while also providing other recreation benefits for fishing and boating.

Determination: This action would fail to provide for a self-sustaining population of June sucker in the Provo River because it does not connect spawning habitat with rearing habitat necessary for successful recruitment in the Provo River. However efforts have been made to reconnect Hobble Creek to Provo Bay and to improve spawning habitat in Hobble Creek. These efforts are helping to address a need for a secondary spawning run of June sucker, as part of a separate criterion for June sucker recovery (see Chapter 1, Section 1.3.6).

Use Existing Drainage Channels/Ditches to Create Habitat

Concept: It was suggested that the Provo River could be routed through existing drainage channels and ditches such as the drain system surrounding the Despain property to the north of the existing river channel. This was suggested as a way to minimize the amount of land acquisition that would be necessary for implementing the project.

Determination: The JLAs determined that this concept would not create enough rearing habitat to meet the project need. Diverting river flow and larval fish to these channels would require constructing a diversion on the Provo River, construction of a channel from the existing river channel to the existing drain, creating rearing habitat in the existing drain, and associated maintenance. The total length of this channel would be approximately 8,300 feet. All of these design features would be feasible to implement; however, the existing drain width varies from only 10–30 feet. Even if the drain was expanded to an average width of 50 feet, the total amount of potential rearing habitat under this concept would be less than 10 acres. This would be less than half the size of the newly restored Hobble Creek project, which is intended to support only a smaller, secondary spawning run of June sucker. Habitat complexity in this linear feature would be very limited as well. There would be no side channels or off-channel pools, or very limited room within a narrow corridor to add these features. Therefore, the JLAs determined that this alternative would not meet the project need.

Divert the Provo River to Powell Slough

Concept: A suggestion was made to connect the Provo River to Powell Slough, an existing wetland complex and Waterfowl Management Area on the eastern shore of Utah Lake approximately 2 miles north of the existing river channel.

Determination: Routing the river to Powell Slough was determined to be infeasible because there is insufficient channel slope to route the river this direction and distance. The elevation of the bed of the Provo River west of Lakeshore Drive Bridge is 4,494 feet. Water in Utah Lake during spring runoff is generally around 4,489 feet. A total of 5 feet of drop over that distance (11,500 feet) would result in an average channel slope of only 0.0003. Since June sucker larvae drift with the current, there would not be enough current to effectively get drifting larvae to Powell Slough unless a diversion was constructed farther upstream, somewhere near I-15. However, it would be infeasible to construct a new “transport” channel with adequate slope though the middle of a highly developed subdivision (Lakeshore Village) to flush larval fish from Provo River into Powell Slough. Furthermore, the majority of spawning activity and drifting larvae occur downstream of I-15.

Create an Artificial Habitat Area

Concept: A suggestion was made to create an artificial habitat area by pumping lake water into a restoration area, thus leaving the existing Provo River channel unaffected. Powell Slough was specifically mentioned as a potential location for this alternative.

Determination: The JSRIP partner agencies have some experience with maintaining artificial habitats to support refuge populations of June sucker at Camp Creek Reservoir, Red Butte Reservoir, and Arrowhead and Teal Ponds. These habitats have been developed, however due to difficulties in maintaining large-scale, artificial habitats, only Red Butte Reservoir continues to support June sucker for the primary purpose of preventing extinction of June sucker. Creation of artificial habitats and/or some type of "pump back" system, even on a much larger scale, would be insufficient for achieving a self-sustaining population of June sucker and eventual delisting of the species and would be prohibitively costly to operate. These artificial systems would also not meet the definitions of "natural" and "self-sustaining" under the June Sucker Recovery Plan.

2.9.2 Existing Channel Options Eliminated from Detailed Consideration

Section 2.5 of this EIS described two design options for the existing Provo River channel, one of which would be implemented in association with one of the three proposed delta restoration alternatives. The following design options for the existing river channel were also considered through the public involvement process but were not advanced for detailed analysis in the EIS.

Keep the Existing Channel as a Flood-Control/Emergency Flow Channel

Option: If all of the flow of the Provo River were directed to a new channel, it was suggested that the existing channel could be maintained as an emergency flow channel. Water could be directed down this channel in the event of an emergency such as flooding or a hazardous material spill upstream that could be detrimental to June sucker.

Determination: The diversion structure for this option would be much larger, complicated, and costly to build and operate. Without regular use as a water conveyance in the upper portion of the existing channel upstream of the fish weir, the old channel would be encroached by vegetation and would collect debris. Maintaining this channel for emergency use would be prohibitively expensive relative to the potential benefit. It would also present a public safety concern; a warning system would need to be implemented to alert landowners and the public of when flows were expected to occur in the otherwise dry channel. Also, this concept would not protect or preserve the existing recreational experiences associated with the river corridor. For these reasons, the JLAs did not advance this option for detailed evaluation.

Create Riparian Wetlands in the Existing Channel Corridor

Option: The existing channel could be partially filled and revegetated with riparian-wetland vegetation. Enough groundwater would likely discharge into the former channel area to support hydrophytic vegetation.

Determination: This concept would not protect or preserve the existing recreational experiences associated with the river corridor and was unpopular in the public involvement process. For these reasons, the JLAs did not advance this option for detailed evaluation.

Completely Fill the Existing Channel

Option: The existing channel could be filled to provide an upland site for other land use purposes.

Determination: This option would not protect or preserve the existing recreational experiences associated with the river corridor and was unpopular in the public involvement process. For these reasons, the JLAs did not advance this option for detailed evaluation.

2.10 Environmental Commitments

Measures to avoid and minimize impacts will be implemented during final design of the project prior to construction, during the construction phase, and as long-term commitments for management of the project area. The following sections describe the environmental commitments that will be included in the Record of Decision if an action alternative is selected. Additionally, Section 2.6 specifies certain commitments and management responsibilities that are included with the proposed action.

2.10.1 Requirements for Final Design (Prior to Construction)

Property Acquisition

Ownership of lands in the study area is a mix of private, municipal, County, State, and federal. In order to implement the proposed action, lands needed for the project will be acquired by the federal government if not already in public ownership and available for full use for project purposes. Various easements, title disputes, and so on (see Chapter 3, Section 3.10.4) will each be addressed in turn in accordance with relevant statutes. Acquisition will follow a standard process required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 USC 61). The purpose of this act is to provide uniformity and fairness in the treatment of property owners. The JLAs must comply with the federal regulations to acquire private property and water rights. The full range of available land acquisition flexibility allowed under law will be explored with landowners to ensure, to the extent reasonable, that project goals can be achieved by means of land acquisitions that are mutually agreeable. With any of the action alternatives, every reasonable effort will be made to complete land acquisitions on a willing-seller basis. If properties needed for the delta restoration component of the project could not be acquired on a willing-seller basis, then property will be acquired through exercise of eminent domain.

In addition to lands necessary for project implementation, additional lands could be acquired on a willing-seller basis, either in conjunction with an action alternative or at a later time. Such lands could be acquired to enhance the habitat values for June sucker, to preserve habitat values for other wildlife, or to provide additional recreation opportunities. In accordance with 43 CFR Part 10005, the Mitigation Commission is authorized to construct recreation projects that increase the quality of or access to outdoor recreation opportunities that rely on the natural environment, or provide opportunities that have been reduced through federal reclamation projects.

Before any property could be acquired, a Phase I Real Estate Environmental Site Assessment will be required.

Water Rights

The Utah Water Rights Database will be queried during the final design and property acquisition process to determine current ownership of water rights. The final design of any action alternative will need to accommodate access to wells, ditches, pipes, and other water right conveyance structures for any water rights not acquired as part of the alternative. Water will be maintained in the existing channel under all action alternatives. Currently, there are no guaranteed minimum flows in the lower Provo River. All action alternatives include providing a minimum flow of 10 cfs in the existing channel, which will improve streamflow during the summer irrigation season when flows otherwise can drop to near zero.

Consumptive Use and Evaporation of Water

Increased consumptive uses and evaporation of water caused by implementation of any action alternative will be covered by water rights owned by or to be acquired by the JLAs for this purpose.

Boat Harbor Drive

A final road design will be developed in consultation with Provo City and Utah County.

Natural Gas Pipeline

Additional coordination with Questar Gas will occur during final design to determine necessary avoidance and mitigation measures for the buried natural gas pipeline. Additional survey work may be needed prior to construction to more accurately determine the location and depth of the pipeline.

Vegetation Management

Vegetation mapping will be completed during the design phase and then again periodically during the monitoring and management phase (post revegetation) to determine level of effort needed to control weeds during and after construction.

Wetlands

The JLAs anticipate that the project will be permitted under a Nationwide 27 permit (aquatic habitat restoration, establishment, and enhancement activities). A detailed survey of the property acquisition area will be completed as part of the final design and Clean Water Act Section 404 compliance process. An effort will be made to identify any degraded peat mounds that may exist; these will be avoided with any project fill or excavation and construction staging areas associated with the selected alternative. The overall impact of any action alternative will be an increase in the quantity and quality of aquatic habitat, restoring wetlands in the study area to a more natural condition with a significant increase in wetland functions provided. An increase in weedy vegetation is possible immediately following project implementation of any action alternative, especially prior to establishment of native vegetation. Aggressive measures contained within the Vegetation Management Plan (Appendix B) will be followed to control the spread of invasive species.

With implementation of either Alternative A or B, the Provo City Wetland Mitigation Site will be maintained as a high-quality wetland within the overall restoration area, with an added function of June sucker rearing habitat. The BLB Drywall Mitigation site will also be maintained as a wetland within the overall restoration area, but is higher in elevation and therefore will not be anticipated to function as June sucker rearing habitat. The intent of the JLAs is that both Provo City and BLB Drywall will be "kept whole" with respect to their wetland mitigation sites within the delta restoration project (Alternative A or B). If the U.S. Army Corps of Engineers determines there is an adverse effect on the credits achieved by either site, the JLAs will work cooperatively with the parties involved to achieve an acceptable solution. The two wetland mitigation sites are outside the proposed land acquisition boundary for Alternative C and will not be affected under that alternative.

Threatened and Endangered Species

Ute Ladies'-tresses (Pre-Construction)

In consultation with the USFWS, the following conservation measures for Ute ladies'-tresses have been developed and will be applied to the proposed project:

1. Perform at least one additional survey for Ute ladies'-tresses prior to construction to meet the USFWS guidance of 3 years of surveys. This survey will determine whether any changes have occurred to known populations since the last survey in 2013. Survey the project area for additional occurrences. Additional surveys may be required, depending on the time between construction implementation and the last survey. The last survey should be performed no later than 3-years from construction initiation.

2. Avoid direct impacts to all identified occurrences during the final design and project implementation, to the extent possible.

3. Fence locations of known occurrences using environmental fencing and the assistance of a qualified biologist prior to construction activities in the project implementation area. Have the qualified biologist establish ingress, egress, and staging areas to avoid known occurrences.

Other additional commitments associated with threatened and endangered species are listed under the construction phase environmental commitments (Section 2.10.2) and the long-term environmental commitments (Section 2.10.3).

Land Owners and Agriculture

Because land uses in the study area are predominately agricultural under baseline conditions, the JLAs identified a number of possible mitigation measures to reduce the impacts to landowners and agricultural operations caused by acquisition of their private property for the project.

1. Scheduling. A project the magnitude of the proposed delta restoration project will take several years to plan, design, fund, construct and implement if approved. The JLAs will coordinate closely with landowners to identify reliable target dates for ranchers/landowners to count on for planning purposes so they know when they might need to begin adjusting herd size, or whether or not to invest in reseeding an alfalfa crop, for example.

2. Temporary Retained Use. The JLAs will exercise as much flexibility as allowed by law to enable landowners/ranchers to retain use of their property as long as possible, which in some cases may extend even after they have sold it to the government for the project.

3. Temporary Replacement Property. The JLAs have a limited amount of agricultural land in another region of Utah County that has been acquired contiguous to another project. The JLAs will consider the temporary or permanent use of those properties as replacement for properties sold to the government for the delta restoration project, to ease the transition out of agricultural production or from the study area to another location.

Airport Hazards (Pre-Construction)

The JLAs will coordinate with FAA and Provo Airport prior to project construction activities to alert them of pending land use changes that may require recalibration of radar systems.

The JLAs will invite USDA Wildlife Services, Provo Airport, and FAA to participate in design of the selected alternative to help identify any wildlife hazard reduction measures (e.g. plant species, design features) that might be compatible with the delta restoration project

The JLAs will implement a bird monitoring and movement study during the final design phase of the selected alternative to maximize data collection opportunities for establishing baseline conditions.

Cultural Resources

It is probable that buried prehistoric sites eligible for listing in the National Register of Historic Places are located within the Provo River Delta Restoration Project area. Prehistoric residential sites can be large, and considering the project area's proximity to previously documented sites of this type, there is a high probability that one or more of these sites will be inadvertently discovered during ground-disturbing activities associated with any of the three action alternatives. A Programmatic Agreement has been developed in consultation with SHPO and the consulting parties (signed copy to be included with the Record of Decision). The Programmatic Agreement represents a commitment on the part of the JLAs to mitigate for the effects of the undertaking.

South Levee Operation and Maintenance

During the planning process for the project, Provo City requested consideration of ways to temporarily provide higher water surface elevations in the existing channel to allow the City to examine the south levee under high water conditions. Under either Option 1 or Option 2, the JLAs will coordinate with Provo City during final design and construction of the existing channel to provide opportunities to periodically and temporarily raise water levels for the purpose of testing the structural integrity of the south levee for operation and maintenance purposes. Strategies will be sought to raise water levels in the existing channel where possible without flooding adjacent properties or impacting other uses/users of the existing Provo River corridor.

Other Required Permits, Approvals and Agreements

Chapter 1, Section 1.6 provides a description of required permits, approvals, and agreements that will be necessary for implementing the proposed action.

2.10.2 Construction Phase Environmental Commitments

Access for Private Property Owners and Construction

Construction activities will be designed to maintain access to all nonproject parcels under agricultural production or that hold livestock. All nonproject irrigation conveyances will be maintained or modified so that crop and pasture irrigation is not interrupted for significant periods of time or during critical irrigation times.

Construction workers and equipment will gain access to the Provo River corridor and the project area from public road access points. Negotiations will be conducted with landowners to determine whether temporary construction access could be obtained if needed. Procedures to avoid conflicts with adjacent property access and uses during construction will be established and followed to prevent conflicts. Unavoidable or unintentional damage to any facilities such as irrigation gates will be replaced or restored.

Natural Gas Pipeline Avoidance

The natural gas pipeline located in the study area will be clearly marked and avoided during construction.

Air Quality

Generation of fugitive dust could be expected in the vicinity of project construction areas as a result of earth excavation, vegetation removal, equipment operation, and traffic activity. Fugitive dust emissions will vary depending on the level of activity, specific construction techniques, soil characteristics, and weather conditions. Fugitive dust is composed of relatively large particles that settle out quickly, thus localizing the effect to air quality. Proper construction techniques, such as utilizing water, mulching, or applying surfactants on areas with high fugitive dust potential, will minimize dust emissions.

The constructor will be required to contact the Utah Division of Air Quality and obtain any needed emissions permitting for construction and will implement best management practices to minimize emissions as practicable.

Noise

Temporary noise disturbances will occur as a result of project construction. Effects will be limited in scope and duration, causing limited and temporary inconvenience to local residents. A Provo City noise ordinance restricts work to between the hours of 7:00 a.m. and 10:00 p.m.

Hazardous Materials and Hazardous Waste

During construction, if workers encounter any previously unknown soil contamination or other hazardous materials or waste, construction activity will cease until the hazard is evaluated and appropriate protection measures were implemented.

Visual Quality

The visual quality of the area will be temporarily affected by excavation, fill, vegetation clearing, and presence of construction vehicles. Staging areas will need to be maintained in an orderly manner and, where practical, off-shift equipment will be parked in designated areas to reduce visual clutter.

Noxious Weed Control

The introduction of noxious weeds will be minimized by requiring that all construction equipment be pressure washed before arriving and leaving the project area. Weeds will be sprayed with herbicide prior to ground disturbance.

To minimize the potential for the establishment of State-listed and other noxious weeds, an aggressive revegetation plan will be implemented. Newly excavated channel banks, backwater pools, and marsh areas will be seeded with a wetland seed mix containing a variety of grass, sedge, and perennial emergent species. Species known to provide high-quality rearing habitat for larval and juvenile June sucker will be emphasized. Planting and seeding will occur during the appropriate season for plant germination and survival.

Obtain clean material for any fill that may need to be brought on site to avoid introductions of noxious species, particularly phragmites.

Following revegetation, invasive weed species will be controlled using spot treatment with an herbicide licensed for safe use in aquatic habitats. Long-term vegetation management is specified in the project-specific vegetation management plan (Appendix B).

Water Quality

Potential short-term, water-quality impacts associated with construction of stream channel and floodplain pond features will be mitigated through the use of appropriate temporary stormwater and erosion control best management practices. Most construction activities in the delta restoration portion of the project area will occur prior to diverting water into the delta and prior to removal of Skipper Bay dike.

Existing Channel Riparian Forest

When constructing diversion structure(s)/dam(s) in the existing Provo River channel, minimize the footprint and impacts to riparian trees to the extent practicable. Replant disturbed areas with native riparian vegetation.

Wildlife

To comply with the Migratory Bird Treaty Act:

- Complete any vegetation clearing between August 30 and April 1, which is outside the typical nesting/brood rearing period for migratory birds.

- Alternatively, have a qualified wildlife biologist perform a nest clearance survey immediately prior to construction activities if any nesting trees/artificial structures have to be removed during the nesting/brood rearing season. Appropriate spatial buffers (generally 100 feet) should be established around any active nests and nests should not be touched until the young have fledged. Particular attention will be paid to surveying riparian disturbance areas for potential occurrence of yellow-billed cuckoo, a threatened species.

- Survey for raptor nests within the range of disturbance of project activities (refer to the USFWS *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* [2002]). Identify nests prior to trees leafing out and surveying again after nesting has begun to determine which nests are active, and what species are utilizing them. If the construction will occur during the nesting season, then surveys should be conducted again prior to construction activity to determine nesting activity. If an active raptor nest is identified, establish appropriate buffer distances and duration given the species and nest location.

Threatened and Endangered Species

June Sucker

- Do not conduct construction activities in the existing Provo River channel during the June sucker spawning period from April 1 to July 31 to avoid adverse effects on the species.

- Take care to minimize sedimentation inputs associated with stream-disturbance activities during construction.

Ute Ladies'-tresses (Construction Phase)

1. Document the extent of the impacted area when avoidance of direct impacts to Ute ladies'-tresses occurrences is not possible. Direct impacts include excavation for river channels or other proposed project features and placing fill material on known occurrences. Direct impacts do not include inundation because the species has survived prolonged periods of past inundation. Based on lake elevation levels, all occurrences except #4 would have been inundated with water for an extended period of time during 1983–1985. Many of the existing occurrences were also inundated for several months during a 10-year flood event that occurred during the 2011 growing season. Additionally, occurrence #6 was observed to be underwater in 2013 during the wetland delineation site visit with the Corps during a time when the Despain property was not being aggressively drained.

2. Salvage soil when avoidance of direct impacts is not possible and relocate it to another portion of the project area where the hydrology is sufficient to support Ute ladies'-tresses. The potential transplant areas are mutually agreeable to the USFWS and identified in the Biological Assessment for this project. Relocation methods will attempt to keep the upper 2 feet of the soil profile intact if the salvage area(s) are small (less than 100 square feet); however, this method may not be feasible if larger areas are salvaged. For larger impact areas, the top 12 inches of soil will be relocated to the transplant site. Because salvage efforts have a high failure rate, this activity is considered an impact-minimization strategy, but the salvaged area would still be included in the impact calculation. If Ute

ladies'-tresses are found in the transplanted areas during the post-construction surveys, then the salvaged area would be removed from the impact calculation.

3. Minimize soil and vegetation disturbance by operating equipment on top of temporary earth fills above geotextile mats when avoidance of temporary impacts (soil compaction by vehicles and machinery) to an occurrence is not possible.

4. Abstain from construction within 300 feet of known occurrences during the Ute ladies'-tresses flowering period of July 31–September 15. A qualified botanist may perform weekly surveys to document the beginning and ending of the flowering period to narrow this timing requirement based on the specific flowering period at the project area. Implement other best management practices for dust control during the Ute ladies'-tresses flowering period if any known occurrences are being impacted by dust. Follow best management practices for sediment control throughout construction to ensure that bare soil and sediment are not transported to Ute ladies'-tresses areas.

5. Avoid, to the extent feasible, construction impacts to peat wetlands, including degraded springs.

The following best management practices or general conservation measures will be followed to protect Ute ladies'-tresses in the study area:

1. Use boulders, root-wads, and other natural materials from local sources to stabilize streambanks and in the active stream channel rather than using concrete, asphalt, steel, other human-made materials.

2. Use erosion-control environmental commitments where project construction will disturb soil. These areas are expected to be along channel-construction and -modification areas, construction access roads, floodplain grading areas, setback berms, and stockpile areas. The procedures will be designed to stabilize soils, restore vegetation to a desired plant community, and to prevent infestation by noxious plants and to avoid erosion.

3. Remove and stockpile topsoil to a depth of 1 foot (or less if topsoil layer is less than 1 foot deep) for site restoration.

4. Secure additional topsoil of suitable quality for revegetating disturbed sites from areas that will have minimal impacts on important fish and wildlife habitats.

5. Implement the weed-control program in the vegetation management plan (Appendix B) to control noxious weeds resulting from project implementation.

6. Examine and wash equipment and vehicles, if necessary, to reduce the possibility of introducing toxic materials and undesirable plant species from previous work sites into the project area.

7. Fuel machinery off site or in a confined, designated area to prevent spillage into the soils, waterways, and wetlands.

8. Monitor disturbed areas for weeds and undesirable plant species during construction and implement necessary weed-control actions.

9. Control noxious weeds and undesirable plants by chemical, mechanical, and hand removal, as well as biological means, as may be appropriate, giving due consideration to compatibility with wildlife management plans, needs for protecting native plant communities, and avoidance of environmental contamination. Obtain approval for procedures and required permits for the controls that are used. See Appendix B for more details.

10. Burn or properly dispose of weeds removed by mechanical- or hand-control methods to prevent their spread to other areas.

11. Control noxious and undesirable vegetation in the vicinity of Ute ladies'-tresses orchid occurrences by methods provided by the USFWS.

12. Manage stockpiles of top soil that would remain barren for extended periods to control erosion and avoid proliferation and spread of noxious weeds and undesirable plants.

13. Reclaim disturbed areas to desired riparian, agricultural, and upland plant communities as soon as possible after construction. Require the contractor to use specified plant materials and reclamation techniques.

14. Implement erosion-control measures to prevent or reduce wind and water erosion and help establish vegetation in areas subject to erosion.

15. Conduct a site analysis on areas where there is a potential erosion problem to determine appropriate procedures that are needed (i.e., soil stabilizing materials, seeding mixtures, and mulching and fertilizing treatments).

16. Select plant species for rehabilitating disturbed areas and erosion control based on soil type, root-stabilizing characteristics, consistency with composition of contiguous native plant communities, ability to compete with undesirable vegetation, and compatibility with restoration goals.

17. Develop a comprehensive revegetation plan for the project implementation area and monitor the area 3 years following implementation to determine success and make recommendations regarding follow-up seeding, planting, and weed-control efforts that may be necessary.

18. Implement USFWS-provided specific herbicide treatment recommendations within Ute ladies'–tresses occurrence areas as detailed in the updated vegetation management plan (Appendix B).

Yellow-billed Cuckoo

- Comply with the Migratory Bird Treaty Act by completing any vegetation clearing between August 30 and April 1, which is outside of the typical nesting/brood-rearing period for migratory birds.
- Alternatively, have a qualified wildlife biologist perform a nest clearance survey prior to construction activities, paying particular attention to surveying riparian disturbance areas for potential occurrence of yellow-billed cuckoo.

Airport Hazards (Construction Phase)

- The JLAs will continue the bird monitoring and movement study during the construction phase of the selected alternative to maximize data collection opportunities for establishing baseline conditions.

- The JLAs will implement appropriate mitigation measures for any increased bird-aircraft strike risk caused by construction of the proposed project using measures appropriate to the species causing the risk. The JLAs will coordinate the measures with FAA, Provo City/Provo Airport, USDA Wildlife Services, and others.

2.10.3 Long-Term Commitments

Long-term commitments for management of the project include Provo River flow management, a vegetation management plan, a mosquito management plan, bird strike risk mitigation, and long-term water quality enhancement for the existing channel.

Provo River Flow Management

With implementation of an action alternative, the JLAs through the JSRIP will: adopt the Lower Provo River Ecosystem Flow Recommendations Report (Stamp et al. 2008) and associated flow regime targets; divide the flow into the restored lower Provo River delta so that the first 10 cfs and up to 50 cfs is delivered to the existing lower Provo River channel to help maintain aesthetics, water quality, and recreational values; and deliver up to an additional 4,500 acre-feet of conserved water annually to either Hobble Creek and/or Provo River to help meet target flow regime recommendations for June sucker. Meeting flow regime targets will be an adaptive process, and the JLAs will commit to work with the June Sucker Flow Work Group of the JSRIP to discuss the flow outlook for the upcoming water year, to coordinate flow patterns and discuss the needs of the June sucker, taking into account the target flow recommendations, available water supplies, and respective commitments for delivery of water to the Provo River and Hobble Creek. The Flow Work Group is a subcommittee of the JSRIP and advises the broader JSRIP group regarding the upcoming water year. Based on these factors the JSRIP will recommend a flow pattern to the U.S. Department of the Interior.

Threatened and Endangered Species

Ute Ladies'-tresses (Post-construction)

1. Report all documented direct impacts to known Ute ladies'-tresses occurrences to the USFWS within 6 months of completion of construction. The report will include map locations, areas of impact, and location(s) of salvaged soils from occurrences that could not be avoided during construction.

2. Use Utah Lake water elevation data to determine inundation periods for known Ute ladies'-tresses occurrences.

3. Perform three consecutive years of post-construction monitoring throughout the project implementation area, paying special attention to known occurrences and salvage and relocation areas. Post-construction begins once the hydrology has been restored to the project implementation area (i.e., removal of Skipper Bay dike and Provo River levee). Provide an annual monitoring report to the USFWS with information consistent with the 2010–2013 survey report for the study area (BIO-WEST 2013), and include an occurrence number, count, location, elevation, wetland type, associated vegetation, and representative photo.

4. Follow USFWS-specific weed-control recommendations for known occurrences. Amend the vegetation management plan (Appendix B), if needed, to include the USFWS measures.

Vegetation Management Plan

The purpose of the Vegetation Management Plan (Appendix B) is to direct the delta project area vegetation management to provide habitat for June sucker recovery and to restore, preserve and improve other native vegetation and riparian and wetland habitats. The goal of vegetation management in the project area is to maintain diverse plant communities and includes the control of noxious weeds or other undesirable vegetation in the delta project area, predominantly common reed (*Phragmites australis*) and, to a lesser degree, reed canarygrass (*Phalaris arundinacea*) and others.

Mosquito Management Plan

The Mitigation Commission conducts mosquito control on mitigation properties under the auspices of the Utah Pollution Discharge Elimination System (UPDES) general permit number UTG170000, administered by the Utah Division of Water Quality, Department of Environmental Quality. A Mosquito Management Plan for the proposed action (Appendix C) has been developed in coordination with the Mitigation Commission's 2012 Pesticide Management Plan (URMCC 2012a) as required under the UPDES permit.

A proposed cooperative approach to mosquito management associated with the proposed project will be implemented as follows:

1. Larval monitoring and control: Responsibility of the JLAs, in consultation with Utah County Health Department. This could be contracted to Utah County Health Department or other third-party entity.

2. Adult mosquito monitoring and control: Responsibility of Utah County Health Department with cooperation and assistance from the JLAs.

3. Communication and education: Cooperative effort among the JLAs, Utah County Health Department, and others.

Bird Strike Risk Monitoring and Mitigation (Post-Construction)

1. The JLAs will commit to conducting a monitoring and movement study and to mitigating any increased bird-aircraft strike risk caused by the proposed project. The Mitigation Commission will execute an agreement or contract to conduct the baseline monitoring/movement study and mitigation efforts.

2. The JLAs will endeavor to execute an Memorandum of Agreement among Provo City, Provo Airport, USDA Wildlife Services, and the FAA to establish cooperation and coordination among the parties for implementing the monitoring and mitigation efforts.

The mitigation measures will be appropriate to the species causing the risk and coordinated with FAA, Provo City/Provo Airport, USDA Wildlife Services, and others. The measures could include temporarily closing the public access to the project area to safely and effectively haze or remove problem birds; installing and implementing bird-detection and warning systems; conducting research; or implementing other measures yet to be determined to ensure an effective mitigation program.

Long-term Water Quality Enhancement for the Existing Channel

As discussed in Section 2.6.3, measures for improving water quality in the existing channel (minimum instream flows and aeration of the water column) are included as part of the proposed action. The JLAs will construct and install an aeration system in the lower Provo River channel that will be retained and managed for recreational, aesthetic and fishery uses. The aeration system will increase DO concentrations and improve water quality during the hot summer, low-flow months compared with existing baseline conditions. The aeration system will also reduce or eliminate blue-green algae and reduce the release of manganese, iron, nitrogen, and phosphorous from the bottom sediments.

The aeration system would be intended for year-round use. Initially, it would be used to oxygenate the bottom sediments and improve conditions for beneficial microbes, which will reduce the muck layer that is currently on the channel bottom. The aeration system would then be operated as needed to maintain State water quality standards for DO. The JLAs will continue to pursue additional measures if needed to meet these objectives.

As a participating project under the Colorado River Storage Project Act, the Bonneville Unit of the Central Utah Project is authorized to utilize Colorado River Storage Project power for project purposes. Therefore, power for the proposed aeration facilities could be obtained from this power allocation.

Dredging the organic-rich sediment layer at the bottom of the existing channel would not likely be necessary to maintain State water quality standards for dissolved oxygen. However, portions of the organic-rich sediments would likely be removed during construction as the aeration system is installed. Other aesthetic and recreational improvements to the existing channel could also be made at that time. The JLAs will coordinate with Provo City, Utah County, and stakeholders in this regard during the final design phase.

A sediment oxygen demand study (Goel et al. 2014) indicates that the decay of organic matter from the watershed is the primary source of sediment oxygen demand in the lower Provo River. With implementation of the proposed project, most organic matter from the watershed would be diverted away from the existing channel and into the delta. Accumulations of both coarse and fine organic matter and sediments are anticipated in the delta. However, with enough space for the delta channels to adjust and migrate over time and with a delta that is more open to wind and the exchange of oxygen from the atmosphere, organic matter accumulations are not expected to cause the same DO problems throughout the water column and across the entire delta that occur in the existing channel.

The JLAs recommend that State and local governments and organizations develop a task force/study group to investigate sources of fine organic matter, nutrients, and other pollutants in the watershed that may degrade water quality conditions in the lower Provo River. The JLAs would participate with and support the efforts of such a group if it is formed.

PROVO RIVER DELTA RESTORATION PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT

Chapter 3: Affected Environment and Impacts

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CHAPTER 3: AFFECTED ENVIRONMENT AND IMPACTS

3.1 Introduction

This chapter describes the baseline environmental conditions and socioeconomic characteristics of the study area and the anticipated impacts that would occur with each alternative. Large-format figures are included in Appendix A.

3.1.1 Baseline Study Area and Environmental Context

Figure A-9 (Appendix A) illustrates the baseline study area and surrounding environment, including the lower portion of the Provo River. As discussed in Chapter 1, the lower 4.9 miles of the river are designated as critical habitat for June sucker (*Chasmistes liorus*) under the Endangered Species Act (ESA).

Lower Provo River Existing Conditions Overview

The Provo River upstream of the Utah Division of Wildlife Resources (UDWR) fish weir (Figure A-9) is used by adult June sucker for spawning in late May and June; afterwards, adults return to Utah Lake. Historically, spawning, rearing, and nursery habitats for June sucker would have been available in whole or in part within the Provo River floodplain and interface with Utah Lake. However, in its current condition, with levees on both sides of the river channel, there is very little if any rearing habitat in the lower Provo River (Radant et al. 1987).

Limitations for spawning have also been an issue on the lower Provo River; in particular, water diversion structures that prevent fish passage and provision of adequate flows during the spawning season. These issues are being addressed through other actions of the interagency June Sucker Recovery Implementation Program (JSRIP). As discussed in various parts of this Environmental Impact Statement (EIS), efforts have been underway for many years to improve these conditions. Over the course of more than 15 years, water has been acquired for the June sucker recovery efforts by direct purchase, water conservation, and environmental commitments associated with new water development projects. On the lower Provo River, the Fort Field Diversion (Figure A-9) was reconstructed in 2008–2009 to accommodate fish passage. Planning is now underway to assess the feasibility of modifying the Lower City Dam to allow fish passage above this location where additional spawning habitat is available. As discussed in Chapter 2, part of the currently proposed action is to adopt flow recommendations and use additional conserved water that may be available for instream flows to facilitate June sucker recovery.

Study Area Overview

Another main component of the proposed action is to restore a delta ecosystem on the lower Provo River capable of providing rearing and nursery habitat. The baseline study area (or simply study area) shown in Figure A-9 encompasses 708 acres within which alternatives for meeting this need were developed.[1] All of the alternatives advanced for detailed analysis utilize only a

[1] As discussed in Chapter 2, other potential geographic locations, including other Utah Lake tributaries, were also considered. The study area was determined to be the only reasonable and practicable location within which the project need could be met; reasons for this are discussed in Chapter 2, with additional details provided in the alternatives development technical memorandum (URMCC 2011).

portion of the overall study area; however, for most of the resource sections reported in this chapter, data were collected for the entire study area, or in some cases, at an even larger geographic scale.

There is no residential development within the study area, and the existing land use is predominantly agricultural. The majority of the study area is located within an unincorporated portion of Utah County. Approximately 333 acres of the study area are within the K. Dale and Sonja Despain Cattle Ranch and Bird Refuge Conservation Easement, a State-designated conservation easement (this easement is discussed in greater detail in Section 3.10: Land Use). The easement is held by Provo City. There are also two existing wetland mitigation sites within the study area, a Provo City mitigation site (approximately 16.7 acres) and the BLB Drywall mitigation site (approximately 3.7 acres). Land uses surrounding the study area include agriculture, residential development, and Utah Lake State Park. Along the south boundary of the existing Provo River channel there are two private recreational facilities—Lakeside RV Campground and a ropes course/canoe rental (CLAS Ropes Course). Provo Airport is located on the Utah Lake shoreline to the south of the study area.

As shown by the estimated 1856 shoreline in Figure A-10 (Appendix A), the study area was within the historic bed of Utah Lake prior to construction of the Skipper Bay dike and the levees surrounding the Provo River channel. These structures prevent the study area from being inundated with surface water most of the time. However, they are not designed to protect the area from flood-level water elevations and, consequently, the majority of the study area is within the 100-year floodplain designated by the Federal Emergency Management Agency (FEMA). The typical high Utah Lake elevation is 4,489 feet. This elevation was set as part of a compromise agreement between Utah County landowners and Salt Lake County water users. The actual water level at the lake can exceed this “compromise elevation”; however, the terms of the agreement dictate that efforts must be made to lower the lake level when it exceeds 4,489 feet.[2] These efforts are conducted at the dam and pumping works near Utah Lake’s outlet to the Jordan River (CUWCD 2007). As shown in Figure A-10, much of the study area is below this elevation; thus, even under current conditions pumping is necessary in the spring of most years to reduce surface water within the study area for the purpose of facilitating agricultural use.

3.1.2 Chapter Contents

Each section of this chapter provides a detailed analysis of project alternatives for respective resources. Resource sections are organized as follows:

- Section 3.2 – Surface and Groundwater Hydrology
- Section 3.3 – Water Rights
- Section 3.4 – Water Quality

[2] More precisely, the compromise elevation of Utah Lake has been set at 4,489.045 (Utah Lake Landowner’s Association, V. Kennecott Corporation, Civil No. 64770, March 8, 1985).

- Section 3.5 – Wetlands
- Section 3.6 – Existing Channel Vegetation Community
- Section 3.7 – Fishery Resources
- Section 3.8 – Wildlife Resources
- Section 3.9 – Threatened and Endangered Species
- Section 3.10 – Land Use
- Section 3.11 – Agriculture and Farmlands
- Section 3.12 – Noxious Species
- Section 3.13 – Utilities
- Section 3.14 – Socioeconomic Impacts and Environmental Justice
- Section 3.15 – Recreational Resources
- Section 3.16 – Public Health and Safety
- Section 3.17 – Cultural and Paleontological Resources
- Section 3.18 – Climate Change
- Section 3.19 – Irreversible and Irretrievable Commitments of Resources

Each resource section begins by describing the potential impact issues and the sources of information consulted. Baseline conditions are described in each resource section prior to evaluating impacts of project alternatives. Each section evaluates the three action alternatives and two existing river channel options, as well as the No-Action Alternative. Cumulative impacts are also evaluated within each resource section. Mitigation measures for identified impacts are then identified.

Baseline resource conditions were identified through literature and data file searches; coordination with local, State, and federal agency personnel; stakeholder and public input; and field investigations by qualified personnel.

3.1.3 Key Terms Used in this Chapter

Direct, Indirect, and Cumulative Impacts

The National Environmental Policy Act (NEPA) requires consideration of direct, indirect, and cumulative impacts of proposed actions, as well as specification of potential mitigation measures for the identified impacts. In federal regulations for implementing NEPA (40 CFR 1500-1508), the terms “impact” and “effect” are used interchangeably. Definitions of direct, indirect, and cumulative are provided in Section 1508:

- **Direct effects** are defined as “effects that are caused by the action and occur at the same time and place.”
- **Indirect effects** are “caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.”
- **Cumulative impacts** are defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.”

Use of the Terms Dike, Levee, and Berm

The terms “dike,” “levee,” and “berm” are frequently used in this EIS. In common usage, the terms dike and levee are synonymous, referring to human-created linear structures, usually earthen berms, which are intended to prevent overbank flow. For consistency, this EIS uses the term dike to refer to the existing Skipper Bay dike located along the Utah Lake shoreline. The term levee is used in reference to existing berms along both sides of the lower Provo River channel. As previously noted, none of these existing structures are built to standards that would protect adjacent lands from 100-year flood levels. Section 3.2 provides a floodplain analysis for the study area under existing conditions and future conditions with any of the proposed action alternatives.

In this EIS, new structures that would be built as part of the proposed action are referred to simply as berms. For purposes of analysis, these berms were assumed to be earthen structures with a minimum top elevation of 4,495 feet. The new berm would be located along the southern project area acquisition boundary. At its east end point, it would tie into the existing Provo River Parkway levee and trail at an elevation of approximately 4,498 feet or existing grade, if higher. The berm would descend in elevation approximately 0.2–0.3 percent for 1,000–1,500 feet to match the drop of the Provo River until it reached an elevation of 4,495 feet. The berm would continue west at an elevation of 4,495 feet until it tied in with the Skipper Bay dike trail north of Utah Lake State Park. The berm’s footprint would likely range from 30 to 70 feet wide at the base, depending on elevation of the existing ground. This width would allow for a 10-foot-wide trail and 1-foot-wide shoulders to be constructed on top of the berm using design standards for trails provided by Utah County, and relatively gentle 3:1 fill slopes in most places. A benched terrace would be included on one side of the 3:1 fill slope for equestrian uses (e.g., an unpaved trail). Where needed to stay within acquired property bounds, steeper slopes up to 2:1 would be constructed.

3.2 Surface and Groundwater Hydrology

This section addresses the baseline and anticipated future annual cycle of river flows, lake levels, and groundwater elevations associated with the proposed action.

3.2.1 Issues Addressed in the Impact Assessment

Issues addressed in this section are as follows:

- How would flows of surface and groundwater change in the study area and surrounding environment?
- Would the project, by creating additional areas of open water and wetlands, significantly reduce water supplies entering Utah Lake as a result of increased surface water evaporation?
- Would sedimentation change any physical characteristics within Utah Lake beyond the study area boundary?
- Would the project cause additional flooding to nearby residential developments or other developed land near the study area?

The proposed action has many implications for surface and groundwater hydrology in and near the study area. There are two surface water bodies of concern for the proposed action, the Provo River and Utah Lake. Streamflow and lake conditions influence June sucker spawning and larval drift as well as the distribution of habitat types at the river-lake interface.

Groundwater hydrology in the study area is also important for a number of reasons. Positioned just west of the Wasatch Mountains and just east of Utah Lake, the study area is located within a large, complex groundwater discharge area. The water table is seasonally at or near the surface throughout the entire study area, and a variety of perennial and intermittent seeps and springs are present, especially along the eastern, more topographically complex portions of the study area. Groundwater elevations near the Lakeshore Village residential development are a concern for residents in terms of flooding potential. Provo City operates a drainage and pump system just west of Lakeshore Drive to control flooding by both groundwater and stormwater. The western portion of the study area is also drained and pumped to control flooding by both groundwater and lake water, primarily to benefit grazing and agriculture.

Hydrology is important to restore a healthy ecosystem because groundwater and surface water influences the types of wetland vegetation communities and habitats that would develop within the restored river and delta. The three action alternatives would affect groundwater conditions primarily in the central and western portions of the study area by partially removing the existing shoreline dike (known as Skipper Bay dike), eliminating or significantly changing existing pumping practices (except for the pumps near Lakeshore Village and Utah Lake State Park), and removing unnecessary drainage ditches in the restored delta area that impact the hydrology of Skipper Bay.

To evaluate these issues, available existing information on surface water and groundwater was compiled. Data sources included U.S. Geological Survey (USGS) streamflow gage data for the lower Provo River, the Utah Lake System EIS (CUWCD 2004), the lower Provo River ecosystem flow recommendations report (Stamp et al. 2008), Central Utah Water Conservancy District gage data for Utah Lake, the Utah Lake Distribution Plan (Utah State Engineer 1992), and USGS hydrogeology information for the area (Anderson et al. 1994, Cederberg et al. 2009). Detailed information on existing Provo River and lakeshore topography and hydraulic conditions was collected and analyzed, and models were developed to predict flood stage and inundation conditions under the various action alternatives.

To supplement existing information, water level stage recorders were installed near the study area on Utah Lake, and a series of 31 groundwater monitoring wells were installed throughout the study area. Property owners and Provo City staff were also contacted to acquire additional information regarding irrigation ditches and pumping practices in the study area. Surveys of the existing Provo River channel were conducted to obtain detailed cross sectional and longitudinal profile information. A topographic survey was conducted throughout the study area using LiDAR. Finally, a hydraulic model (HEC-RAS) was developed for the existing channel and proposed channels to predict water surface elevations during various flooding scenarios under the action alternatives and the No-Action Alternative.

The study area occurs within a designated 100-year flood hazard area. Because the action alternatives would involve relocating the Provo River channel and altering the dike and levee systems, they have the potential to shift the location of land areas susceptible to flood hazards associated with the river and lake. Utah County participates in the voluntary National Flood Insurance Program administered by FEMA. Communities that participate in the program are evaluated for flood hazard areas and a Flood Insurance Rate Map is developed for that community. In this system, the flood hazard area is based on any area determined to have a 1 percent chance of being flooded in any given year (or a 100-year flood area). The Utah County Flood Insurance Rate Map was most recently updated in 1988 (Figure A-11, Appendix A). This map shows the majority of the study area occurring within the 100-year flood zone. The eastern edge of the study area near 3110 West Street, along with some of the development east of 3110 West Street, is mapped as a 500-year flood area.

3.2.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to surface and groundwater hydrology were eliminated from further analysis. The evaluations of baseline surface and groundwater conditions also provided context for other analyses presented in this chapter, particularly the following:

- Section 3.5 – Wetlands
- Section 3.6 – Riparian Vegetation
- Section 3.7 – Fisheries
- Section 3.8 – Wildlife
- Section 3.9 – Threatened and Endangered Species

3.2.3 Area of Influence

Hydrologic evaluations focused on the study area including the portion of the lower Provo River that would be modified by the proposed action. The broader context of the Utah Lake watershed was also considered where appropriate.

3.2.4 Affected Environment (Baseline Conditions)

This section describes baseline surface water hydrology in the lower Provo River and Utah Lake and groundwater conditions in the study area.

Provo River

The historic streamflow of the lower Provo River is well documented. The USGS currently maintains a streamflow gage on the lower Provo River (Station Number 10163000 located west of Geneva Road in Provo) that has recorded streamflow data continuously since 1937. Over the period of record, many human activities have influenced the hydrology of the river. To name only a few, these have included: construction of two large dams (i.e., Deer Creek and Jordanelle) and many smaller diversions; trans-basin importation of water from the Weber River and Duchesne River, urbanization of portions of the drainage basin; livestock grazing within the riparian corridor; and channelization of major segments of the river. The hydrologic effects of these dams, diversions, and other impacts are illustrated in Figure 3-1, which plots Provo River hydrographs for a typical water year (1999) at various locations along the river.

Natural streamflow in the Provo River is driven largely by snowmelt. As such, the daily mean streamflow varies seasonally throughout the year (Figure 3-2). Streamflow is highest during the months of May and June, when high-elevation snowmelt runoff is at its peak (Figure 3-3). Low-flow months on the Provo River include July, August, and September, when precipitation is low and diversion for irrigation and other uses is high. In the study area, zero flow in the Provo River due to irrigation diversions has occurred at least once in every month between April and October but never between November and March. The periodic low-flow conditions during late spring and summer months are a potential concern for successful June sucker recruitment.

Water management and protection is one of six major elements for June sucker recovery identified in the JSRIP document (CUWCD et al. 2002). This element focuses on providing and protecting streamflows sufficient to provide for June sucker recruitment while allowing for continued development of water resources for human use. Specific efforts implemented to date have included acquisition of water to supplement flows, development of target June sucker hydrographs (Keleher 1999), annual meetings and assessments of how well targets are met, commitments to deliver flows to the lower Provo River (CUWCD 1999, 2004), and more recent preparation of comprehensive ecosystem flow recommendations for Provo River (Stamp et al. 2008) and Hobble Creek (Stamp et al. 2009). More specifics regarding these (separate but related) efforts and hydrologic effects are included in the *Alternatives Development Technical Memorandum* (URMCC 2011).

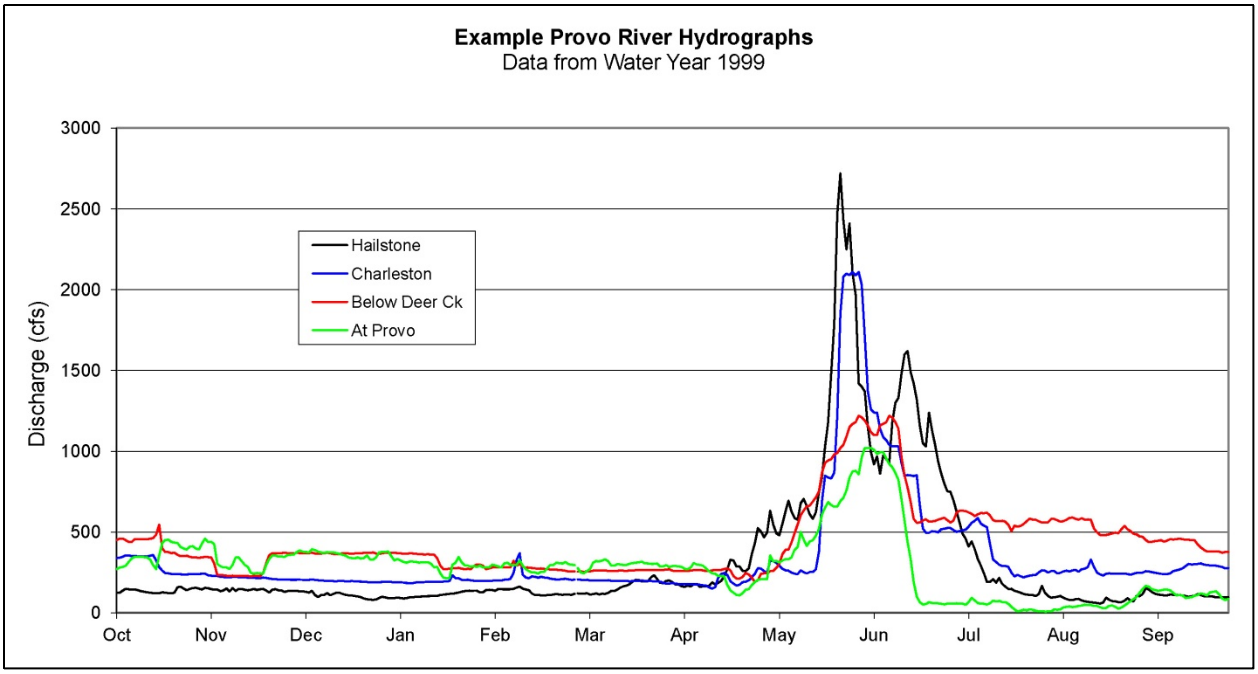


Figure 3-1. Example Provo River hydrograph at Hailstone (above Jordanelle Dam), Charleston (below Jordanelle Dam), below Deer Creek Dam, and at Provo (near the study area).

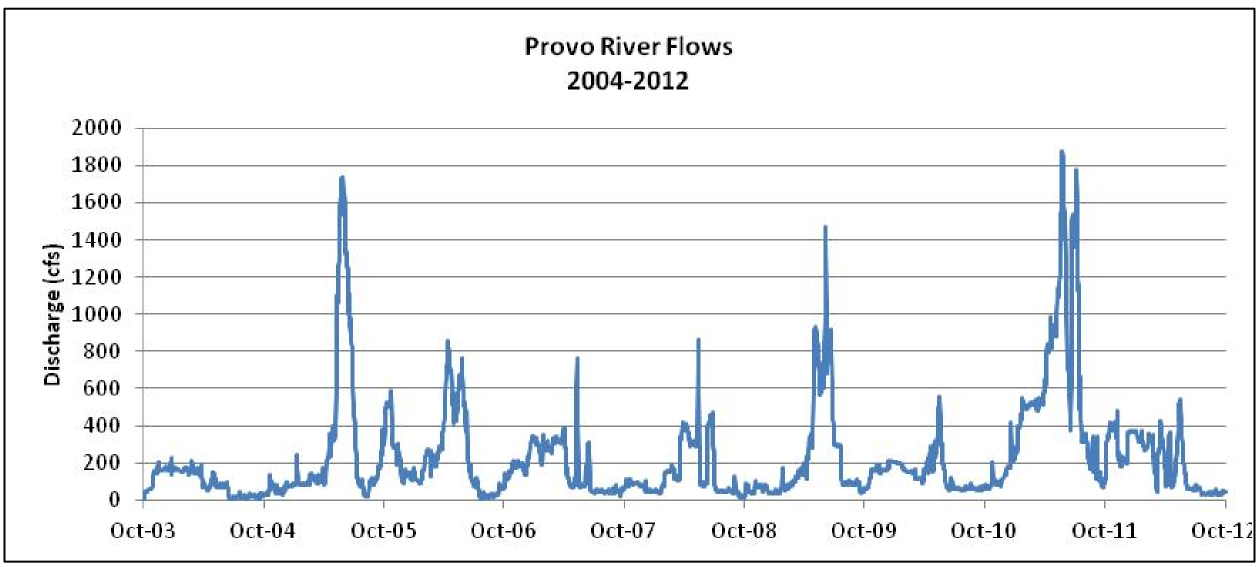


Figure 3-2. Nine years of daily average flows in the lower Provo River at the Boat Harbor Drive Gage.

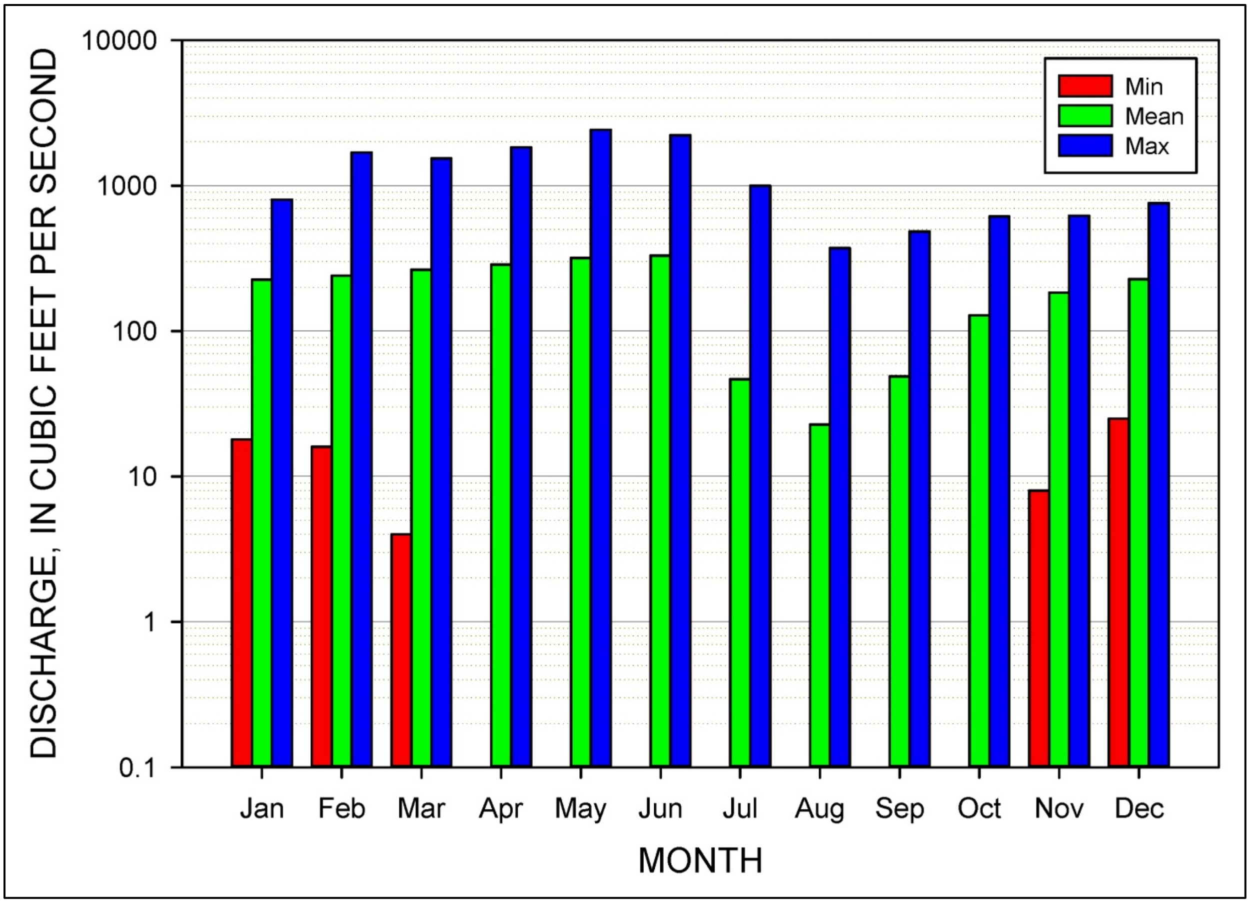


Figure 3-3. Distribution of monthly mean discharges for the Provo River at Provo, Utah, 1937–2012. Red (Min) bars are not visible on this graph for April through October because zero discharge has occurred during each of these months and the y-axis stops at 0.1.

The *2004 Utah Lake Drainage Basin Water Delivery System Environmental Impact Statement* (CUWCD 2004) and associated Records of Decision evaluated and committed to deliver (upon completion of the Utah Lake Drainage Basin Water Delivery System [ULS]) supplemental water to the lower Provo River to aid in reaching previously established year-round instream flow target levels to meet JSRIP instream flow goals. The volume of supplemental water delivered to Provo River would vary from year to year, depending on natural hydrology, the need to deliver exchange water[3], water shortages, and volume constraints for the various conveyance systems. As discussed in Chapter 1 (Section 1.3.8), under baseline conditions, supplemental water could consist of the delivery of 13,789[4] acre-feet of conserved water annually, plus up to 2,586 acre-feet of purchased water rights annually, plus the release of an annual average of 16,000 acre-feet

[3] See Section 1.3.8 of this Environmental Impact Statement for a more thorough discussion of the exchange process and how it works for the Utah Lake System and the Bonneville Unit of the Central Utah Project.

[4] This amount was anticipated to be 12,165 acre-feet annually when the ULS EIS was written. It is now anticipated to be 13,789 acre-feet annually, subject to shortages.

of exchange water from the Spanish Fork-Provo Reservoir Canal Pipeline to the lower Provo River.

The Records of Decision for the ULS EIS indicated the average annual streamflow target from the Murdock Diversion to U.S. Interstate 15 (I-15) would be 216 cubic feet per second (cfs). This is 36 cfs (20 percent) more than the period of record prior to the ULS. With the supplemental ULS releases, monthly flows increase in all months of the year, with percentage increases ranging from 7 to 47 percent higher (CUWCD 2004, pp. 3–22). These increases would result from delivering the aforementioned supplemental water.

From I-15 to Utah Lake, the average annual streamflow target is 157 cfs with ULS deliveries. This is 43 cfs (38 percent percent) more than prior baseline conditions. Monthly flows will increase in all months of the year, with percentage increases ranging from 8 to 1,425 percent higher (CUWCD 2004, pp. 3–22). The largest percentage increases occur from ULS operations in August and September and result from the fact that the Provo River downstream from I-15 was nearly dry during those months prior to June sucker recovery efforts beginning in the 1990s to buy or lease water to provide flows to support June sucker recovery. Photographs of differing streamflow conditions in the lower Provo River, Figure 3-4, provide an illustration of the benefit provided by the described deliveries.

There are times when exchange water would need to be delivered to Utah Lake and if it was delivered via the Provo River it would be in excess of the nonirrigation season target flows. During those times exchange water could be delivered to Utah Lake by way of the Spanish Fork River. Supplemental water would not be added to high spring runoff flows if there is a risk of flooding along Provo River (generally flows greater than 1,800 cfs). The peaks of the target flow regimes are below the 10-year, peak-flow magnitude of 1,722 cfs (Table 3-1). The amount of water added to Provo River in any given year will vary depending on weather conditions, local water use, amounts available, need for delivery of exchange water, and delivery system capacity availability. Analysis shows that there are times (generally during the peak irrigation season) that system delivery capacity is fully utilized with contracted water deliveries and thus not available for full delivery of desired supplemental flows.

Table 3-1. Provo River peak flow magnitudes for various runoff recurrence intervals (based on data at USGS gage #10163000 period of record 1937–2012).

FLOOD CHARACTERISTIC	DISCHARGE (CUBIC FEET PER SECOND)
2-year runoff [a]	859
10-year runoff [a]	1,722
100-year runoff [a]	2,752
100-year runoff [b]	2,700

[a] Runoff recurrence intervals calculated using Log-Pearson Type III analysis of instantaneous peak flow data (IACWD 1982).
[b] 100-year runoff value being used for Provo's Flood Insurance Rate Map update project, currently in progress by the Federal Emergency Management Agency.

Figure 3-4. Photos of the lower Provo River during an extreme low-flow event that occurred in 2004 (less than 5 cfs in the upper photo) and above-normal winter flows in 2010 (173 cfs in the lower photo). This portion of the lower Provo River is above the influence of Utah Lake (just upstream of cross section 26).

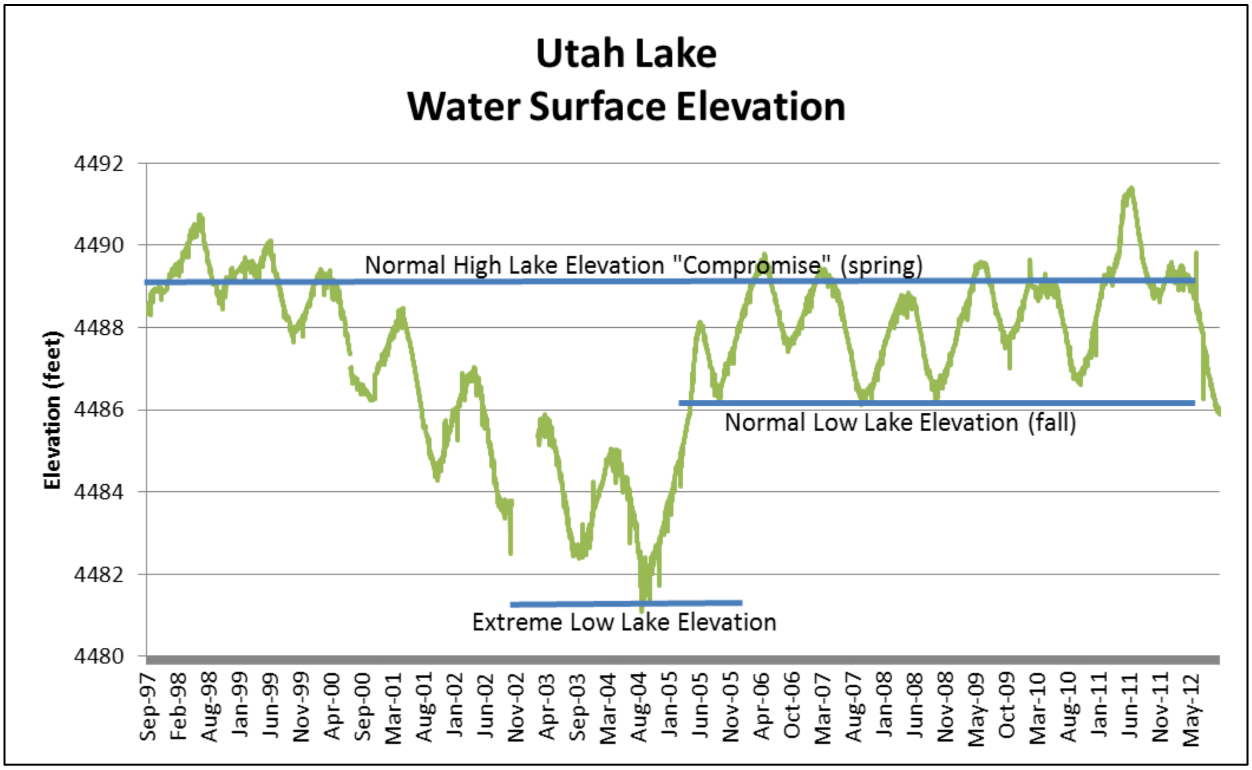
Utah Lake

As with the Provo River, the hydrology of Utah Lake and its other tributaries has been highly altered by human activities, in particular by the construction of dams and diversions. Currently, Utah Lake water elevations are controlled primarily by the dam and pumping plant/outlet works built near Utah Lake's outlet to Jordan River (CUWCD 2007).The Utah Lake and Jordan River Operating Procedures and Flood Management Document require that, "Whenever the level of Utah Lake is at or above Compromise Level, the Control Gates shall be fully opened …" (the compromise elevation is officially set at 4,489.045 feet, 1929 National Geodetic Vertical Datum).[5] Utah Lake storage capacity is about 870,000 acre-feet (710,000 active; 160,000 inactive) when at the current compromise elevation. The elevation of the inactive storage level is 8.70 feet below the compromise elevation (Utah State Engineer 1992).

Utah Lake water levels fluctuate seasonally and from year to year, depending on climatic conditions and water storage and release operations (Figure 3-5). Typically, lake levels are highest in the spring and lowest in the fall (CUWCD 2004), and levels fluctuate on average approximately 3 feet per year. Water elevations in Utah Lake are constantly in a state of flux considering natural and anthropogenic caused variability in climate, changes in watershed conditions, continued development of water systems such as ULS water delivery infrastructure system, and changes in water use.

As part of planning and analyses for the ULS project, baseline monthly Utah Lake water levels were simulated using current/planned water operations overlaid on water year 1950–1999 hydrologic conditions (CUWCD 2004). Using these simulation results (expected lake levels in the future), plots and summaries of lake levels for different time frames were prepared (Figures 3-5 and 3-6). Lake levels are expected to range from approximately 4,481 to 4,493 feet over the simulated 50-year time period. Using the 20th, 50th, and 80th percentile values to represent high, medium, and low lake level conditions, respectively, the typical high Utah Lake level is 4,489 feet (compromise elevation), the typical medium lake level is 4,488 feet, and the typical low lake level is 4,486 feet (NGVD 1929 datum) (Table 3-2). If the proposed action is implemented, the seasonal and year-to-year variation in lake levels would influence the amount of time that various portions of the study area are inundated by water, which in turn would influence the vegetation types and available rearing habitat for June sucker and other aquatic species. The typical anticipated May–June spring runoff lake level is 4,488.4 feet.

[5] The Utah Lake and Jordan River Operating Procedures and Flood Management Document as referenced in [Utah Lake Landowner's Association V. Kennecott Corporation, Civil No. 64770, March 8, 1985].



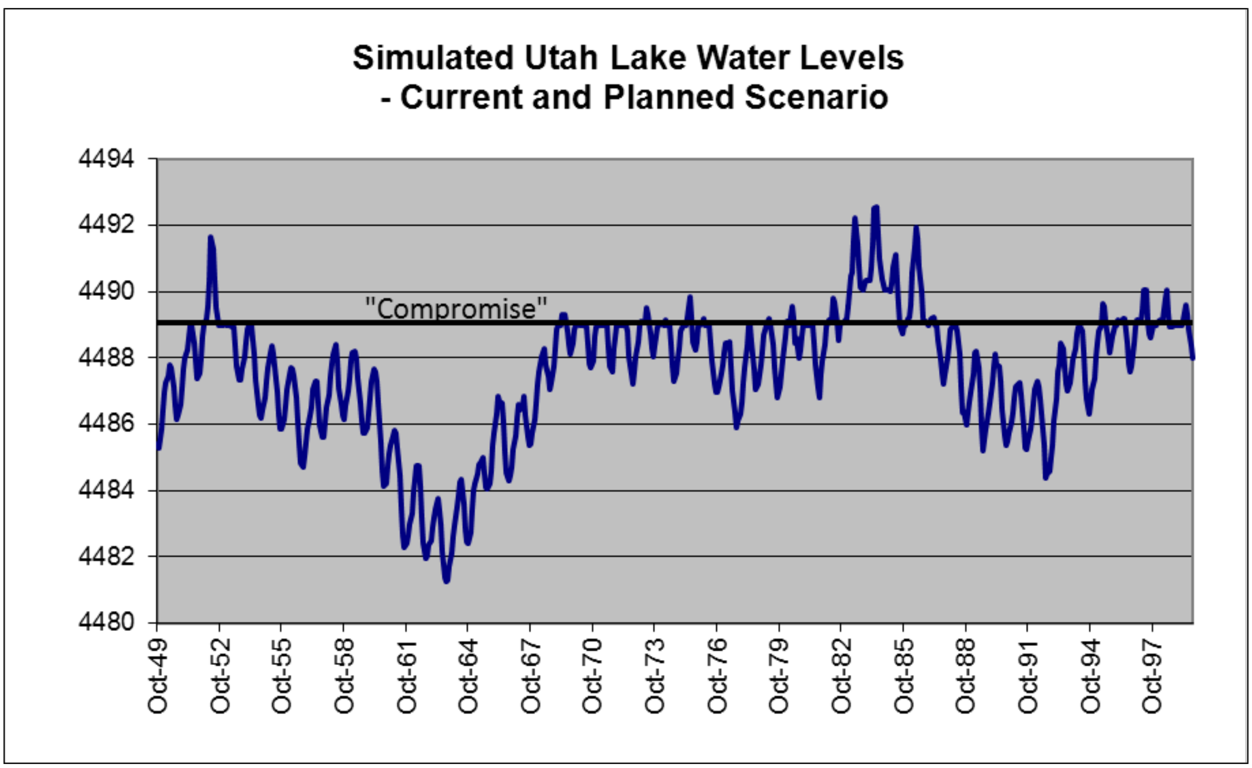


Figure 3-5. **Utah Lake existing and baseline (planned) water surface elevations. The top graph shows the past 15 years of data, whereas the bottom graph shows the simulated planned elevations based on 50 years of data, as described in the Utah Lake Drainage Basin Water Delivery System Environmental Impact Statement.**

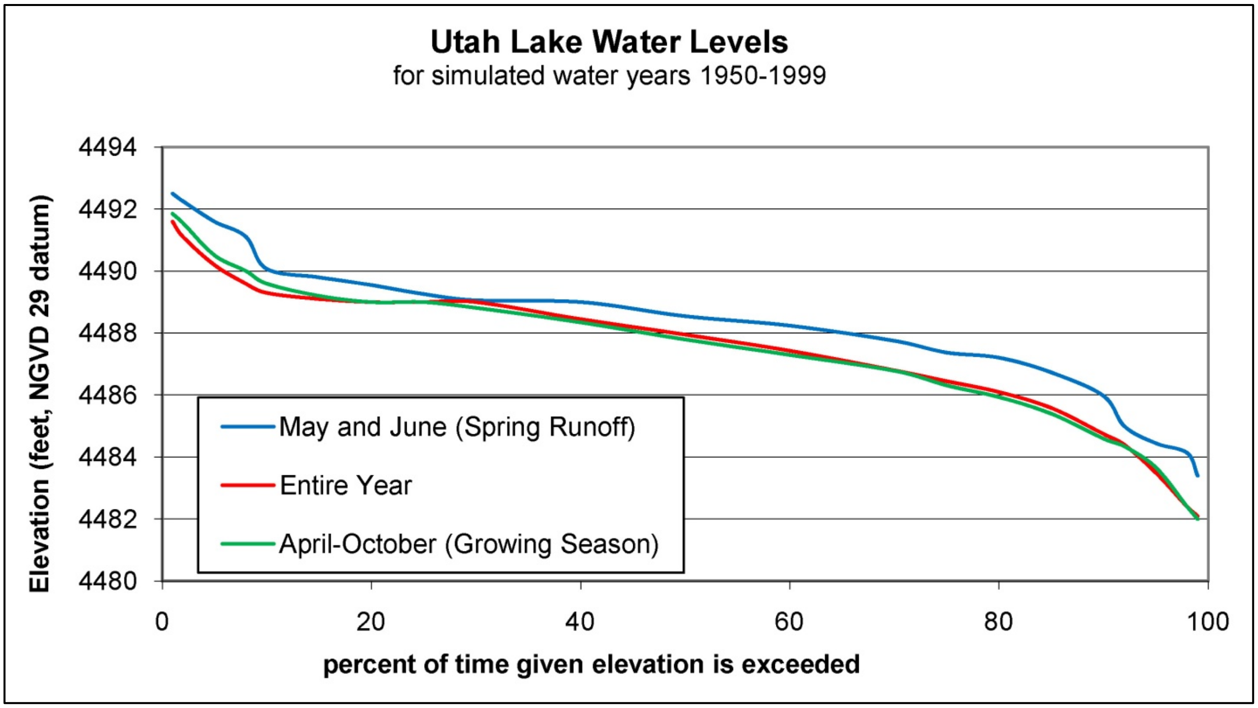


Figure 3-6. Elevation duration curves of predicted Utah Lake water levels for various seasons of interest.

Table 3-2. Summary of predicted Utah Lake water levels for various seasons of interest. Data based on current/planned water operations simulated for water years 1950–1999.

MEASUREMENT	UTAH LAKE WATER LEVEL (FEET, NGVD29 DATUM)		
	Entire Year	Growing Season (April–October)	Spring Runoff (May and June)
Minimum	4,481.25	4,481.25	4,483.00
Maximum	4,492.55	4,492.55	4,492.55
Mean	4,487.57	4,487.53	4,488.35
20th Percentile	4,489.00	4,489.00	4,489.55
50th Percentile	4,487.95	4,487.80	4,488.55
80th Percentile	4,486.10	4,485.94	4,487.21
FEMA [a] lake elevation for 100-year flood[b]	4,494.5		

Source: CUWCD 2004.
[a] FEMA = Federal Emergency Management Agency.
[b] Sources (see Chapter 5: References): FEMA 1988 and FEMA 2014.

Official Utah Lake water-level data are collected by Central Utah Water Conservancy District (CUWCD) at a gage located near the lake's outlet at Jordan Narrows. To coincide with our collection of groundwater monitoring data in the study area (described in the next subsection) a water-level logging device was installed at the Utah Lake Marina in November 2010. Data were collected from November 5 through December 3, 2010, as well as May 21 through June 14, 2011. Results were compared to records collected at the CUWCD gage, and water level differences were generally found to be quite small (Table 3-3), although they occasionally approached 0.5 foot. Based on the combined data for those two periods, water levels at the marina were 0.12 feet higher, on average, than the values recorded by the CUWCD at Jordan Narrows. The difference between the gages was somewhat more consistent during the fall 2010 monitoring period than during the spring 2011 period. Past monitoring in the Provo Bay area (south of the study area) suggests that lake levels can vary due to wind. However, overall, the data indicate that data collected by the CUWCD at Jordan Narrows appear to be adequate to represent the hydrology of Utah Lake within the study area.

Table 3-3. Differences between water levels recorded at the Central Utah Water Conservancy District gage at Jordan Narrows and Utah Lake Marina during the 2010 and 2011 monitoring periods.

VALUE	WATER LEVEL DIFFERENCE (FEET); JORDAN NARROWS MINUS MARINA		
	Fall 2010	Spring 2011	Combined
Average	0.16	0.07	0.12
Median	0.15	0.02	0.12
Maximum	0.33	0.42	0.42
Minimum	0.04	-0.21	-0.21

Groundwater Conditions

Available mapping for Utah County (e.g., shallow groundwater shapefile obtained from the Utah Automated Geographic Reference Center) indicates that groundwater is within 10 feet of the ground surface throughout the entire study area, and that the entire study area lies within a groundwater discharge zone (Anderson et al. 1994, Cederberg et al. 2009). There are a number of natural seeps and springs throughout the study area, including areas where the groundwater is at the ground surface. Near-surface groundwater that produces most of the seeps and springs in the study area likely originates from a combination of the unconfined Lake Bonneville Aquifer and deeper confined aquifers. The confined aquifers at deeper zones beneath the surface likely provide spring flow in certain portions of the study area. Study area irrigation wells (Figure A-12, Appendix A) are generally artesian and are greater than 100 feet deep, drawing water from the deeper confined aquifer.

Groundwater conditions (i.e., the water table) within the study area are spatially influenced by a number of pumps in the southwest, southeast, west, and northwest portions of the study area (Figure A-12). There are two separate pumps in the southwest corner, one owned and operated by Utah Lake State Park and the other by private landowners. The private facility is owned and operated by landowners to drain their agricultural fields during periods of high lake levels and seasons of high groundwater. The Utah Lake State Park pump is only used during high-water levels to protect portions of Utah Lake State Park from flooding.

Another pump house facility is located near the southeast corner of the study area. This pump station is operated by Provo City and is used to drain stormwater from the Lakeshore Village residential areas and ditches to the east (G. Beckstrom 2011, pers. comm.). The facility typically functions as a gravity drain that releases water into the Provo River via a culvert under Boat

Harbor Drive; the pumps operate only when flows in the river are high enough to cause backup problems. Flows can also be diverted near the pump house into the irrigation ditch to the west. In the springtime this facility serves to drain groundwater that accumulates in the ditch east of the study area in addition to surface runoff from storm events. It is estimated that springtime flow releases to the river from the facility are on the order of 10–15 cfs, and that most of that water is groundwater discharge (G. Beckstrom 2011, pers. comm.). It is anticipated that the continued operation of this pump will be necessary to address current flooding problems in the nearby residential development.

During early July 2011, a supplemental temporary pump-and-dike system was observed being used to discharge flow from the ditch system at the northwest corner of the study area by pumping water from the study area over the dike into Utah Lake, which effectively dropped water levels by approximately 3 feet east of the dike compared to Utah Lake. It is assumed that this temporary pumping system was implemented only because of the unusually high spring and summer 2011 runoff and lake levels that exceeded 4,491 feet for several months, and that pumping and/or diking at this location is not a typical occurrence. However, a temporary pump was also observed in March 2012 when the lake was only 0.33 feet above compromise elevation at another location along the Skipper Bay dike about midway between the southwest and northwest corners of the study area. These observations demonstrate that, under baseline conditions, the study area is susceptible to flooding from Utah Lake and from groundwater, and that active measures such as targeted diking and pumping are taken to reduce water levels as needed.

A network of ditches and drains has been constructed within the study area. Most of the ditches have been developed and maintained to reduce flooding in this area. However, some of the ditches are also used for irrigation. Water from the eastern portions of the study area generally drains northwest, perpendicular to the topographic contours. The ditches are also used to convey stormwater from Provo City streets and residential developments, and they require occasional maintenance.

During wetland mapping field work, a natural-flowing spring was observed north of Boat Harbor Drive near the eastern end of the study area (Figure A-12). This feature indicates that the study area functions as a groundwater discharge zone and generally has a near-surface water table. Flowing water was also observed at an irrigation well located on the west side of the oxbow feature south of Boat Harbor Drive; this water is assumed to be artesian well water leaking from the well's pipe system.

Hydrologic conditions in the eastern portion of the study area are also influenced by discharges from the stormwater drainage system that discharges in the east-central portion of the study area; these features are also illustrated on Figure A-12. In addition to conveying stormwater, this ditch system appears to flow perennially, along and through the BLB Drywall wetland mitigation site. The perennial flow appears to originate from wetlands and springs located east of the study area that are piped under the Lakeshore Village residential development. These flows eventually drain into the large, south-to-north ditch that ultimately discharges into Utah Lake at the northwest corner of the study area, or during certain times of the year the water appears to leak out of the ditch and into an existing stand of cottonwood (*Populus* spp.) trees.

Significant areas of groundwater-supported emergent marsh, wet meadow, and riparian forests are currently present within the study area, including pond areas with permanent open water. These types of wetlands develop where groundwater is at or within 1 foot of the ground surface and provide further evidence of the shallow nature of the water table within the study area.

To better assess existing groundwater conditions and the potential effects of any of the action alternatives on groundwater near the residential developments east of the study area, a network of 31 groundwater monitoring wells (piezometers) were installed in June 2011 and 2012 with water level recording devices installed to collect groundwater elevation data every 15 minutes. Locations of these wells are illustrated on Figure A-12. Groundwater elevation monitoring has been ongoing during the EIS process.

Groundwater elevation data has been downloaded and corrected periodically during the monitoring period. Barometric pressure corrections are necessary for the raw elevation data. The corrected 15-minute data were then converted into monthly averages for each well. Monthly average groundwater elevations were then modeled for the entire study area and extending east into the western portion of Lakeshore Village using nearest-neighbor methods (Figure A-13). The groundwater elevation profile slopes strongly from east to west on the eastern side of the study area, flattening out to the west, with more than 10 feet difference in water surface elevations from one side of the study area to the other at any time. It is interesting to note that the groundwater elevation on the western portion of the study area is generally lower than Utah Lake. Skipper Bay dike and other hydrologic alterations effectively kept Utah Lake water from flooding the lower portions of the study area under conditions seen in 2011, 2012, and 2013.

The groundwater elevation data were then converted to “depth-to-groundwater” for every square meter of the study area, which is more relevant to vegetation and their rooting depths (Figure A-14). Depth to groundwater was determined by subtracting monthly average groundwater elevation from LiDAR-based digital elevation model ground elevations (illustrated in Figure A-10). The results clearly show a seasonal fluctuation in depth-to-groundwater throughout the study area. The easternmost area north of Provo River maintains the most consistent conditions, with groundwater remaining relatively close to the surface even during the dry summer months. This result is not surprising given the presence of nearby springs and seeps, and the unique characteristics of area peat soils. Depth-to-groundwater increases more significantly on the southwestern portion of the study area along the existing channel, and north (heading northwest of the big bend, below the oxbow) along one of the old abandoned channels.

The temporal patterns observed at the wells generally show a seasonal pattern in groundwater elevations from spring to fall, but patterns vary spatially depending on the well location. The spatial patterns observed show wells located along the eastern portion of the study area retain groundwater elevations much higher than wells located within the middle and western portions of the study area. Groundwater levels in the eastern wells remained much higher than Utah Lake elevations throughout the monitoring period, demonstrating that groundwater conditions in this area are apparently controlled by the locally high water table and other potential influences such as the naturally flowing spring and the perennial flows in the stormwater outfall channel. This result is consistent with the fact that the eastern wells are located in a portion of the study area characterized by hummocky, uneven topography and a mosaic of peat soils intermixed with alluvial and lacustrine deposits.

Overall, the groundwater monitoring results also show that the lower Provo River is primarily a "losing" stream, meaning that surface water elevation in the river is generally higher than the adjacent groundwater, and that there is a general slope in the water table away from the existing river channel, except during the spring on the east side of the study area when groundwater elevations are high and flows in the Provo River are low.

Flooding Hazards-Provo River

During the high-water years in the 1980s, the entire study area below 4,493 feet flooded after a breach occurred in the dike on the north side of the Provo River. This breach occurred in spring 1983 when river flows peaked at 2,420 cfs and the Utah Lake elevation exceeded 4,493 feet (Utah Lake subsequently exceeded 4,495 feet in 1985). The flooding lasted for several years. Skipper Bay dike also failed and was completely inundated during the 1983 floods. Repairs and improvements to the dike and Provo River levee system were completed in the late 1980s and have mostly contained the river since that time; however, the experience of the 1980s is an indicator that the study area is currently susceptible to flooding risk during extreme high-water years if existing structural protections suffer damage.

Water surface elevations for the existing river channel were modeled for the 100-year FEMA flood discharge (2,700 cfs) as well as the 10-year and 2-year flood discharges (Table 3-1) using the Hydraulic Engineering Center–River Analysis System program, also known as HEC-RAS. HEC-RAS is a model developed by the U.S. Army Corps of Engineers (Corps) that calculates water surface elevations using energy equations. Several Utah Lake water surface elevations were used for the downstream boundary condition in the HEC-RAS model runs.

Model results demonstrate that the river levees are overtopped at the 100-year discharge in the vicinity of the river bend near Boat Harbor Drive and the Lakeshore Drive bridge crossing, between cross sections 28.5 and 26.4 (locations of cross sections are illustrated in Figure A-12 (Appendix A); Figures 3-7 and 3-8 illustrate modeling results at cross sections 28.5 and 27, respectively). Overtopping of the northern levee would flood nearly the entire study area, where land elevations are well below the modeled cross section 28 water surface elevation of 4,501.31 feet.

Flooding Hazards-Utah Lake

The study area is also currently susceptible to flooding by Utah Lake. The FEMA 100-year lake level is 4,494.5 feet (Table 3-2), and the existing Skipper Bay dike is only 4,493 feet tall at its highest point. At a lake level of 4,494.5 feet, all but the easternmost "lobe" of the study area would be inundated (Figure A-10, Appendix A). The flooding experienced in the study area during the 1980s was exacerbated by the failure of Skipper Bay dike and the associated inundation by Utah Lake. Flood risk in the study area is greatest during periods when Utah Lake levels and Provo River flows are unusually high at the same time.

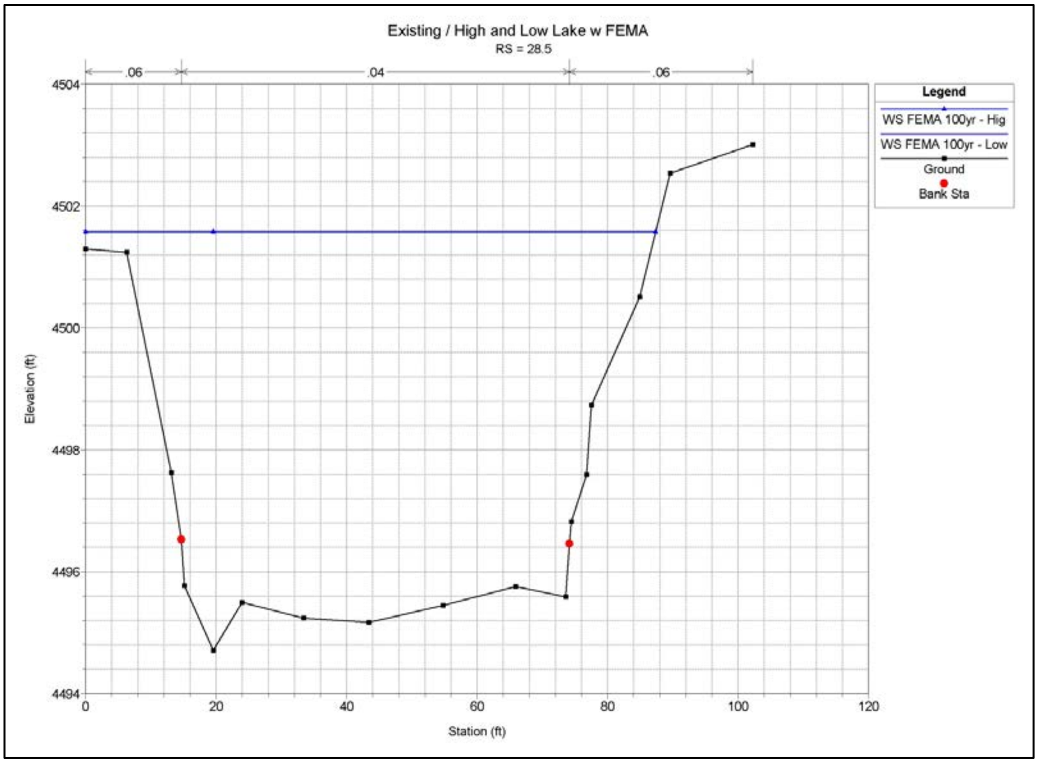


Figure 3-7. **Model results for 100-year flood discharge of 2,700 cubic feet per second, Provo River cross section 28.5.**

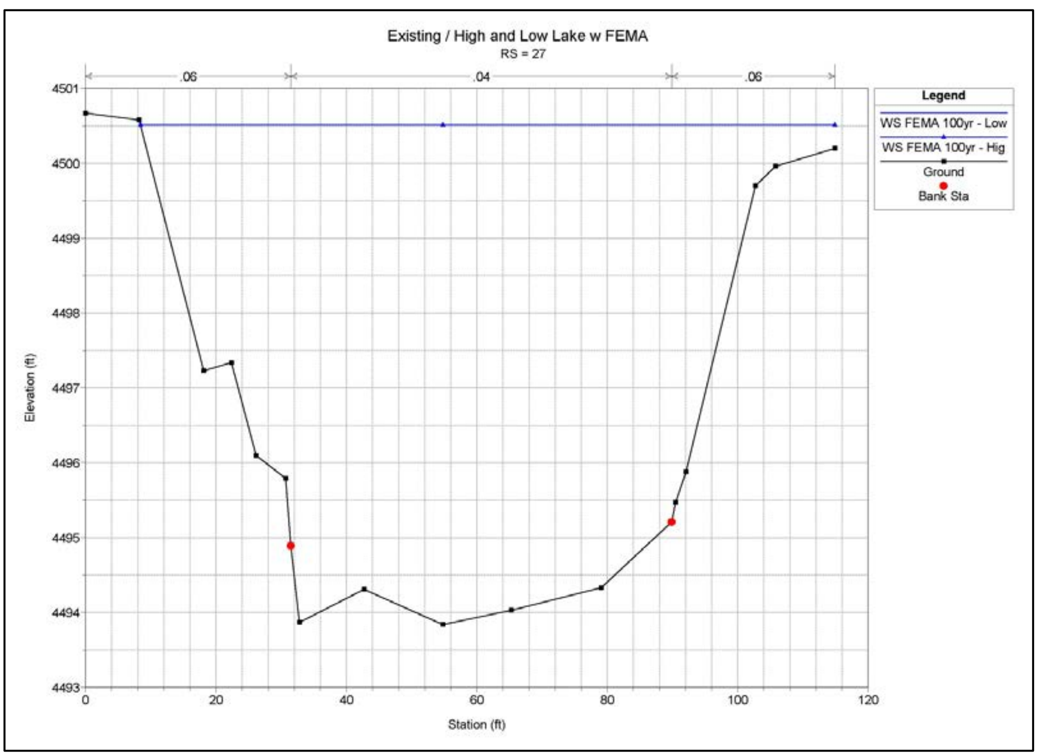


Figure 3-8. **Model results for 100-year flood discharge of 2,700 cubic feet per second, Provo River cross section 27.**

3.2.5 Impacts of the No-Action Alternative

Under the No-Action Alternative, the location of lower Provo River would remain unchanged. It is assumed that channel dredging, channelization, and bank stabilization practices would continue as needed. Pumping practices to reduce surface water in the study area would also likely continue.

The average monthly discharge characteristics described for baseline conditions would be expected to continue, including supplemental flows to the Provo River that were approved as part of the ULS water delivery infrastructure system. The volume of supplemental water delivered to Provo River would vary from year to year, depending on natural hydrology, the need to deliver exchange water, and space available constraints in various conveyance systems. If no action were taken to improve habitat for June sucker on the lower Provo River in accordance with the June Sucker Recovery Plan and mitigation commitments of water development projects being completed under the Central Utah Project Completion Act, then the joint lead agencies (JLA) and other JSRIP partners would likely need to consult with the U.S. Fish and Wildlife Service (USFWS) regarding how to move forward with recovery objectives. The June Sucker Flow Work Group would be expected to continue to meet and to make recommendations to the U.S. Department of the Interior regarding flow patterns in the Provo River and Hobble Creek to support June sucker.

3.2.6 Impacts of Action Alternatives

Changes to Provo River Hydrology

As described in Chapter 2, any of the action alternatives for the proposed action would alter the amount of surface water flowing through the lower 2 miles of the existing Provo River. A new "delta" diversion dam would be constructed downstream of the new Lakeshore Drive Bridge to divert most flows into a newly constructed channel and delta ecosystem designed to benefit June sucker and the ecosystem upon which it depends. Most sediment and other debris would be directed into the new delta ecosystem. The flow regime into and through the existing channel would be as described in Chapter 2 (Section 2.6). Water elevations in the "lake-influenced" portions of the existing channel would either fluctuate with Utah Lake as currently occurs (Option 1), or would be managed at a stable elevation, approximately 4,489–4,490 feet (Option 2).

Changes to Utah Lake Hydrology

Any of the action alternatives would expand the extent of Utah Lake to the east by removing portions of the existing shoreline dike (Skipper Bay dike) and allowing the lake to re-occupy some of its historic location at Skipper Bay. The existing surface area of Utah Lake is 96,600 acres (PSOMAS and SWCA 2007). In developing designs for project alternatives, highly accurate study area topography data were collected (URMCC 2011). Based on study area elevation mapping (Figure A-10, Appendix A) and known Utah Lake level patterns, in nearly all years a portion of the study area would be inundated by the lake for at least part of the year with partial removal and lowering of Skipper Bay dike. Alternative A would result in the largest increase of open water, followed by Alternative B, and Alternative C would result in the least amount of open water, especially when the lake falls below 4,487 feet.

Restoring the surface water connection of Utah Lake to Skipper Bay would result in a very small increase in the overall Utah Lake surface area, and would not be expected to alter the elevation patterns of Utah Lake. Table 3-4 shows the area of additional inundation of the typical medium elevation of Utah Lake (4,488 feet) for each action alternative.

Table 3-4. Acres of inundation by alternative and percent change in water surface acreage of Utah Lake at 4,488 feet.

INDICATORS	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
Acreage of Utah Lake inundation in the project implementation area	281	192	154
Percent change in Utah Lake water surface acreage	0.29%	0.20%	0.16%
Acres of upland to wetland conversion	175.6	30.9	156.2

With Alternative A, the area directly inundated with Utah Lake water (Table 3-4) would be defined by the natural topography on the north and east boundary, and a bermon the south boundary. Alternative B includes a berm that would exclude much of the existing uplands from the project implementation area. Most of the area included in the Alternative B property acquisition boundary is already wetland, having standing water for part of the year that either recedes with evaporation or is pumped out of the area into Utah Lake. Alternative C includes a berm excluding much of the existing wetlands on the east and northeast portions of the study area from inclusion in the project.

Changes in Consumptive Uses and Evaporation in the Study Area

The conversion of existing pasture and irrigated hay fields to wetlands, riparian woodlands, and open water would alter current levels of consumptive uses of water and evaporation from affected portions of the study area during most months (Table 3-5).

A report by Hill et al. (2011) provided a basis for approximating consumptive water use and evaporation associated with existing and predicted study area land uses. The report, titled "Crop and Wetland Consumptive Use and Open Water Surface Evaporation for Utah," provides estimates of consumptive and evaporative water losses for various types of land cover in various locations around the State. The most appropriate figures for the study area were reported in Table 20 (Santaquin, Utah). Land cover types from Hill et al. (2011) used in the current analysis were pasture, alfalfa (beef), and other hay, wetland (large), other orchard (riparian woodland), and shallow open water. Existing and predicted acres for each land cover type were determined using mapping information collected throughout the study area as described in subsequent sections of this document, particularly wetlands (Section 3.5) and wildlife (Section 3.8). Acres of open water were determined for a representative year (2012), which was a relatively normal year for Utah Lake water elevations and was also a year that groundwater elevation data, depth to groundwater, and acres of surface water were monitored throughout the study area (Figure A-14, Appendix A). Evaporation estimates for open water were used for all areas with standing water, regardless of vegetation type being inundated.

Table 3-5. Consumptive use of water and open water surface evaporation of the study area under existing conditions and action alternatives.

MONTH	EXISTING CONDITIONS (acre-feet)	ALTERNATIVE A (acre-feet)	ALTERNATIVE B (acre-feet)	ALTERNATIVE C (acre-feet)
January	5.41	14.16	13.22	8.69
February	10.78	37.90	30.02	25.93
March	28.62	92.21	64.28	72.07
April	102.35	153.88	143.04	129.28
May	212.85	245.09	270.45	205.91
June	322.40	328.34	342.83	315.10
July	390.84	414.68	375.20	427.80
August	339.45	379.65	332.05	386.20
September	222.18	257.08	221.39	259.16
October	63.22	93.71	77.35	84.47
November	8.61	21.52	20.02	13.41
December	4.74	12.39	11.57	7.61
TOTAL	**1,711.45**	**2,050.61**	**1,901.41**	**1,935.62**

The results indicate that Alternative A would increase total net consumptive uses of water and evaporation by 339 acre-feet, or approximately 20 percent over existing conditions. Alternative B would increase total net consumptive uses of water and evaporation by 190 acre-feet, or approximately 11 percent over existing conditions. Alternative C would increase total net consumptive uses of water and evaporation by 224 acre-feet, or approximately 13 percent over existing conditions. The increased amounts of open water causes the biggest changes for Alternatives A and B, whereas the increased amounts of wetlands causes the biggest change for Alternative C. Increased consumptive uses and evaporation of water caused by implementation of any action alternative would be covered by water rights owned by or to be acquired by the JLAs for this purpose.

Sedimentation Impacts

Because the proposed channel would have much lower banks and be connected to a broad floodplain with any of the action alternatives, the channel would behave more naturally and dynamically compared to the existing channel, adjusting to variable sediment loads and debris obstructions. The eastern portions of the restored channel (east of the proposed Provo Lakeview Parkway and Trail) would be designed with similar width constraints as the existing channel. The portions of the restored channel west of the proposed Provo Lakeview Parkway and Trail would increase in width downstream of the proposed crossing and be designed more naturally with low banks and a wide active floodplain. This contrast is illustrated in Figure 3-9; the portion of the Provo River upstream of the study area would retain the characteristics of the existing levee-confined channel while the portion in the project implementation area would be designed consistent with the historic cross section. Deposition of alluvial materials would occur from below the crossing and throughout the delta. The channel would transition from a single-threaded, confined channel to a more complex channel with a wide, active floodplain.

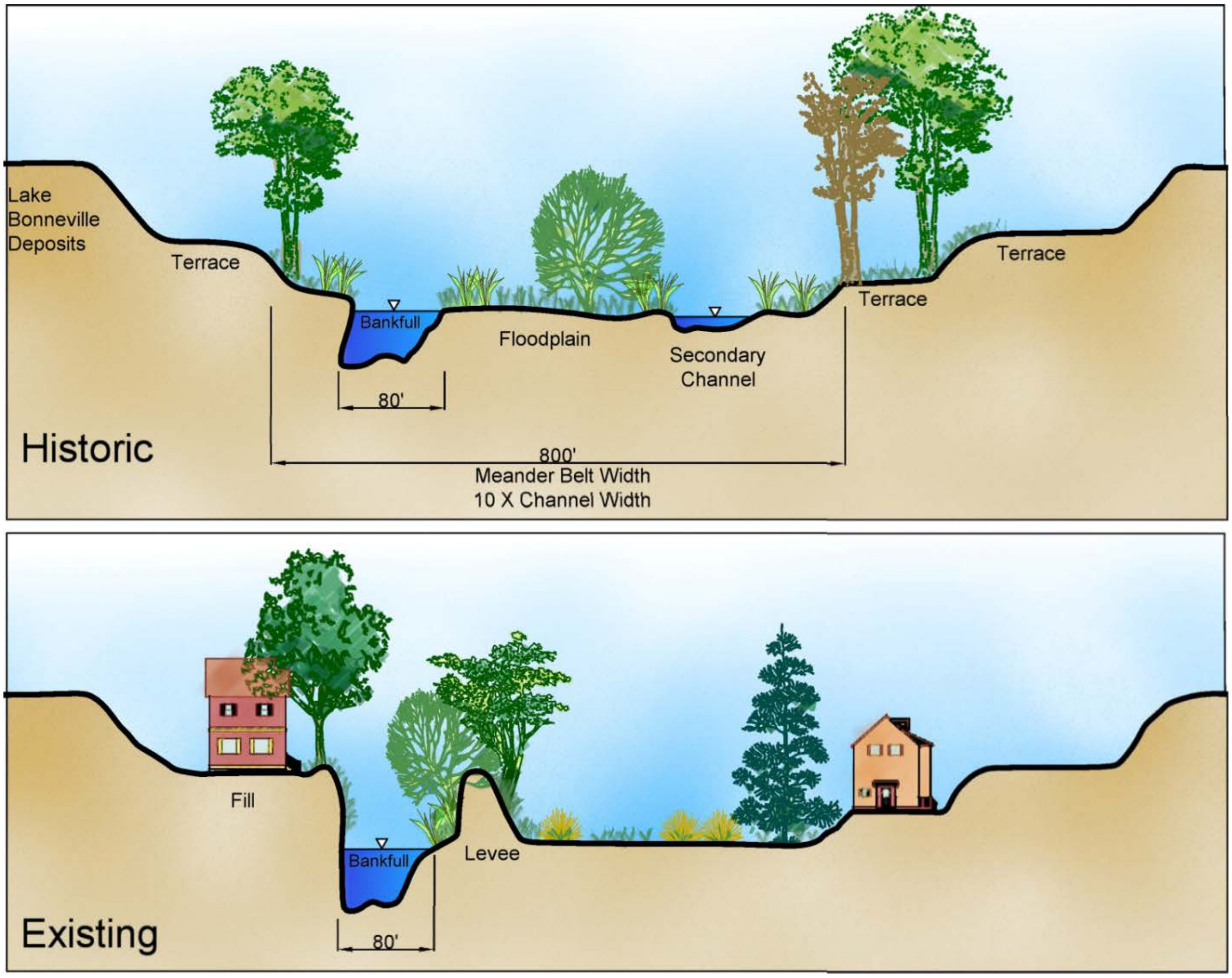


Figure 3-9. Schematic cross sections comparing historic channel and riparian corridor/floodplain to existing levee-constrained channel.

Once the river reaches the point that it would be influenced by Utah Lake (at approximately the 4,490-foot elevation contour, see Figure A-10, Appendix A), the channel would split and maintain a distributary form. The multiple channel threads and distributary channels that would be initially constructed would be anticipated to fill with sediment or become obstructed with organic debris, such as fallen trees, and migrate across the study area over time. The new channel and floodplain system would include diverse, complex vegetation structure, introducing more surface roughness and increased water-vegetation interaction during floods. This increased surface roughness would cause sediments to drop out and deposit on the floodplain, likely reducing sediment inputs to Utah Lake over the long term. It is anticipated that the formation of sediment splays and bar deposits would occur entirely within the study area, and that these processes would not significantly alter physical conditions in Utah Lake west of the existing Skipper Bay dike alignment other than maintaining three or four channel outlets into the lake.

Groundwater Changes and Flood Risk from Utah Lake

Under any of the action alternatives, lowering portions of Skipper Bay dike and increasing the extent of Utah Lake inundation would affect groundwater elevations in the western and central portions of the study area but not along the eastern developed portions. The hydrologic barrier and private pumping operations on the southwest end of the study area would be effectively removed under Alternatives A and C, but remain operational under Alternative B. It is assumed that the existing private pump in the southwestern corner would continue to be operated and maintained by landowners under Alternative B, but it would not affect water elevations in the restored delta area north of the new berm and trail or the existing channel. Under all three action alternatives, it is assumed that the existing Utah Lake State Park and Provo City pump stations would continue to operate similarly to baseline conditions.

Future groundwater conditions in the study area would be affected by a combination of factors, including:

- soil conditions and the spatial distribution of soil types,
- existing near-surface groundwater associated with the unconfined Lake Bonneville Aquifer,
- pumping and ditching practices where those activities continue,
- inundation and recharge by Utah Lake, and
- inundation and recharge by the newly aligned Provo River.

The result of the complex interactions of these various controlling factors is difficult to summarize for the study area as a single unit. Therefore, it was determined that potential for increased flooding risk to existing development east of the study area would be based on a "worst-case scenario" (highest potential groundwater increase) assumption.

To evaluate this worst-case scenario, it was assumed that groundwater elevations would closely match the surface water elevations of Utah Lake and Provo River under any of the action alternatives. This assumption is a conservative estimate because tight, fine-grained soils in certain portions of the study area would limit how far surface water levels would "translate" horizontally through the ground. Also, in areas being recharged by surface water, the groundwater in the immediate vicinity of the surface water source may increase to match the surface water elevation but then would gradually drop with increasing horizontal distance from the source. Therefore, the assumption used provides a conservative, worst-case estimate of the potential for the action alternatives to increase groundwater levels within and east of the study area.

The effect of reconnecting Utah Lake to all or portions of the study area would vary depending on lake level. Under existing conditions, Skipper Bay dike is entirely overtopped when Utah Lake exceeds 4,493 feet. Therefore, the action of lowering Skipper Bay dike would not alter groundwater elevations relative to existing conditions during severe flood events when the lake exceeds 4,493 feet, such as the FEMA 100-year lake level (4,494.5 feet) scenario (Figure A-11, Appendix A).

At lake levels that are high but less than 4,493 feet, such as those experienced during 2011, inundation by Utah Lake would affect water elevations throughout much of the western low elevations of the study area, but they would not be expected to change conditions along the higher eastern perimeter. In 2011, when the lake exceeded 4,491 feet for more than 2 months, sandbags and additional temporary pumping were used to reduce the effects of high lake levels to existing out buildings in the study area. These types of actions would not be necessary within the project implementation area but would continue to be necessary outside of the project implementation area under any of the action alternatives for similar water levels as experienced in 2011.

Currently, the lower 1.5 miles of the south levee acts as a river and lake levee, depending on flows in Provo River and water levels in Utah Lake. With implementation of any action alternative and the associated rerouting of Provo River peak flows into the delta, the existing south levee downstream of the new diversion would act primarily as a lake levee without the need to contain peak river flows. At lake levels of the 10–100-year flood, the western portion of Boat Harbor Drive and the north levee are overtopped under existing conditions, thus making the south levee a lake levee every 10 years on average. The proposed project would have no effect on that situation; at high lake levels the south levee is already a lake levee and subject to long periods of standing water and wave action.

However, the segment of river upstream of the UDWR fish weir (cross section 18 shown in Appendix A, Figure A-12) historically experiences higher water levels from peak flows in the Provo River. Peak flows in the Provo River have caused water levels to nearly overtop the levee during previous floods, sometimes exceeding 4,498 feet at the river bend near cross section 22 (Appendix A, Figure A-12). With river flows being diverted to the north under any action alternative, this segment of the south levee would not experience the same high water levels or be tested during high-flow situations; it would only need to contain high lake levels that are 3–4 feet lower along this segment of the levee during a 100-year flood event.

The proposed project would not interfere with Provo City’s access or ability to maintain the south levee. However, because the proposed project would lower flood stage on a portion of the south levee, routine operation and maintenance activities that Provo City is currently implementing might become less of a priority in the future, which is a current staff concern. During the proposed project planning process, Provo City requested consideration of ways to temporarily provide higher water surface elevations in the existing channel to allow examination of the south levee under high water conditions. Under either Option 1 or Option 2, the JLAs would coordinate with Provo City during final design and construction of the existing channel to try to provide opportunities to periodically and temporarily raise water levels for the purpose of testing the structural integrity of the south levee for operation and maintenance purposes. Strategies will be sought to raise water levels in the existing channel where possible without flooding adjacent properties or impacting other uses/users of the existing Provo River corridor.

Referring back to Figure A-13, groundwater elevations throughout the study area currently range from 4,486–4,500 feet in April during the wettest time of the year when the lake is near the Utah Lake compromise elevation (a little over 4,489 feet), and from 4,482–4,500 feet in October during the driest time of the year when the lake is at its normal low (approximately 4,486 feet). Under any of the action alternatives where the lake is reconnected with different portions of the study area, groundwater elevations would be predicted to increase throughout the western portion of the study area by approximately 2–3 feet via inundation by Utah Lake. However, groundwater elevations on the eastern portion of the study area are currently and would continue to be independent of lake elevations. The existing high-groundwater (perched) conditions as observed in the eastern wells, including wells 1, 2, 6, 6.5, and 9, would be expected to persist, and depth to groundwater would remain at the surface during the spring wet months, and within 2 feet of the surface during the fall drier months.

Provo River Flooding Impacts

With any of the action alternatives, the channel-floodplain system would be designed to allow water within the restored river floodplain to flood over bank with an approximate average frequency of once every 2 years. This flooding would be an essential component of creating a more naturally functioning connected floodplain, and would also be essential to the creation and long-term success of the created riverine wetlands within the delta area. Because the new channel configuration would include a wide, accessible, well-vegetated floodplain, flow depth and velocity during flood conditions would decrease relative to conditions in the existing narrow, leveed channel. This change would dissipate overall flood energy and increase surface water storage during floods.

Out-of-bank flows would be contained within the project implementation area by existing high ground to the east (Figure A-10) or by the new berms that would be constructed to a height of 4,495 feet or higher (up to 4,498 feet or higher if needed) to match the existing levee on the north side of the Provo River and provide the existing degree of containment of the predicted Provo River 100-year flood elevation at those locations. A berm height of 4,495 feet is more than 2 feet higher than the existing Skipper Bay dike and western portions of the north river levee and trail. Therefore, areas outside of the project implementation area for any of the alternatives, including the lake-influenced portion of the existing channel, would continue to be susceptible to flooding by high lake levels as currently exists.

Existing barns and agricultural buildings that would be within the acquisition boundary of any action alternative would be removed. As with potential flooding from Utah Lake, other remaining structures outside of the acquisition boundary of each action alternative would remain as susceptible to flooding from Provo River as they are currently. Therefore, no new flooding hazards to developed infrastructure would be created with implementation of any of the project action alternatives. Any new structures that would be constructed within the project boundaries (e.g., trails, boardwalks) would need to be designed to withstand periodic flooding.

Making this determination required some intensive hydrologic modeling efforts. Two HEC-RAS models for action alternatives were created for comparison to the HEC-RAS baseline conditions. (Alternatives A and C were similar enough in terms of proposed stream flow patterns that only a single model was generated to represent both alternatives.)

The best way to summarize the hydraulic effects of the proposed conditions is to compare water surface elevations, under identical streamflow and lake level conditions, at several locations upstream of the study area. These comparisons were completed for the FEMA 100-year flow event in the Provo River (2,700 cfs) with Utah Lake at compromise elevation (4,489.045 feet). Table 3-6 includes the computed 100-year event water surface elevations for several of the cross sections under baseline conditions and compared to the models for the action alternatives.

Table 3-6. Existing and proposed Federal Emergency Management Agency (FEMA) 100-year water-surface elevations downstream and upstream of Lakeshore Drive Bridge.

PROVO RIVER CROSS SECTION LOCATION[a]	BASELINE MODEL (EXISTING CONDITION)	MODEL FOR ALTERNATIVES A AND C		MODEL FOR ALTERNATIVE B	
		Water Surface	Change from Baseline	Water Surface	Change from Baseline
XS27	4,500.51	4,500.44	-0.07	4,499.35	-1.16
XS28	4,501.31	4,501.27	-0.04	4,500.8	-0.51
XS29	4,502.35	4,502.34	-0.01	4,502.14	-0.21
XS30	4,503.07	4,503.07	0	4,502.95	-0.12
XS31	4,504.29	4,504.29	0	4,504.24	-0.05
XS32	4,505.67	4,505.66	-0.01	4,505.64	-0.03

[a] Cross-section locations are illustrated in Appendix A, Figure A-12.

Computed water surface elevations are roughly the same or slightly lower under proposed conditions than under baseline conditions, suggesting that none of the action alternatives would have a detrimental effect on flooding. It is important to reiterate that the baseline conditions model results indicated that the existing north river levee is currently not adequate to provide flood protection (Figures 3-7 and 3-8): it would be overtopped during the 100-year event, likely flooding any surrounding properties.

Farther downstream, direct comparison between the three models is more difficult because the cross sections are not located at the same point in space due to different locations for the proposed channel. However, it was possible to choose equivalent locations in each model for comparison of water surface elevations. Figure 3-10 includes two sets of colored dots (green and yellow), each representing a location where water surface elevations were compared between the three models. For each colored set, the southernmost point is the existing channel location, the middle point is for Alternatives A and C, and the northernmost point is for Alternative B. Results are presented in Table 3-7. These data also support the finding that water levels would be lower under proposed conditions than under baseline conditions. This is an expected result because the existing channel causes higher water surface elevations as the flow is confined between levees and cannot access the floodplain. The proposed condition allows flood flows to access the floodplain and spread over a much larger area, thus reducing the water surface elevation during periods of flooding.

Figure 3-10. Locations where water surface elevations were compared between the three HEC-RAS models.

Table 3-7. Baseline and proposed FEMA 100-year water-surface elevations downstream of Lakeshore Drive Bridge near the Utah Division of Wildlife Resources fish weir (green dots) and Alligator Park (yellow dots).

CROSS SECTION LOCATION [a]	BASELINE MODEL	MODEL FOR ALTERNATIVES A AND C		MODEL FOR ALTERNATIVE B	
		Water Surface	Change from Baseline	Water Surface	Change from Baseline
Green dots	4,494.61	4,493.59	-1.02	4,493.95	-0.66
Yellow dots	4,493.24	4,492.19	-1.05	4,490.56	-2.68

[a] Locations indicated in Figure 3-10.

A variety of additional scenarios were modeled, including the following:

- Alternatives A and C with high lake level of 4,495.5 and FEMA 100-year flood discharge,
- Alternative B with high lake level of 4,495.5 and FEMA 100-year flood discharge,
- Alternatives A and C with Lakeview Parkway Bridge span of 100 feet, and
- Alternative B with Lakeview Parkway Bridge span of 100 feet.

In each case outlined above, no detrimental effect on flooding was visible in the HEC-RAS models. Even with a lake level of 4,495.5 feet (highest ever recorded), the effect of the levees on the local water surface is dominant over backwater effects caused by the lake, and computed flood water elevations near the homes remain unchanged or slightly lower in all cases. Of course, many properties within and outside of the study area are directly flooded by the lake when lake levels are 4,495.5 feet, but the proposed action alternatives do not change that situation in any appreciable way.

Federal Emergency Management Agency (FEMA) Floodplain Impact Conclusions

Floodplain impacts could occur if a project alternative modifies the 100-year floodplain. Although all three action alternatives effectively lower water elevations upstream of the study area very slightly during various flood scenarios, this project would have no effects on FEMA floodplains. Flood potentials would not change.

3.2.7 Indirect and Cumulative Impacts

Anticipated changes in hydrology are considered part of the proposed action. Utah Lake hydrology would not be affected by the project. Indirect changes in groundwater elevations would occur within the project implementation area for each action alternative, and would benefit wetland habitat types. No indirect changes in groundwater elevations would occur in the developed portions east of the project implementation area. Sedimentation would primarily occur within the delta under all action alternatives. Fine sediments would deposit over time as the delta evolves and expands mostly along the channels entering the lake.

Based on this analysis, no increase and no significant decrease in flood elevation would be caused by the proposed action. The proposed action would not increase flood risk for any existing or reasonably foreseeable development and would benefit, not impair, floodplain values. The portion of the south levee along the existing channel downstream of the diversion would no longer be subject to high river flows since flows greater than 50 cfs would be directed into the project area (see Chapter 2, Section 2.5). The inspection and maintenance of this levee has been and will continue to be performed by Provo City. Other than reducing peak flows in the existing channel, the proposed project would neither impact the south levee nor affect Provo City's ability to inspect or maintain it as deemed necessary.

The proposed project would not interfere with Provo City's access or ability to maintain the south levee. However, because the proposed project would lower flood stage on a portion of the south levee, routine operation and maintenance activities that Provo City is currently implementing might become less of a priority in the future, which is a current staff concern. During the proposed project planning process, Provo City requested consideration of ways to temporarily provide higher water surface elevations in the existing channel to allow examination of the south levee under high water conditions. Under either Option 1 or Option 2, the JLAs would coordinate with Provo City during final design and construction of the existing channel to provide opportunities to periodically and temporarily raise water levels for the purpose of testing the structural integrity of the south levee for operation and maintenance purposes. Strategies will be sought to raise water levels in the existing channel where possible without flooding adjacent properties or impacting other uses/users of the existing Provo River corridor.

3.2.8 Mitigation Measures

During the proposed project planning process, Provo City requested consideration of ways to temporarily provide higher water surface elevations in the existing channel to allow examination of the south levee under high water conditions. Under either Option 1 or Option 2, the JLAs would coordinate with Provo City during final design of the existing channel to try to provide opportunities to periodically and temporarily raise water levels for the purpose of testing the structural integrity of the south levee for operation and maintenance purposes. Strategies will be sought to raise water levels in the existing channel where possible without flooding adjacent properties or impacting other uses/users of the existing Provo River corridor.

3.2.9 Hydrology Summary

It is anticipated that the formation of sediment splays and bar deposits would occur entirely within the study area, and that these processes would not significantly alter physical conditions in Utah Lake west of the existing Skipper Bay dike alignment other than maintaining three or four channel outlets into the lake.

The results of the HEC-RAS modeling effort indicate that the proposed action would not have any detrimental effect on flooding. Under existing conditions, the water is confined between levees, which actually raises floodwater elevations and can lead to overtopping of levees. The proposed alternatives allow water to spread over large areas of the floodplain, which would lead to decreased water surface elevations and minor decreased risk of flooding for nearby homes and businesses.

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3.3 Water Rights

Irrigation water in the study area is supplied by a mix of underground wells, diverted surface water, and pumped surface water conveyed through a network of ditches.

3.3.1 Issues Addressed in the Impact Assessment

Some water rights may be acquired with implementation of the proposed action. Also, modifications to access for adjacent water rights holders may be necessary.

Existing water rights in the study area were investigated by the following methods:

- consulting the Utah Division of Water Rights database and coordinating with personnel from the Division;
- conducting field investigations to identify wells, ditches, and points of diversion; and
- meeting with potentially affected landowners.

3.3.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to water rights were eliminated from further analysis.

3.3.3 Area of Influence

The study area boundary was the area of influence for potential effects on water rights.

3.3.4 Affected Environment (Baseline Conditions)

Irrigation water in the study area is supplied by a mix of underground wells, diverted surface water, and pumped surface water conveyed through a network of ditches (Figure A-15, Appendix A). Within the study area, only one surface water point of diversion is noted in the Utah water rights database (UDWRT 2015a). This point of diversion, associated with water right WR 55-500, change number a16279, consists of a pump in the Provo River about 700 feet downstream from the Center Street Bridge and adjacent to Utah Lake State Park. Water rights WR 55-1349 and WR 55-1350 divert surface water east of the study area but have shared rediversion points from ditches within the study area. The source for WR 55-1349 is listed as "unnamed stream," and the source for WR 55-1350 is listed as Provo River (UDWRT 2015a). The remaining points of diversion listed for the study area are associated with underground water wells (Table 3-8). Well depths average about 140 feet and range from 114 feet to 250 feet deep according to the Utah Water Rights Database (UDWRT 2015b).

It is possible that additional points of diversion exist within the study area but have not been updated in the available water rights database information. For example, a large pump is visible on the south side of Provo River downstream from the fish weir, but it is not listed as a point of diversion in the State database. It is not known whether the pump is active or how it is operated.

Table 3-8. **Study area water rights listed in the Utah Water Rights Database (Version 2012.03.21).**

WATER RIGHT NUMBER	OWNER	CUBIC FEET PER SECOND	ACRE-FEET	SOURCE
55-1038	B. A. Brockbank	1	n/a	underground water well
55-110	Reed J. Knudsen	1	223.4	underground water well
55-1349	Alfred Madsen	2	n/a	unnamed stream rediversion
55-1350	Dun Roamin Corporation	3	n/a	Provo River rediversion
55-1608	Donald D. & Dorothy C. Reese	0.267	n/a	underground water well
55-2051	Elton L. and Ethel S. Taylor	0.334	n/a	underground water well
55-2058	Isaac B. Nelson	0.446	n/a	underground water well
55-2283	Reed J. Knudsen	0.446	n/a	underground water well
55-2284	Reed J. Kundsen	0.134	n/a	underground water well
55-2285	Reed J. Knudsen	0.156	n/a	underground water well
55-2301	Charles Madsen	1.114	n/a	underground water well
55-2302	Charles Madsen	0.446	n/a	underground water well
55-2303	Charles Madsen	0.668	n/a	underground water well
55-2357	Dun Roamin Corporation	0.446	n/a	underground water well
55-2363	L. A. Adams	0.167	n/a	underground water well
55-2364	L. A. Adams	0.679	n/a	underground water well
55-2365	L. A. Adams	0.045	n/a	underground water well
55-2945	Fisher Lake Farm Limited Partnership	0.455	n/a	underground water well
55-3138	J. W. Howe	0.78	n/a	underground water well
55-3145	Mathew and Dana Mansfield Revocable Living Trust	n/a	40	underground water well
55-3146	Nellie B. Edwards Revocable Trust Agreement	0.011	n/a	underground water well
55-3147	Phil & Nellie Edwards	0.129	55.66	underground water well
55-3148	Nellie B. Edwards Revocable Trust Agreement	n/a	80.45	underground water well
55-3149	Dana Mansfield Revocable Living Trust	0.78	200	underground water well (abandoned)
55-3149	Jackie Lynn Edwards and R. Diane Edwards Revocable Living Trust	0.78	200	underground water well
55-3152	Paul S. Dixon	0.189	n/a	underground water well
55-3153	Paul S. Dixon	0.446	n/a	underground water well
55-3259	James Fisher	0.553	n/a	underground water well
55-424	Fisher Lake Farm Limited Partnership	0.75	n/a	underground water well
55-483	Heber A. Knudsen	1	n/a	underground water well
55-500	State of Utah Division of Parks & Recreation	0.247	n/a	underground water well
55-500 (a16279)	State of Utah Division of Parks & Recreation	0.247	38.58	Provo River
55-5439	Dean N. Mason	0.015	n/a	underground water drain
55-5669	Elton L. And Ethel S. Taylor	1.37	n/a	underground water drain
55-589	Dun Roamin Corp.	0.809	n/a	underground water well
55-590	Charles Madsen	0.752	n/a	underground water well
55-736	B. A. Brockbank	1	n/a	underground water well
55-737	B. A. Brockbank	4	n/a	underground water drain
55-8033	Rudolph P. Reese	0.002	n/a	underground water well
55-8034	Rudolph P. Reese	0.018	n/a	underground water well

3.3.5 Impacts of the No-Action Alternative

The No-Action Alternative would not affect water rights.

3.3.6 Impacts of Action Alternatives

With property acquisition under any of the three action alternatives, some water rights may be acquired. The proposed action would make accommodations for legally recognized water rights, or compensate legal water right holders if unable to provide water or alternative source or supply.

3.3.7 Indirect and Cumulative Impacts

Because the study area is at the downstream end of the Provo River and no diversions are known to exist downstream of the proposed project there would be no indirect impacts caused by any changes in use of water rights by the proposed project. Any direct impacts to water rights for adjacent property owners would be accommodated in final design; therefore, no cumulative effects associated with the project would occur.

3.3.8 Mitigation Measures

The final design of any action alternative would need to accommodate access to wells, ditches, pipes, and other water right conveyance structures for any water rights not acquired as part of the alternative. The Utah Water Rights Database was current through March 21, 2012 when searched for the water rights described in this analysis. If an action alternative is selected, the database would be queried again during the final design and property acquisition process. Water would be maintained in the existing Provo River channel under all action alternatives. Currently, there are no guaranteed minimum flows in the lower Provo River. All action alternatives would provide a minimum flow of 10 cfs in the existing channel, which would improve streamflow during the summer irrigation season when flows otherwise can drop to near zero.

3.3.9 Water Rights Summary

Irrigation water in the study area is supplied by a mix of underground wells, diverted surface water, and pumped surface water conveyed through a network of ditches. Some water rights may be acquired with implementation of the proposed action. The final design of any action alternative would need to accommodate access to wells, ditches, pipes, and other water-right conveyance structures for any legally recognized water rights not acquired as part of the alternative.

3.4 Water Quality

Existing and future water quality conditions in the Provo River and Utah Lake have important implications for aesthetics, recreation, habitat for fish and other aquatic species, and other subsequent water uses.

3.4.1 Issues Addressed in the Impact Analysis

Under Section 303 of the Clean Water Act (33 U.S.C. § 1251 et seq. [1972]), each state must establish and maintain water quality standards. In Utah, State regulations are administered through the Utah Division of Water Quality (UDWQ). During project planning, water quality issues that could be associated with implementation of the project were identified. Specifically, there was a concern about the potential for water quality conditions in the existing lower river channel to decline following diversion of flow into the newly constructed delta area. The existing river channel and corridor downstream from Lakeshore Drive is heavily used for recreation including biking, jogging, walking, running, and roller-blading on the Provo River Parkway Trail, and fishing and canoeing in the river. A commercial ropes course that rents canoes and boat rides, and a RV campground are also located adjacent to the river in this reach. The quality of the riverside recreational experience could suffer if degraded water quality were to lead to unsightly algae blooms or unpleasant odors. Furthermore, the fishery could be impacted if dissolved oxygen (DO) concentrations drop to or below lethal levels.

To address this issue, existing information on study area water quality was compiled and summarized, and the potential for changing those conditions was analyzed.

3.4.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to water quality were eliminated from further analysis.

3.4.3 Area of Influence

The area of influence includes the existing portions of the lower Provo River downstream of the proposed diversion, the study area for the proposed project, and Utah Lake.

3.4.4 Affected Environment (Baseline Conditions)

<u>Designated Beneficial Uses for Provo River and Utah Lake</u>

Utah Administrative Code (Rule 317) classifies surface water bodies in the State according to their beneficial uses using the classes listed in Table 3-9. Utah Lake has the designated beneficial uses 2B, 3B, 3D, and 4. The Provo River and tributaries from Utah Lake upstream to the Murdock Diversion has designated beneficial uses 2B, 3A, and 4. Most classifications have associated numeric water quality standards. Water bodies that fail to meet water quality standards set for the designated beneficial uses are deemed impaired and placed on the Utah 303(d) list. Such impaired water bodies are subject to an analysis of Total Maximum Daily Load (TMDL). This analysis determines the total mass of a pollutant that a water body can accept before becoming impaired.

Table 3-9. Beneficial use classifications for Utah rivers, streams, lakes, and reservoirs.

CLASS	DESCRIPTION
1	Protected for use as a raw water source for domestic water systems.
1C	Protected for domestic purposes with prior treatment by treatment process as required by the Utah Division of Drinking Water.
2	Protected for recreational use and aesthetics.
2A	Protected for primary contact recreation such as swimming.
2B	Protected for secondary contact recreation such as boating, wading, or similar uses.
3	Protected for use by aquatic wildlife.
3A	Protected for cold-water species of game fish and other cold-water aquatic life, including the necessary aquatic organisms in their food chain.
3B	Protected for warm-water species of game fish and other warm-water aquatic life including the necessary aquatic organisms in their food chain.
3C	Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
3D	Protected for waterfowl, shore birds, and other water-oriented wildlife not included in classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.
3E	Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.
4	Protected for agricultural uses including irrigation of crops and stock watering.
5	The Great Salt Lake. Protected for primary and secondary contact recreation, waterfowl, shore birds, and other water-oriented wildlife including the necessary aquatic organisms in their food chain, and mineral extraction.

Environmental Controls on Water Quality in the Provo River and Utah Lake

Water quality conditions in rivers and lakes are the result of complex interactions between various physical, biological, and chemical variables and processes. On the lower Provo River, the primary water quality parameters that potentially affect beneficial uses include water temperature, DO, nutrient and sediment loads, and the frequency/intensity of algal blooms. The discussion below addresses some of the major factors controlling these parameters.

Fish and other aquatic organisms require oxygen to breathe and specifically utilize oxygen gas that is dissolved in the water column. In Utah the UDWQ has set standards for minimum DO levels to protect the health of aquatic wildlife (Table 3-10). Diffusion, aeration, or physical reoxygenation, is one process by which oxygen is introduced into the water column. In lakes or large, open river channels, wind events that create wave action help to mix and aerate the water column. In smaller streams and rivers, turbulent, high-velocity flow conditions similarly act to mix, aerate, and saturate the water column with DO. In contrast, oxygen diffusion can be minimal in deep, low-gradient rivers with low velocities or stagnant flows, especially rivers that are sheltered from wind, and in lakes when weather conditions are stable and no wind events occur.

Table 3-10. Relevant Utah water quality standards and indicator levels for aquatic wildlife.

PARAMETER	COLD WATER FISHERY (CLASS 3A)		WARM WATER FISHERY (CLASS 3B)	
	Early Life Stages Present	All Other Life Stages	Early Life Stages Present	All Other Life Stages
Minimum Dissolved Oxygen (mg/L)[a], 1-day average	8.0	4.0	5.0	3.0
Minimum Dissolved Oxygen (mg/L), 7-day average	9.5	5.0	6.0	4.0
Minimum Dissolved Oxygen (mg/L), 30-day average	6.5		5.5	
Maximum Water Temperature (degrees Celsius)	20		27	
Total Phosphorus as P (mg/L), rivers and streams (indicator)	0.05		0.05	
Total Phosphorus as P (mg/L), lakes and reservoirs (indicator)	0.025		0.025	
Nitrate as N (mg/L), indicator	4		4	

[a] Milligrams per liter.

Water temperature plays a number of important roles in determining water quality. Colder water is able to hold more DO than warm water; thus, DO problems are typically more common during warm, summertime conditions. Water temperature also directly affects fish and aquatic organisms. Different species are adapted to different temperature conditions and can experience stress and even death when temperatures exceed the threshold for a particular species or life stage. Sudden and dramatic temperature fluctuations can be damaging to fish and aquatic organisms. In Utah the UDWQ has set the maximum temperature standard at 20 degrees C for cold water (3A) organisms and at 27 degrees C for warmwater (3B) organisms.

Temperature influences biological processes in the water column. Warmer water is more productive and promotes growth of aquatic plants such as macrophytes (rooted aquatic plants), periphyton (sediment-attached plants, including algae and cyanobacteria), and phytoplankton (aquatic plants suspended in the water column, including algae and cyanobacteria). Warmer water also stimulates the rate of decomposition of decaying organic matter, a process that consumes and depletes oxygen.

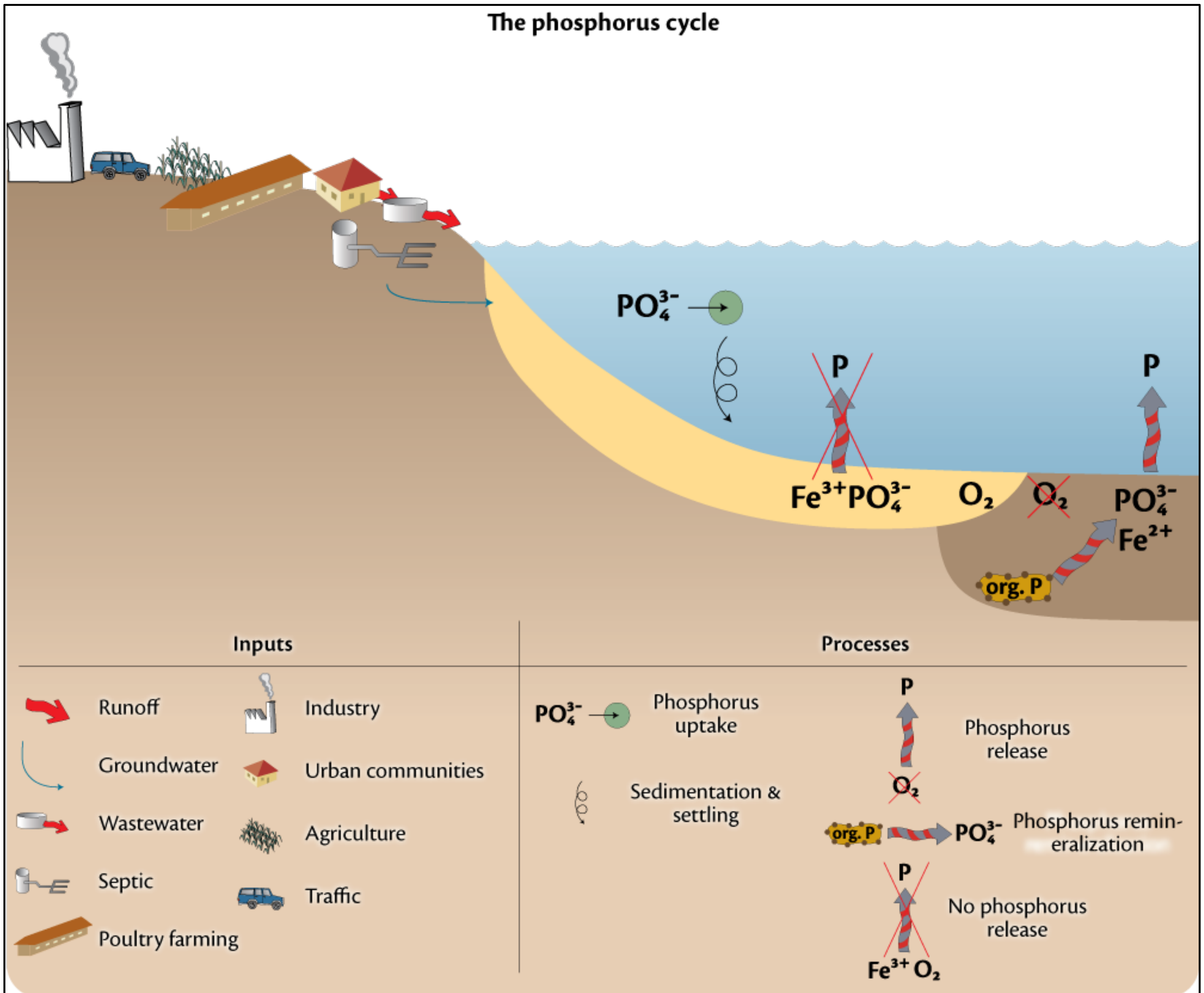
Sunlight, specifically light penetration, is another important factor that affects water quality. Rivers and lakes that lack shading will receive greater solar heating, resulting in warmer water temperatures. High levels of sunlight also stimulate photosynthesis and production of aquatic plants, including algae. However, light penetration is not just a function of sunlight exposure or shading; high levels of turbidity (caused by suspended sediment and/or phytoplankton in the water column) reduce light penetration. Water depth is also an important factor because sunlight can penetrate most or all of a shallow water column, but only the upper portion of a deeper water column.

Biochemical processes including photosynthesis, respiration, and decomposition have important effects on water quality conditions. Photosynthesis rates will be high in water bodies that are warm and receive high levels of light penetration. Photosynthesis consumes carbon dioxide and produces oxygen, so DO levels are typically high when photosynthesis rates are high (during daylight hours). However, photosynthesis ceases after the sun goes down, and respiration by aquatic plants becomes the active process during nighttime. Because respiration consumes oxygen and produces carbon dioxide, nighttime oxygen levels can become depleted in productive systems where phytoplankton levels are high. Rivers or lakes with low flow velocities, warm temperatures, minimal aeration by wind, and abundant aquatic plants are the most susceptible to daily oxygen “sags” caused by the shift between photosynthesis and respiration (Allan 1995).

Microbial decomposition of decaying organic matter is another oxygen-consuming process that can deplete DO levels, especially near the bottom of the water column. Sources of organic matter may include dead aquatic plants and algae, sewage or animal waste, and leaves and twigs that fall from the riparian canopy or are transported from upstream. Decomposition also releases gases that can cause unpleasant odors and affect the suitability of a water body for recreation.

Water-quality conditions are influenced by the magnitude, timing, and types of nutrient and sediment loads that enter the water body. Phosphate and nitrate levels are the specific nutrients that most commonly may limit primary production in water bodies. To protect against overly nutrient-rich (hypereutrophic) conditions, the UDWQ has established indicator levels for phosphorus and nitrate. Excessive nutrient levels can cause nuisance blooms of algae or cyanobacteria. Such blooms are most common when water temperature and sunlight levels are high. Algal blooms can result in unattractive water color and impede swimming and boating. Blooms are not sustainable and once resources are depleted, major die-offs occur, leading to excessive volumes of decaying plant matter and depleted oxygen levels. Certain types of cyanobacteria have the potential to produce metabolites that are toxic to humans and animals, adding to the problems associated with phytoplankton blooms. Phytoplankton blooms typically only occur in lakes or in low-velocity, stagnant portions of rivers; in flowing rivers where nutrients are constantly replenished from upstream, factors other than nutrient levels (such as light penetration) typically limit primary production and phytoplankton amounts (Allan 1995).

Nutrients enter water bodies in either dissolved or sediment-attached forms, and internal cycling from lake or streambed sediments can also add to nutrient levels. Common sources of nutrient loads include untreated runoff from developed portions of the watershed, effluent from wastewater treatment plants, leaching from poorly designed or maintained septic tanks, fertilizer runoff, and sediment-laden runoff caused by poorly controlled erosion. Sediment loads are particularly important where phosphorus is a limiting nutrient, as significant amounts of phosphorus can be sediment attached, especially in drainages containing phosphatic geologic formations. Processes that remineralize phosphorus from streambed sediments can be as important for primary production as phosphorus loads from point and nonpoint source inputs (Figure 3-11).



Conceptual diagram illustrating the phosphorus cycle. The availability of phosphorus to organisms is dependent on how much oxygen is present in the sediment

Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: *Dennison, W.C., J.E. Thomas, C.J. Cain, T.J.B. Carruthers, M.R. Hall, R.V. Jesian, C.E. Wazniak, and D.E. Wilson. 2009. Shifting Sands: Environmental and cultural change in Maryland's Coastal Bays. IAN Press, University of Maryland Center for Enviromental Science*

Figure 3-11. Conceptual diagram illustrating elements of the phosphorus cycle important for algae and/or cyanobacteria growth, dissolved oxygen depletions, and impacts to aquatic organisms. Image by Jane Thomas, Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagelibrary).

Other Common Water Quality Problems in Shallow Lakes (i.e., Existing River/Lake Interface)

Shallow lakes with limited flow-through are susceptible to high temperature, low DO, decomposition, and algae/cyanobacteria-associated water quality problems as described above. The balance between nutrient loads, a healthy amount of rooted aquatic vegetation, zooplankton and other predators of phytoplankton, and phytoplankton is fragile in shallow lakes and ponds, and hard to restore once damaged (Scheffer 2004). Water quality and ecological functions in ponds and shallow lakes are influenced by a combination of inflowing water temperature, sediment and nutrient inputs, wave action, and benthivorous fish such as carp (Figure 3-12). Large zooplankton use submerged aquatic vegetation as a refuge against predation. Zooplankton

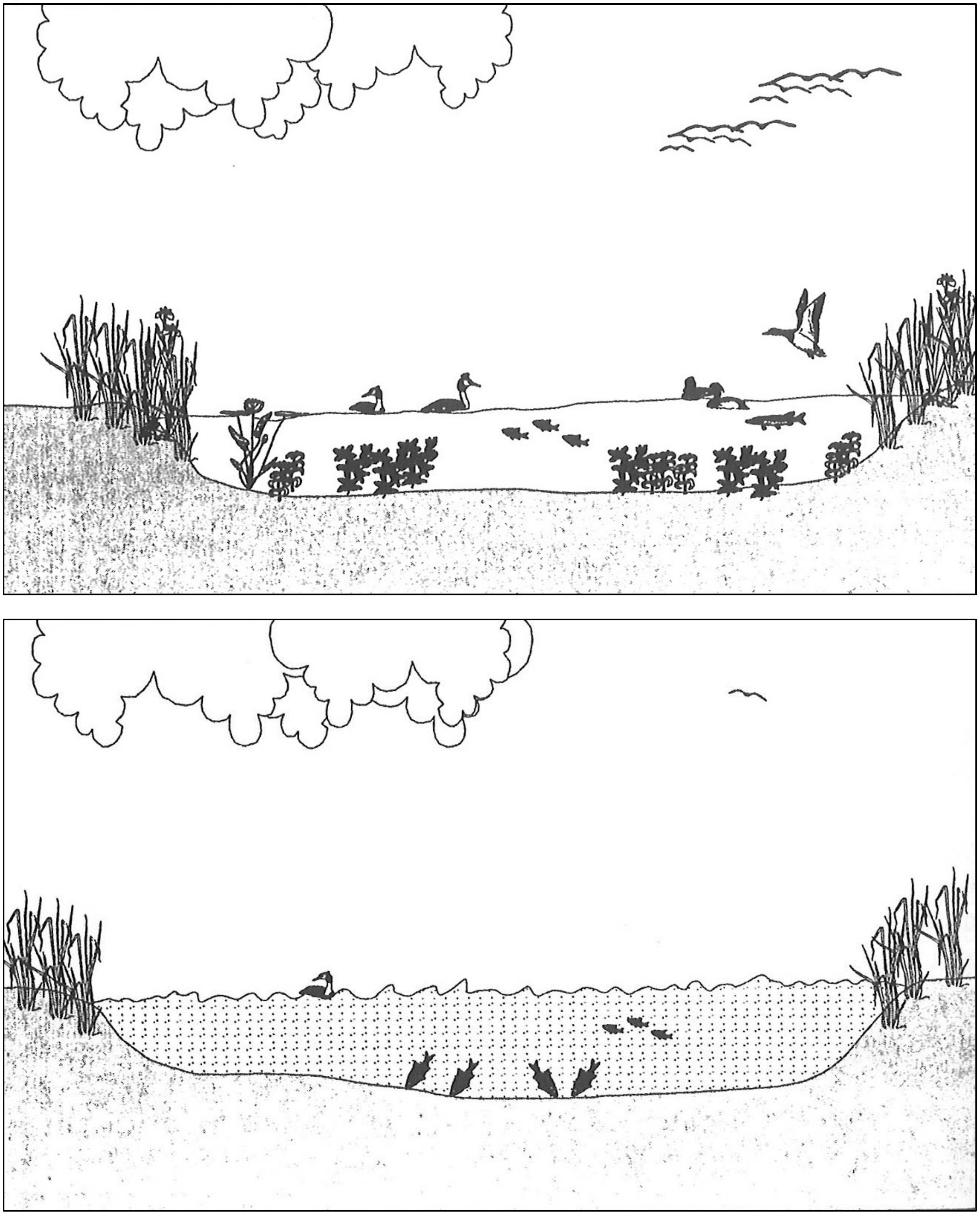


Figure 3-12. Schematic representation of a shallow lake in a vegetation dominated state (upper panel) and in a turbid phytoplankton dominated state (lower panel) in which submerged plants are largely absent and benthivorous fish and waves stir up the sediments. Reprinted with permission from Springer Science + Business Media B.V. (Scheffer 2004, Figure 1).

can contribute significantly to the control of phytoplankton biomass. Therefore, a pond or shallow lake void of submerged aquatic vegetation lacks natural controls of algal blooms.

An abundance of carp is generally associated with poor water quality for many reasons. Invertebrates that are associated with rooted aquatic vegetation disappear with carp, along with fish and other animals that require refuge from predators. This is partly due to the destruction or removal of rooted aquatic vegetation through carp feeding behavior. Shallow lakes with low nutrient content and a small population of bottom-oriented fish usually have a vegetation community dominated by relatively small rooted plants and clear water (Scheffer 2004). The upper panel in Figure 3-12 represents an undisturbed shallow lake and a desirable ecological condition for the backwater portions of the lower Provo River. Biomass in the form of nuisance aquatic macrophytes and/or phytoplankton tends to increase with increased nutrient loading. Sudden reductions in external loadings are often compensated at least temporarily by internal nutrient loading (i.e., phosphorus release from the rich sediments as described in Figure 3-11), delaying the response in biomass of the water-nutrient concentration to the reduction of external loading (Scheffer 2004). Restoration of these ecosystems via reduction of external loading of nutrients takes time.

Provo River Water Quality

Currently, the Provo River from Utah Lake to Murdock Diversion is listed on Utah's 2010 303(d) list as impaired based upon benthic macroinvertebrate assessments; the source of this impairment is listed as "unknown" (UDWQ 2010). At this time TMDL studies related to this impairment have not yet been initiated and the TMDL status is listed as "low priority" (UDWQ 2010). This benthic macroinvertebrate listing means that the ratio of "observed" native macroinvertebrate taxa to the "expected" number of taxa (as determined for reference sites relatively unaffected by human-caused disturbance) was found to be below the established impairment threshold (UDWQ 2011).

Other than the listing for benthic macroinvertebrates, the section of the lower Provo River within the study area is not listed for any other water quality impairments (UDWQ 2010). However, available data indicate that water quality standards are occasionally not met for certain parameters.

There are two distinct reaches of the lower Provo River that need to be considered separately for water quality; the first is the shallow sloping reach upstream of the UDWR fish weir, and the second is the deep flat reach downstream of the UDWR fish weir (Figure A-16, Appendix A). In the reach upstream of the UDWR fish weir, hydraulic conditions are wholly controlled by Provo River discharge and conditions are riverine in character (i.e., relatively shallow water depths, periodic riffle habitats with turbulent flow, gravel-dominated substrate material). Based on HEC-RAS model results (URMCC 2011), flow velocities in this portion of the river typically average between about 0.5 feet/second at low flow to more than 4 feet/second during high-flow conditions. Streambed gradient averages 0.3 percent. The fish weir is located at HEC-RAS cross section 18.

In the reach from below the weir to the river's outlet at the Utah Lake marina jetty, streambed gradient drops to less than 0.1 percent. In fact, the river bed rises west of Center Street Bridge, resulting in a bath tub like profile (Figure A-16, Appendix A). Because of this flat gradient and the backwater influence of the lake, water surface slope in this portion of the river can often approach zero. Water surface elevation in this reach is controlled by elevations in Utah Lake. Except during spring runoff in high-water years, velocities in this reach are slow to stagnant. Conditions in this lower reach are more similar to a pond (deep water, fine-grained silty substrate, slackwater conditions). Downstream from cross section 4, the river widens and shading by the riparian canopy is reduced, allowing for the greater solar and wind exposure that characterizes open lake environments. Wave action appears to be much more active in the open lake west of cross section 4.

Because of the lack of gradient and flow velocity, the reach from below the UDWR fish weir to the river's outlet functions as a depositional environment for sediment and organic debris, and the river has historically been dredged following large runoff events in the 1950s and 1980s to maintain its depth and connectivity to Utah Lake. Currently, a sandbar deposit has developed at the mouth of the river (at distance 0.0 in Figure A-16, Appendix A). The elevation of this sandbar is approximately 4,484 feet (1929 National Geodetic Vertical Datum [NGVD]) and the bar would create a backwater effect if Utah Lake levels were to drop below that elevation. The lack of gradient combined with the position of the Utah Lake Marina jetty, leveed channel condition, and prevailing westerly wind pattern act to "trap" Provo River water and limit mixing with Utah Lake water as the river channel is confined east of this location. As seen in the aerial photo in Figure A-16, the darker-colored river water "hugs" the jetty before it is able to mix with the lighter-colored lake water. The colder Provo River water is denser than the warmer water in Utah Lake, and would therefore tend to drop below the less dense lake water and hug the bottom of the lake.

Water quality data in the shallow-sloping segment of the lower Provo River upstream of the UDWR fish weir are collected by the UDWQ at its monitoring station near Geneva Road/U-114 (Station #499669), and by the CUWCD at its gage at Boat Harbor Drive. During the springtime, when streamflows are relatively high and June sucker target flows are being released, water quality is typically good and would be unlikely to limit aquatic flora and fauna. However, water quality can become poor during summer low-flow periods due to low DO levels and elevated temperatures. Below Upper City Dam, polluted stormwater runoff from urbanized areas contributes a large portion of the streamflow during storm events. Fish kills associated with polluted runoff are possible in the lower reaches of the river if these storm events occur during low-flow periods (USFWS 1999a). Fish kills due to low streamflow, high water temperatures, and low DO occurred during summer 2013. The chronic effects of potentially toxic constituents in polluted runoff are not known in the lower Provo River.

Nutrient and sediment inputs, combined with warm temperatures and shallow water depths, are known to contribute to summertime algal build-up and macrophytes within the channel. This aquatic vegetation can cause armoring of spawning gravels and accumulations of fine sediments that degrade spawning habitat quality.

As part of the ULS EIS, available UDWQ water quality data from 1990–2002 were reviewed (CUWCD 2004). This review found that monthly total phosphorus (TP) concentrations in this reach of the lower Provo River exceed the Utah pollution indicator value of 0.05 milligrams per liter (mg/L) in May and September (CUWCD 2004). Utah Lake TMDL studies analyzed a slightly different time period, from 1980–2003, and found that the indicator value was exceeded in August (average TP concentration of 0.054 mg/L) while average May and September values were just below the indicator value (0.048 and 0.046 mg/L, respectively) (Cassel and King 2005).

Water quality data in the deep, flat segment of the lower Provo River downstream of the UDWR fish weir were collected historically by UDWQ, and more recently by CUWCD and BIO-WEST, Inc. (BIO-WEST) for the purposes of this project. The only available UDWQ water quality information for this lake-influenced portion of Provo River downstream from the fish weir is a limited dataset of about 30 data points collected between 1976–1981 and in 1990 at the UDWQ monitoring site located near the Center Street Bridge crossing. The data include two instances when measured temperature exceeded the cold-water fishery (class 3A) standard of 20 degrees C and two instances when DO levels dropped below the standard of 4 mg/L. These exceedances occurred during sampling completed during mid-morning on days in July, at flows of 1.4, 10, and 19 cfs. In terms of nutrients, 16 out of 25 available phosphorus data points equaled or exceeded the State indicator level of 0.05 mg/L (Figure 3-13).

Recent Water Quality Data for the lower Provo River Downstream of the Utah Division of Wildlife Resources (UDWR) Fish Weir

Because available water quality data for the downstream portion of the Provo River are limited and not current, a recent data collection effort was completed by BIO-WEST and CUWCD to help better determine current water quality conditions of the lower Provo River. Specifically, three sets of data were collected. Methods and results for each of these types of data are provided below.

Deployed Water Quality Sensor

A water quality probe (RV probe) was deployed in the river approximately 0.4 mile upstream of the Center Street Bridge (about 1 mile above the mouth of the river) near the Lakeside RV Park. The RV probe was deployed between June 6 and October 1, 2012, and then again April 12, 2013 through September 24, 2013. Hourly water temperature, DO, specific conductance, and pH data were continuously recorded during this time period. Short durations of data are missing due to equipment malfunctions. Specific conductance and pH remained within their expected normal ranges.

Monitoring results for water temperature and DO are concerning and indicate that the portion of the lower Provo River downstream of the UDWR fish weir is impaired during the warm summer months for water temperature and DO (Figures 3-14 and 3-15). Average daily DO values remained above the 1-day average standard of 4 mg/L in 2012; however, significant daily fluctuation occurred and hourly values commonly drop below 4 mg/L during August and early September. Daily high values during this time of the year are generally above 8 mg/L with daily low values commonly dropping below 2 mg/L. It was believed at this time that the diurnal DO sag is likely associated with daytime photosynthesis/nighttime respiration patterns. It is assumed that DO also dropped below the State standard of 4 mg/L in July and early August 2012, but data were not collected during this time frame due to equipment malfunctions.

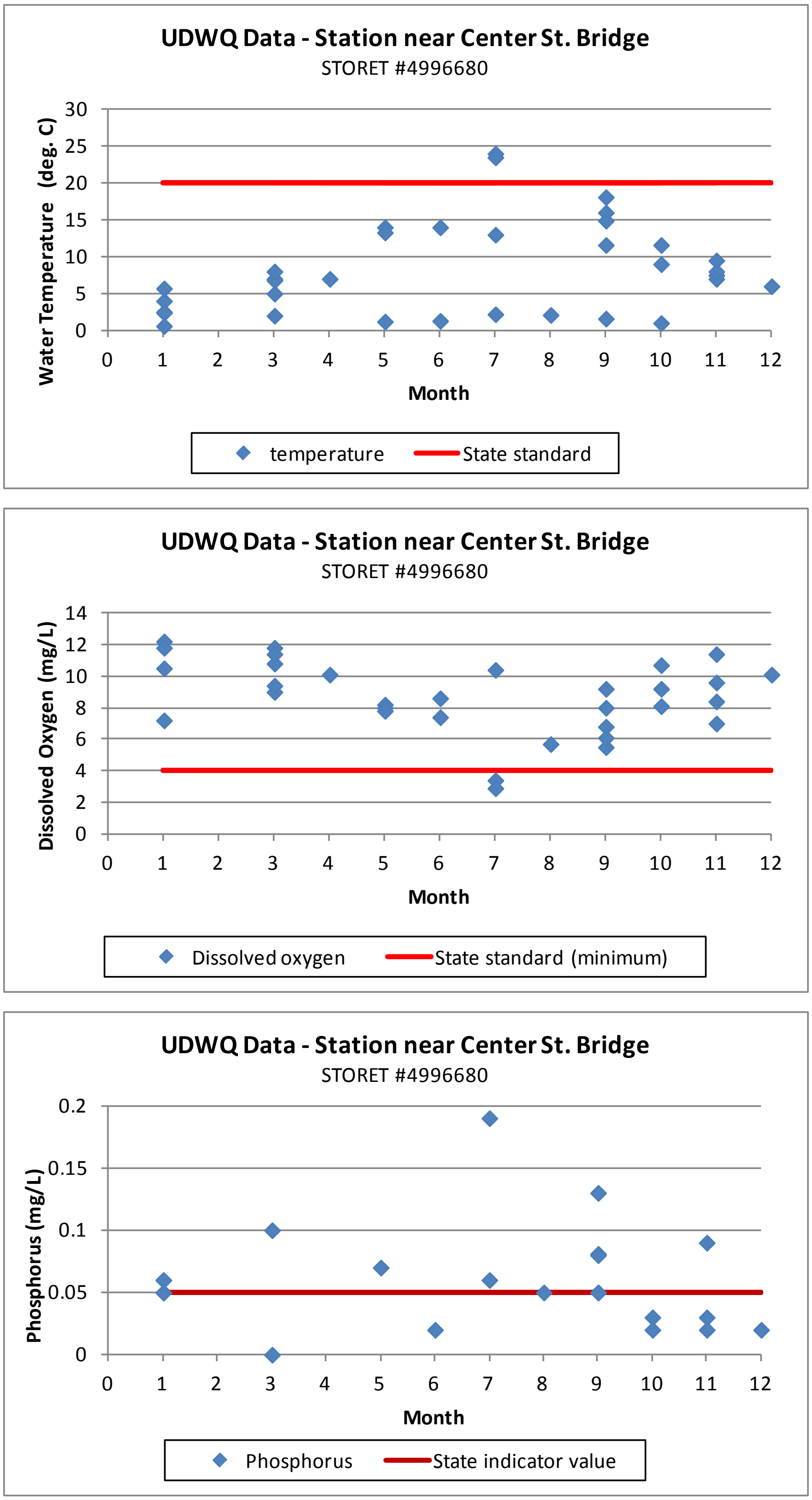


Figure 3-13. Water temperature, dissolved oxygen, and phosphorus data collected by Utah Division of Water Quality between 1976 and 1990 at their monitoring site (STORET 499668) near the Center Street Bridge.

The State standard for water temperature was exceeded during the latter half of July and nearly the entire month of August 2013 when flows were at their lowest (Figures 3-14 and 3-15). Data collected in 2013 show average daily DO levels below the one-day standard of 4 mg/L occurring in late May, early June, late June, and mid-July through the end of August (Figure 3-14). The daily low DO concentrations drop below 1 mg/L, which is generally considered lethal to most fish species and other aquatic organisms. Fish kills occurred in 2013 in portions of the river that were dewatered. Algal blooms were also photographed in August 2013 (Figure 3-16). A meeting was held with UDWQ in August 2013 to discuss the monitoring results, evaluate conditions and potential causes of impairment, and brainstorm about what could be done to improve the existing water quality problems in this depositional reach of the river. As a result of the discussions with UDWQ, it is believed that the reach of the lower Provo River downstream of the UDWR fish weir is a depositional zone for silt and other fine-grained sediments and organic debris, and that the buildup of this "muck" is causing a high sediment oxygen demand (SOD) in this historically dredged channel. The last major dredging of this reach happened during the late 1980s following the floods of 1983–1985.

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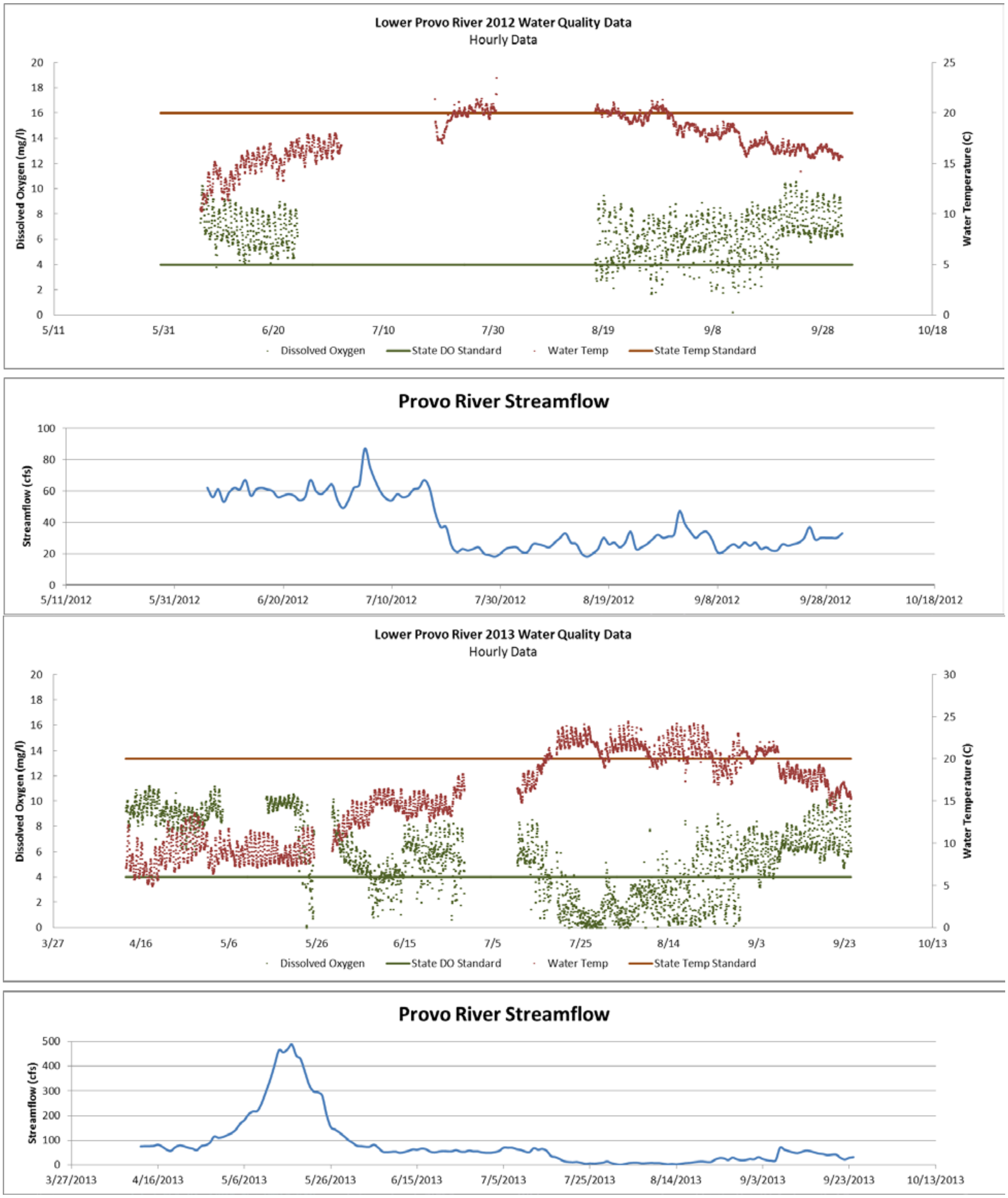

Figure 3-14. Plots of hourly water temperature, dissolved oxygen, and streamflow collected in 2012 and 2013 by the datasonde deployed at Lakeside RV Park approximately 0.4 mile upstream of Center Street Bridge. Flows dropped below 10 cubic feet per second at the US Geological Survey gage from July 23 through August 18, 2013, during the time when the highest water temperatures and lowest dissolved oxygen concentrations were measured.

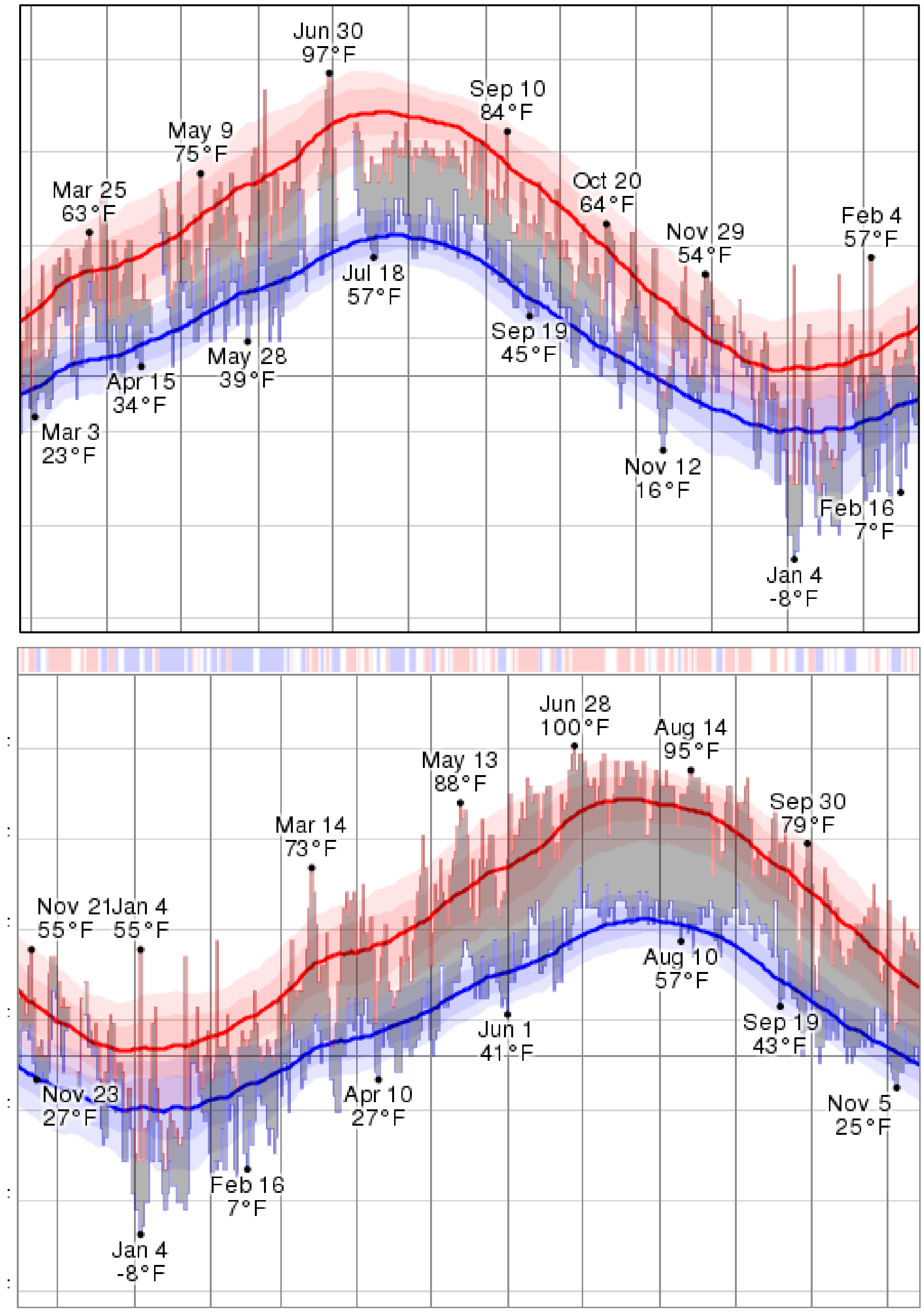

Figure 3-15. **Air temperature for the Provo Municipal Airport during a portion of 2012 and 2013 (top graph extends from March 2012 to February 2013, whereas the bottom graph extends from November 2012 to November 2013). Copied directly from WeatherSpark February 2013 and November 2013. The daily low (blue) and high (red) temperature with the area between them shaded gray and superimposed over the corresponding averages (thick lines), and with percentile bands (inner band from 25th to 75th percentile, outer band from 10th to 90th percentile). The bar at the top of the graph is red where both the daily high and low are above average, blue where they are both below average, and white otherwise.**

Figure 3-16. Algal bloom in the lower Provo River near the Utah Lake interface August 20, 2013 (Provo River at the US Geological Survey gage = 14 cubic feet per second). The top left photo was taken from Center Street Bridge looking downstream. The top right photo was taken from the south bank looking upstream at Center Street Bridge. The bottom left photo was taken from the north bank at the Utah Lake State Park showing the exposed muddy substrate and accumulation of organic debris across the channel bottom. The bottom right photo was taken from the south bank near Utah Lake State Park.

June 15, 2012 Depth and Profile Sampling

A series of nine water quality measurements were collected using a water quality multi-probe between the fish weir and the river's mouth on June 15, 2012. These measurements were taken between 9:45 a.m. and 1:30 p.m., when river flow was 59 cfs (as measured at the CUWCD gage) and lake elevation was slightly above average, at about 4,488 feet. Parameters measured included temperature, specific conductance, pH, and DO. At each water quality sampling location (Figure 3-17), measurements were made from the water's surface down to near the channel bottom at approximately 1-foot depth increments. Water depths averaged about 7 feet and ranged from less than 2 feet deep at the fish weir to nearly 12 feet deep at the site at the big river bend near cross section 13.

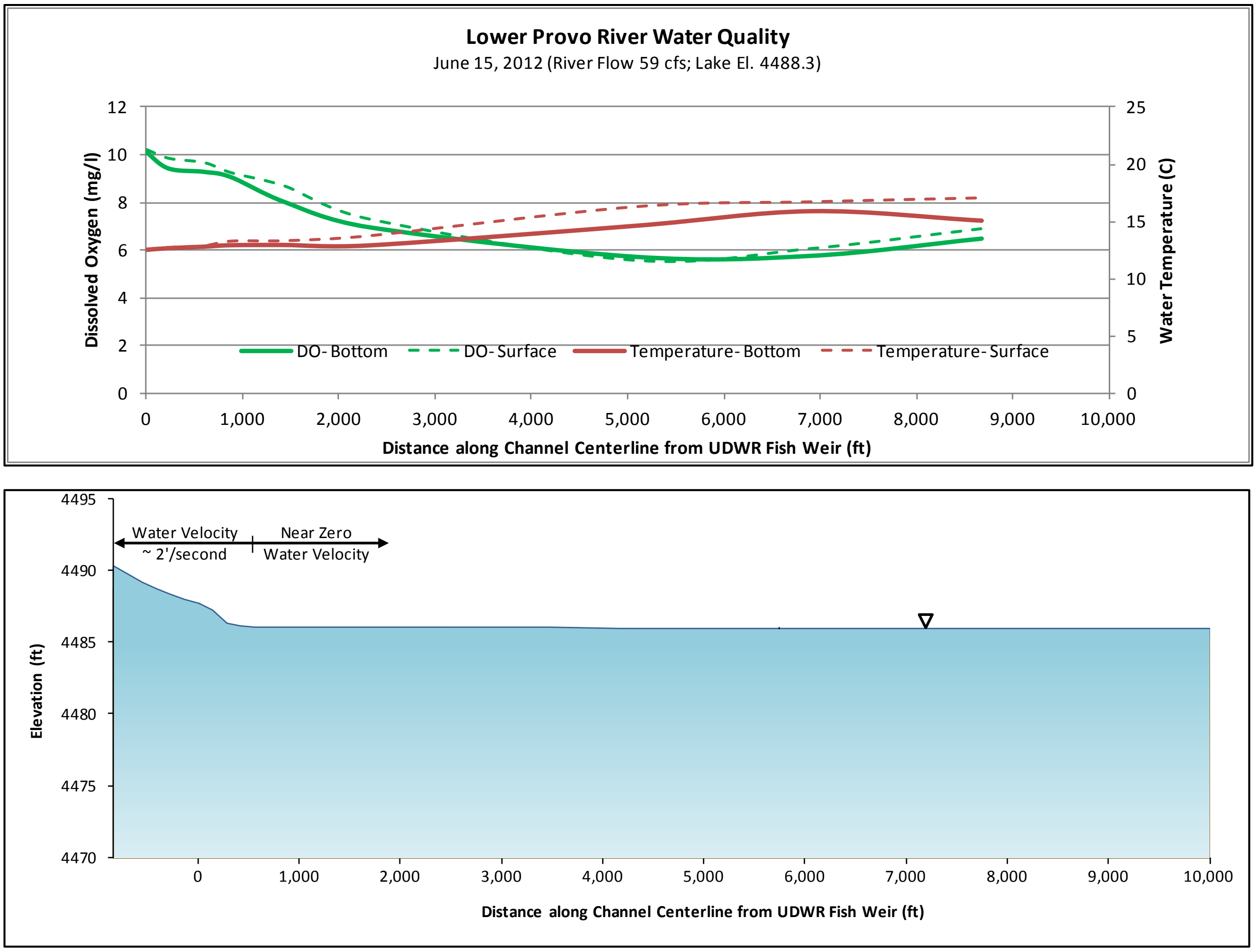

Figure 3-17. Lower Provo River temperature and dissolved oxygen data collected between the fish weir and the mouth of the river on June 15, 2012.

Dissolved oxygen and temperature results for the June 15 sampling event indicate that conditions near the water surface and near the channel bottom are very similar. This suggests that the water is well-mixed with essentially no vertical stratification at the time of the sample. Although DO levels generally decrease moving downstream, levels remain above the 4 mg/L State standard. Surface water temperatures increase gradually by a total of about 4.5 degrees C moving downstream, but remain below the cold water fishery standard (20 degrees C).

Results for pH and specific conductance are very consistent both within the vertical surface-to-channel bottom profile and along the horizontal profile from the weir to the river mouth (Figure 3-18). This further illustrates the lack of vertical stratification, and also suggests a very consistent water chemistry throughout the study area.

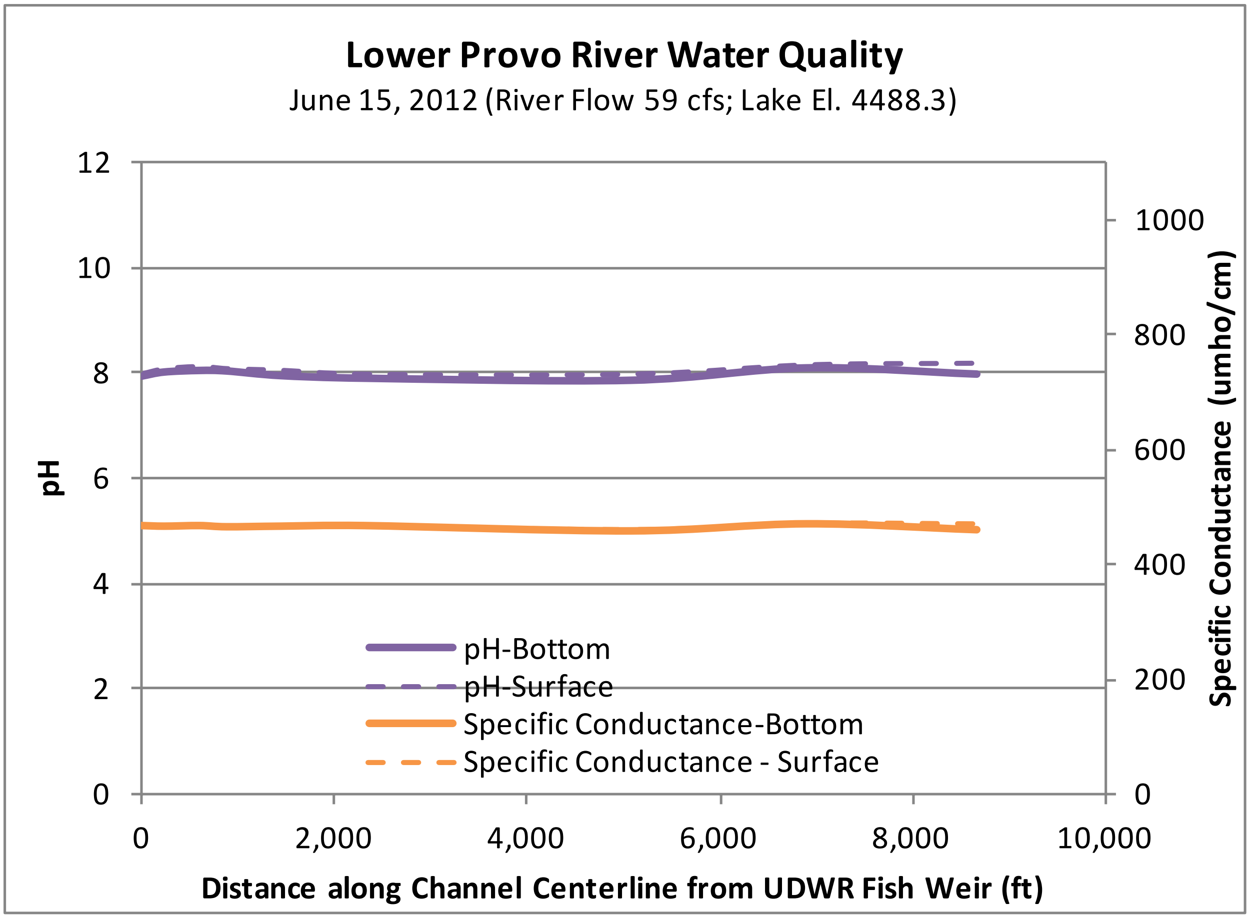

Figure 3-18. Lower Provo River specific conductance and pH data collected between the fish weir and the mouth of the river on June 15, 2012.

July 28, 2012 Depth and Profile Sampling

The vertical and horizontal profile water quality sampling effort was repeated on July 28, with some minor modifications. Because the June 15 results did not show evidence of significant vertical stratification, only 2 to 4 vertical measurements (fewer at shallower sites, more at deeper sites) were completed at each sampling location during the July effort. Also, two additional sampling locations were added in July: station 8.5 was added near cross section 3, and station 10 was added to extend the sampling area farther west to the lake proper. The new sample location (10) was much more open to the lake, had greater wave action during the time of the sample, and had a noticeable water color difference on the surface (same as the lake water color) than the other monitoring sites, which were a darker "Provo River blue." The July 28 measurements were taken between 10:00 a.m. and 1:30 p.m., when river flow was 35 cfs (as measured at the CUWCD gage) and lake elevation was slightly below average, at about 4,487 feet.

In July, water temperature values were higher, and DO values lower, than during the June sampling effort (Figure 3-19, Table 3-11a). This result is not surprising given the lower flow conditions and warmer air temperatures in July. As in June, the July temperature data show minimal thermal stratification when surface versus near-bottom values are compared. However, DO results show some more substantial surface-versus-bottom differences at station 7 (distance 5,080) and at station 10 (distance 9,673). Surface water temperatures increase gradually by a total of about 4 degrees C moving downstream from station 1 to station 9, and then increase more rapidly by another 2.7 degrees C between stations 9 and 10 (Figure 3-19). Surface water temperatures begin to exceed the cold water fishery standard (20 degrees C) at station 7. Temperatures at the bottom of the water column also slightly exceed the standard beginning at station 8 near Center Street Bridge. Dissolved oxygen levels remain above the State standard (4 mg/L) with the exception of the bottom reading at station 9, which had a value of 3.77 mg/L.

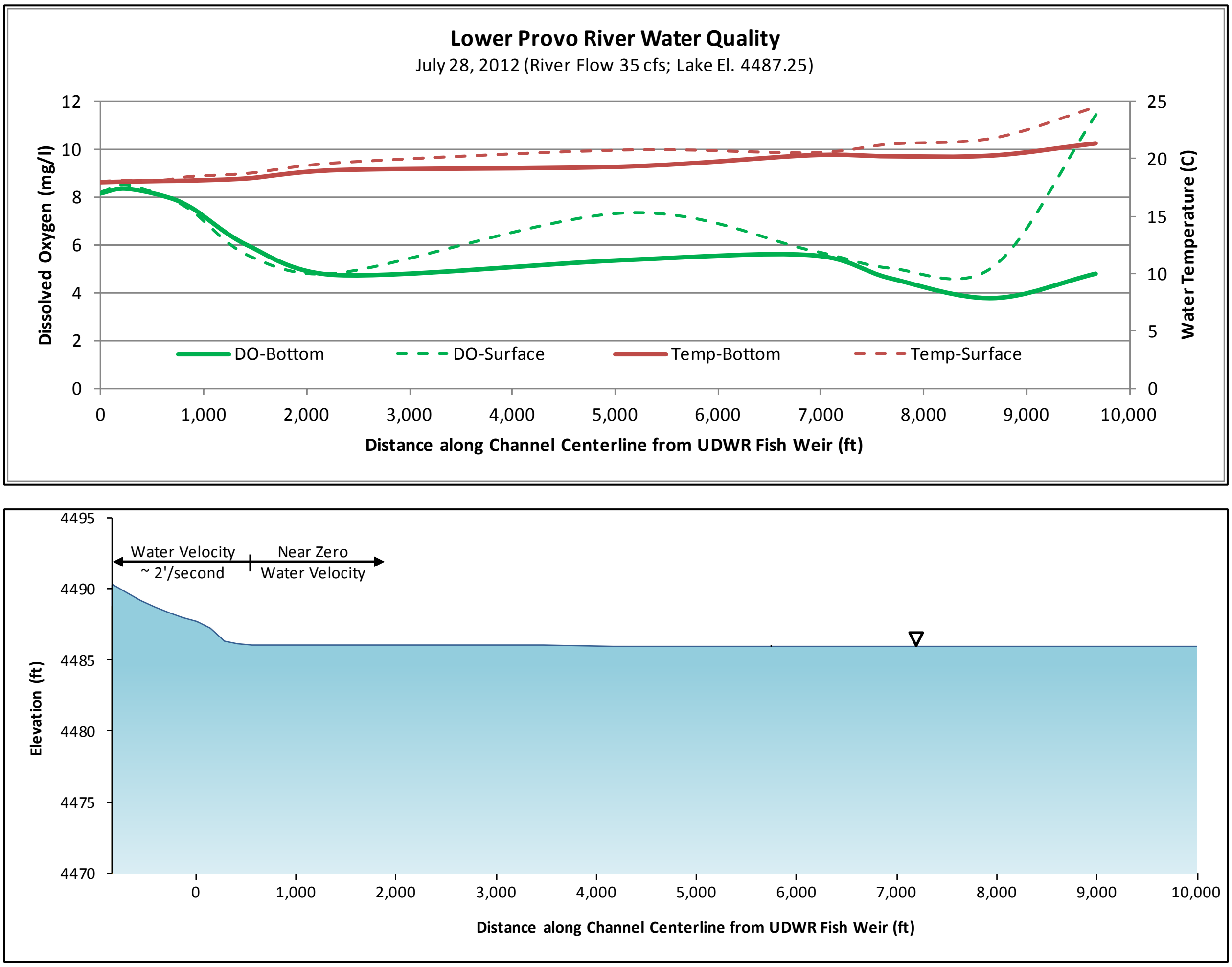

Figure 3-19. Lower Provo River temperature and dissolved oxygen data collected between the fish weir and the mouth of the river on July 28, 2012.

Table 3-11a. Results of 2012 depth and profile water quality sampling; presented values have been vertically averaged for each sampling location.

STATION	DISTANCE FROM FISH WEIR (feet)	JUNE 15, 2012				JULY 28, 2012			
		Temperature (degrees C[a])	Specific Conductance (umho/cm[b])	pH	Dissolved Oxygen (mg/L[c])	Temperature (degrees C)	Specific Conductance (umho/cm)	pH	Dissolved Oxygen (mg/L)
1	0	12.6	469	7.94	10.15	18.0	544	7.59	8.22
2	236	12.7	469	8.03	9.57	18.1	544	7.57	8.42
3	603	12.8	469	8.07	9.47	18.1	545	7.87	8.10
4	883	13.0	468	8.04	9.02	18.2	546	7.85	7.54
5	1,446	13.0	468	7.96	8.17	18.5	547	7.72	5.74
6	2,309	13.2	469	7.91	7.21	19.3	538	7.73	4.84
7	5,080	15.2	461	7.92	5.75	20.2	529	8.08	6.61
8	6,903	16.2	472	8.09	5.91	20.4	530	7.92	5.72
8.5	7,673	no data				20.7	533	7.83	4.85
9	8,673	16.1	467	8.08	6.73	20.8	546	7.79	4.26
10	9,673	no data				23.0	821	8.23	8.15

[a] Celsius.
[b] Microseimens per centimeter.
[c] Milligrams per liter.

As with the June 15 data, the pH and specific conductance data for stations 1–9 are very consistent vertically and horizontally along the profiles sampled (Figure 3-20). However, station 10 shows a significant difference in the surface-versus-bottom specific conductance values. The station 10 surface value (1,022 microsiemens per centimeter [umho/cm]) is within the range of typical conductivity values in Utah Lake, which range from about 900 to 2,200 umho/cm at the 3 monitoring stations nearest Provo River. The station 10 bottom value (619 umho/cm) is slightly higher than, but fairly similar to, the bottom values measured at the other Provo River stations.

Based on the June 15 and July 28, 2012, depth and profile sampling results, colder water coming from Provo River pushes out into Utah Lake and mixing does not occur until the mouth of the river opens into the lake proper. Water quality sampling station 10 shows evidence that the colder river water dives under the warmer lake water. The mixing appears to be incomplete, as the results for the bottom of the water column at station 10 remain similar in character to the upstream Provo River sites, and the top is similar to characteristics of Utah Lake water, which is much higher in specific conductance. This is not surprising; the colder, denser river water would be expected to dive below the warmer, lighter lake water. No evidence of mixing between Utah Lake water and Provo River was found upstream of station 10.

2014 Sediment Oxygen Demand (SOD) and Aeration Studies

The JLAs conducted additional studies regarding sediment oxygen demand (SOD) to further understand causes of existing water quality problems in the lower Provo River and the feasibility of relying on aeration to maintain State water quality standards for DO (Goel et al. 2014, Kling 2014). Based on the study results and review of all available information, it was

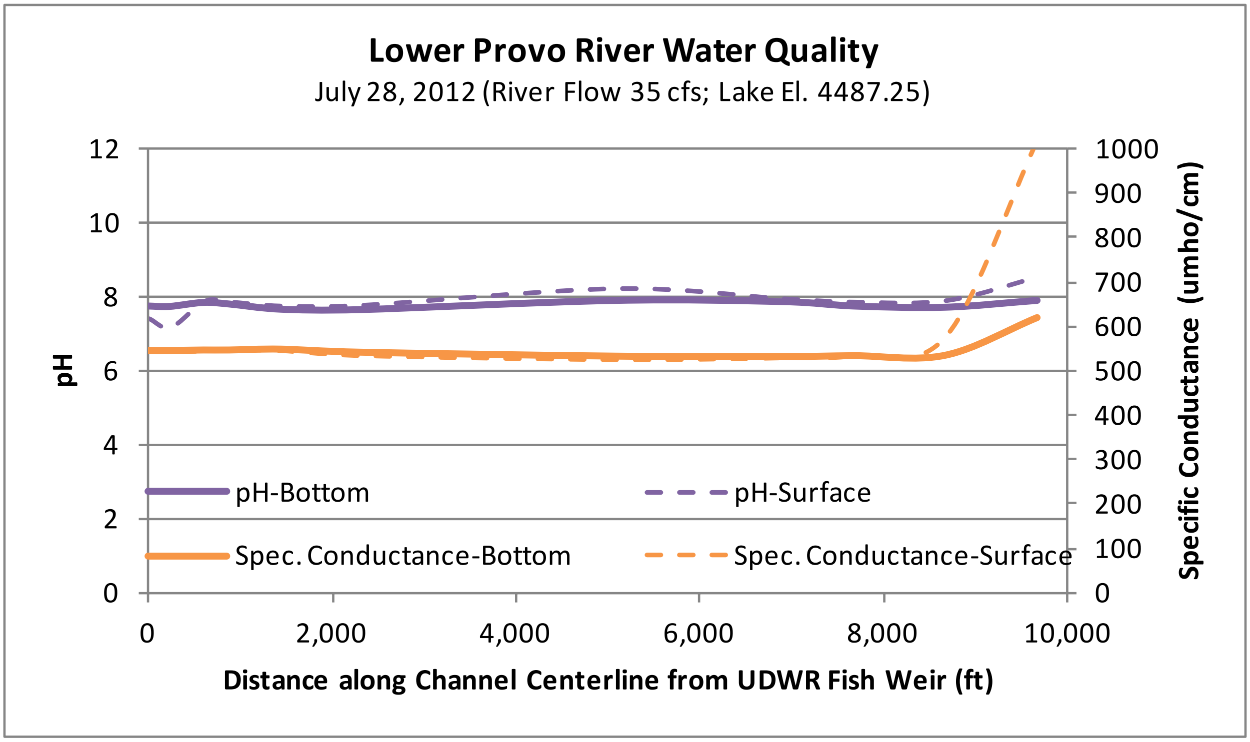

Figure 3-20. Lower Provo River specific conductance and pH data collected between the fish weir and the mouth of the river on July 28, 2012.

determined that diffused aeration using continuous nonturbulent laminar flow would significantly improve water quality in the lower 1.5-mile “ponded” portions of the lower Provo River and meet the goal of maintaining State water quality standards for DO. The results of the SOD study (Goel et al. 2014) are summarized below.

Four sites were sampled for SOD in the lower 1.5 miles of the Provo River. The Big Bend site represented the beginning of the ponded section of the river. The Ropes Course and RV Park sites are located adjacent to high use areas and are evenly spread out over the lower Provo River. The Utah Lake State Park site is located near the outlet of the river and does not have the riparian canopy that is present at the upstream sites. Since the lower Provo River has been channelized and heavily rip rapped, sites were located in the depositional zones on the inside edge of river meanders to allow for SOD chamber installment. The calculated values of SOD for each site are summarized in Table 3-11b.

The negative values signify oxygen being consumed at the sediment-water interface. As a general rule, SOD values less than -1 gram of DO per square meter per day are associated with organically enriched sediments (Chapra 2008, p. 452). As evident from Table 3-11b, all measured SOD values in the Provo River were less than -1, indicating organically enriched sediments.

Table 3-11b. Sediment oxygen demand (SOD) sample site results.

SITE	SEDIMENT OXYGEN DEMAND (SOD)[a]				DARK WATER COLUMN RESPIRATION[c]	APPROXIMATE DEPTH (METERS)	PERCENT SOD
	Sample 1	Sample 2	Average	SOD 20[b]			
Big Bend	-6.2	n/a	-6.2	-6.6	-4.5[d]	2.0	32
Ropes Course	-2.6	-2.1	-2.3	-2.3	-0.8	1.5	66
RV Park	-2	-2.2	-2.1	-2.2	-0.42	1.5	77
Utah Lake State Park	-1.6	-1.6	-1.6	-1.8	0.0[e]	1.5	~100

[a] Dissolved oxygen in grams per square meter per day (g/m^2/day).
[b] SOD normalized to 20 degrees Celsius.
[c] Grams per cubic meter per day (g/m^3/day).
[d] High water column dissolved oxygen consumption.
[e] Negligible contribution.

The greatest SOD (evidenced by the most negative number) was recorded at the Big Bend site and coupled with a high water column oxygen demand. Based on these values, the lower Provo River falls in the range of a moderately polluted-to-polluted stream. In general, SOD fluxes were the highest at the Big Bend site and decreased with distance downstream. The Big Bend site had a very high SOD, and the sediments were composed of organically enriched muck that released large amounts of swamp gas when disturbed. The sediments became more homogeneous with distance downstream and SOD fluxes decreased. It appears that a large amount of course particulate organic matter enters the lower Provo River from upstream, and large amounts of deposition occur at the beginning of the ponded portion of the river. It should also be noted that the supersaturated ambient DO concentrations in the afternoon indicate instream primary production, which adds to the reservoir of organic matter in the sediments. Surprisingly, the lowest SOD fluxes were measured near the outlet of the Provo River into Utah Lake. This is most likely a result of particulate organic matter settling upstream, while phytoplankton may be a significant source of SOD near the outlet.

The following benefits are expected from aeration:

1. Aeration would stabilize DO concentrations throughout the water column and the sediment-water interface for all aquatic life. The water column would have a minimum of 5–6 parts per million of DO during system operation and would eliminate constantly rising and falling DO levels. This reduces stress on fish and improves growth rates, vitality, and overall health. Stable DO levels also increase aquatic insect populations (natural fish food) and natural populations of beneficial aerobic microbes, which can be killed when the lower part of the water column is anoxic.

2. Aeration would provide a reduction in nutrients and suspended solids in the water column that can contribute to algal growth.

3. Aeration would provide a reduction in organic sediments and SOD, thus reducing muck on the bottom of the river and improve river sediments.

4. Aeration would eliminate stagnant areas of water and any odors resulting from stagnant conditions.

The feasibility to construct, operate, and maintain an aeration system in the lower Provo River was also evaluated by industry representatives and concluded to be feasible (Kling 2014).

Residence Time of Water in the Existing Lower Provo River

Deep, stagnant water that does not experience wind events will receive minimal reoxygenation via diffusion. Deep, stagnant water that lacks inflows of fresh cool water may also become overly warm during the summer when solar inputs are high. Residence time (the length of time that a given "unit" of water spends in an area) is a parameter that can help assess the susceptibility of a water body to the potential DO and temperature problems that can result from stagnant conditions. Water bodies with long residence times have slow turnover rates and will be more prone to experience water quality problems.

The HEC-RAS model developed for the Provo River (URMCC 2011) was used to calculate residence time for the lower Provo River. The model provides outputs of total cumulative water volume between the downstream end of the model (at cross section 3, located about 0.4 miles above the mouth of the river) and each cross section. Because the exact point at which streamflow would be diverted out of the existing river channel varies among the proposed action alternatives, residence time was calculated at both Lakeshore Drive (HEC-RAS cross section 27.5) and the fish weir (cross section 18) by dividing water volume by river flow. At each of these locations, residence times were determined for various river flow rates and both high (4,489 feet) and low (4,486 feet) lake levels.

Residence time results are plotted in Figure 3-21 and summarized in Table 3-12. Results indicate that there is little difference in residence time between Lakeshore Drive and the fish weir, especially when flows are low. This similarity is a function of the fact that between Lakeshore Drive and the fish weir, the conditions are shallow and riverine in nature, and water volume increases with channel distance at a slow rate. From the mouth of the river up to the oxbow (HEC-RAS cross section 16), where the channel is deep and flat, water volume changes much more rapidly with distance.

Lake level has a more noticeable effect on residence time. At 50 cfs, the residence time during high lake level conditions is nearly twice that during low lake level conditions (Table 3-12). However, even under the conditions with the highest potential for stagnation (high lake level, only 10 cfs conveyed down existing channel below Lakeshore Drive), residence time remains fairly short at 4.6 days, and 2.7 days during low lake level.

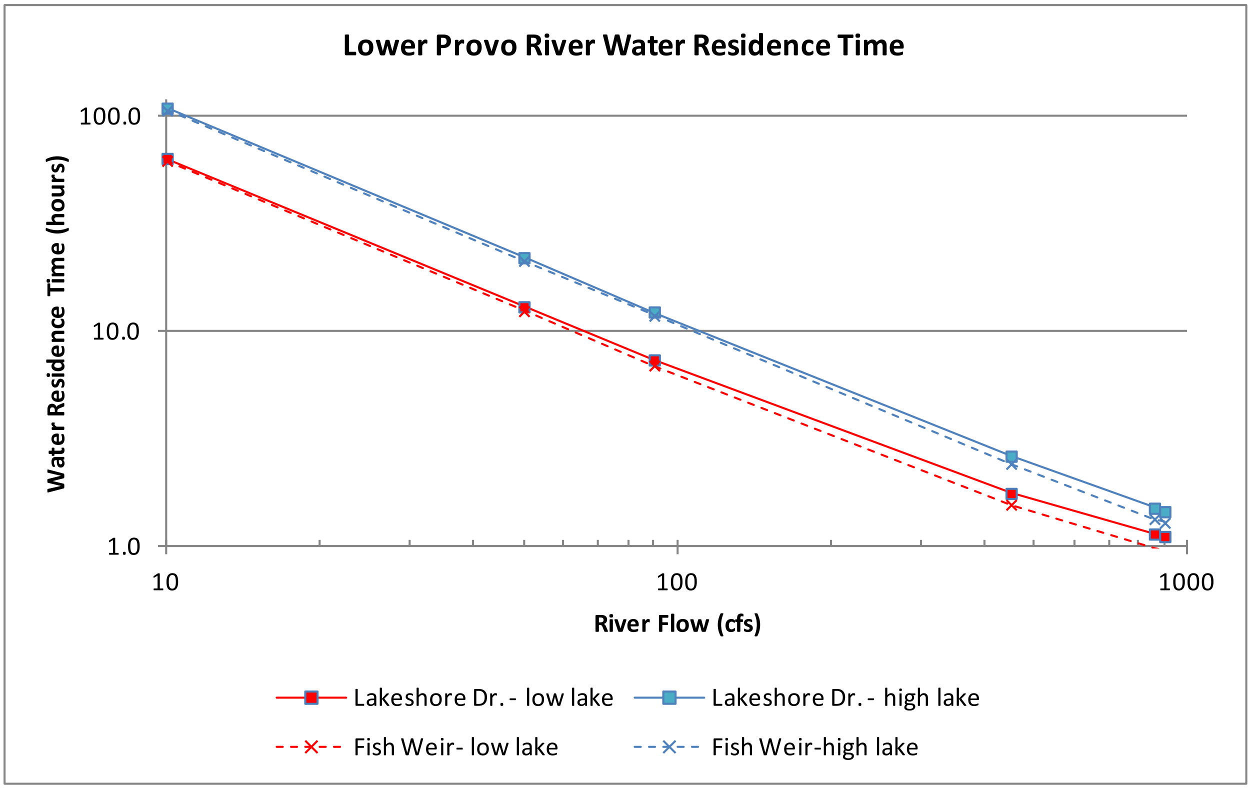

Figure 3-21. **Residence time of water in the lower Provo River based on HEC-RAS model results.**

Table 3-12. **Residence times of water in the lower Provo River at various river flows for high and low lake level conditions.**

LOCATION	FLOW (cfs)	LOW LAKE (4,486 feet)			HIGH LAKE (4,489 feet)		
		Water Volume (acre-feet)	Residence Time (days)	Residence Time (hours)	Water Volume (acre-feet)	Residence Time (days)	Residence Time (hours)
Lakeshore Drive (XS 27.5)	10	52.8	2.7	63.8	90.4	4.6	109.4
	50	53.9	0.5	13.1	91.2	0.9	22.1
	90	55.0	0.3	7.4	91.8	0.5	12.3
	450	65.8	0.1	1.8	98.1	0.11	2.6
	859	81.4	0.05	1.1	107.3	0.06	1.5
	900	83.0	0.05	1.1	108.3	0.06	1.5
Fish Weir (XS 18)	10	51.4	2.6	62.2	88.1	4.4	106.6
	50	51.5	0.5	12.5	88.1	0.9	21.3
	90	51.8	0.3	7.0	88.1	0.5	11.8
	450	58.4	0.07	1.6	90.3	0.10	2.4
	859	69.9	0.04	1.0	95.5	0.06	1.3
	900	71.1	0.04	1.0	96.2	0.05	1.3

Utah Lake Existing and Baseline Water Quality

Utah Lake's designated beneficial uses include 2B, 3B, 3D, and 4. Utah Lake is currently listed by UDWQ as impaired for total dissolved solids (TDS), TP, and PCB in fish tissue (UDWQ 2010), and a TMDL is currently in progress for the lake. More specifically, measured TDS values in the lake occasionally exceed the established agriculture/irrigation (4) standard of 1,200 mg/L, and TP values exceed the warmwater fishery (3B) pollution indicator value of 0.025 mg/L for lakes.

Utah Lake is a shallow, productive, turbid lake. It is considered to be hypereutrophic and suffers from algal blooms in the summer and fall (PSOMAS and SWCA 2007).

The UDWQ samples water quality in various locations around Utah Lake. Data for the three monitoring stations located closest to the mouth of Provo River (Figure 3-22) were downloaded from the STORET database and analyzed. These stations include a mid-lake site located about 3.5 miles west of the river mouth (STORET #4917340); a mid-lake site located 1.4 miles west of the river mouth (STORET #4917390); and a site located at the mouth of Provo Bay, about 3.3 miles directly south of the river mouth (STORET #4917770).

The available data demonstrate that Utah Lake water is relatively warm compared to Provo River, but that the lake temperature rarely exceeds the State warmwater standard of 27 degrees C (see Figure 3-18). Similarly, DO levels in the lake are nearly always above the warmwater standard of 3 mg/L. Conductivity levels in the lake are about 1,600 umho/cm on average.

The majority of the available UDWQ Utah Lake data are for sampling completed at the water's surface. However, on a number of occasions, data were also collected "at depth", allowing for comparison of water quality conditions in profile within the lake. In many lakes, a strong thermal stratification develops where conditions at the surface and near the lake bottom are quite distinct (typically warm, high oxygen conditions near the surface and cold, low oxygen conditions near the lake bottom). Because Utah Lake is shallow and commonly experiences strong winds that promote mixing, it does not frequently develop strong thermal stratification. Available temperature and DO data for the three lake sites near Provo River for the time period 2001-2009 indicate that stratification does occur occasionally, but that most of the time there is not a great difference between conditions at/near the surface and conditions at depths of 1- 3 meters below the water surface (Figure 3-23). Analyses of data from the time period 1989-2003 completed as part of the Utah Lake TMDL process also indicate that strong stratification is relatively rare in the lake (PSOMAS and SWCA 2007). These TMDL analyses also found that when conditions near the lake surface did not meet State warmwater fishery standards, deeper water quality was suitable and vice versa (PSOMAS and SWCA 2007).

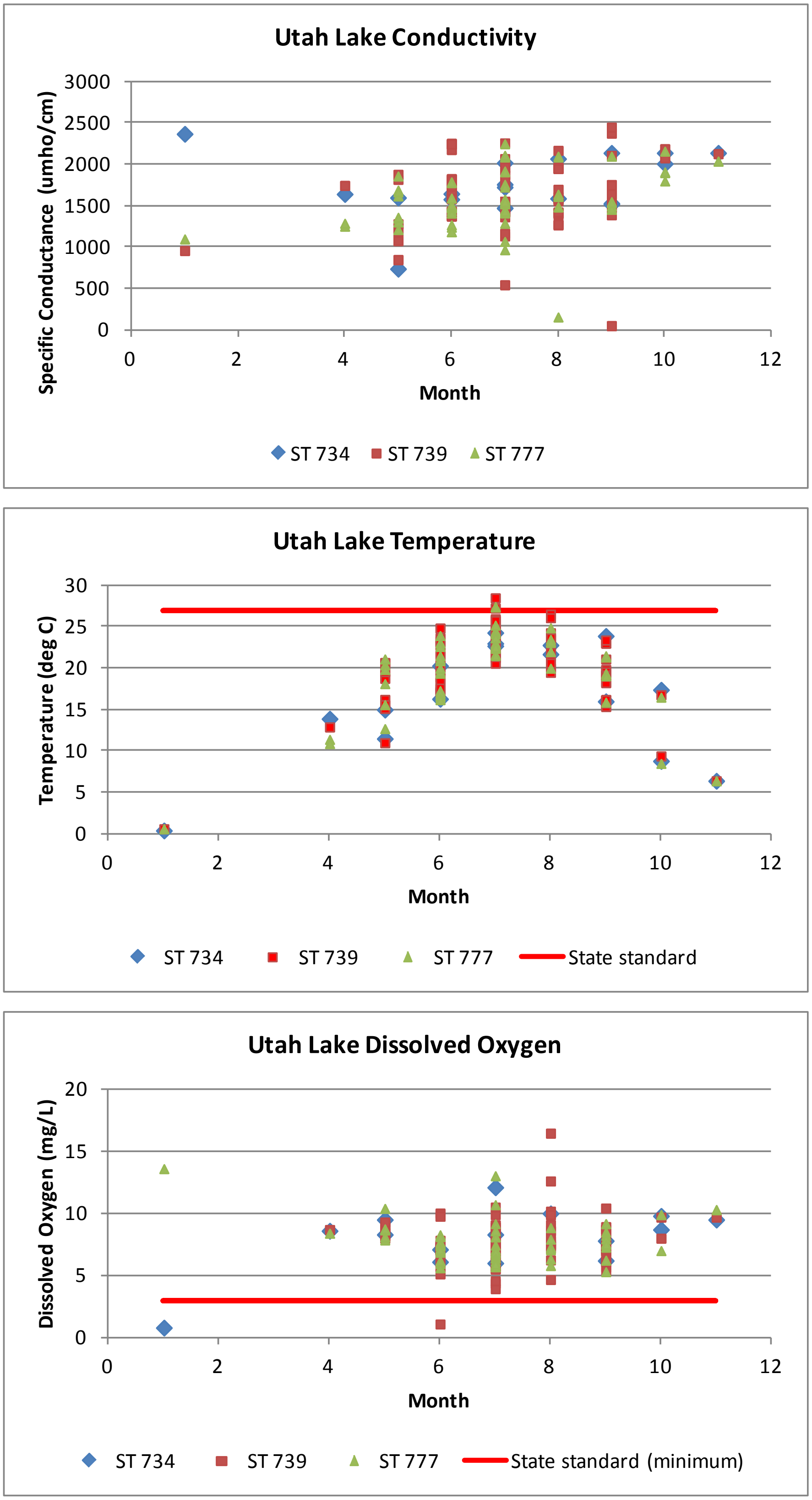

Figure 3-22. Plots of Utah Lake conductivity, temperature, and dissolved oxygen data.

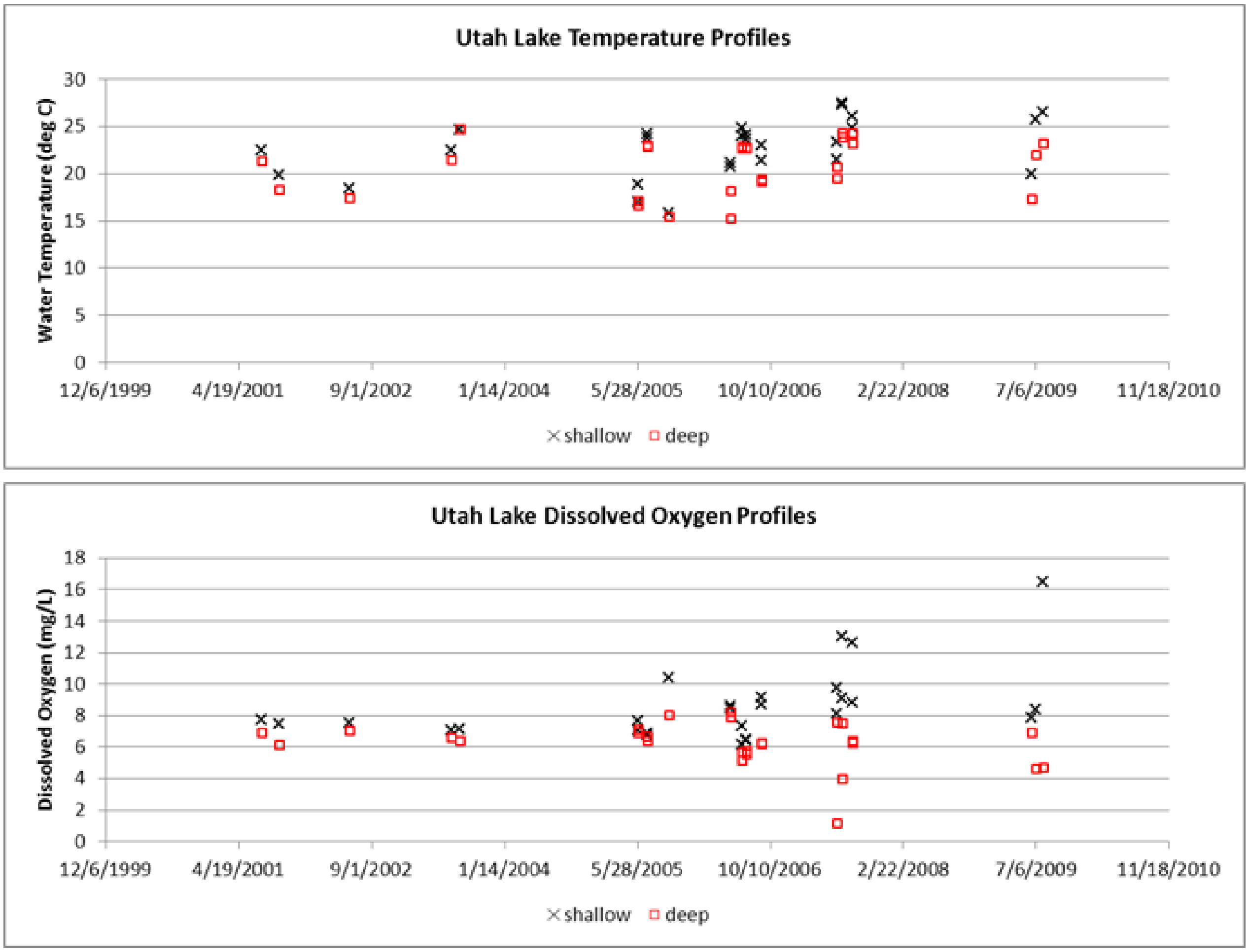

Figure 3-23. Plots of shallow versus deep temperature and dissolved oxygen data (2001–2009) for Utah Lake monitoring sites near the Provo River.

Existing and Baseline Water Quality Conditions Summary

In summary, analysis of available water quality data suggests the following:

1. Despite the fact that the hydraulic backwater effect of Utah Lake at times extends more than 1.5 miles above the mouth of the river, Utah Lake water does not appear to "backflow" up into the channel or mix with the river water. Rather than promoting mixing, the backwater effect appears to effectively "pond" the Provo River water in this channelized portion of the lake. No evidence of mixing has been observed except at station 10, located beyond the western extent of the south bank/levee of the Provo River. The leveed, relatively narrow vegetated banks of the lower river appear to keep the channel "closed" and free of exposure to wave action that would promote mixing. Strong storms might disrupt this observed pattern.

2. The water quality data collected in 2012 and 2013 indicate that groundwater inputs do not appear to be significant in the lower Provo River. The chemical "signature" (pH, conductivity, etc.) of the sampled water was very consistent along the length of channel

from the fish weir through sample station 9 near the marina. No sudden drops in water temperature or shifts in pH or conductivity that might indicate an area of groundwater input were observed. The water at the downstream sample locations (through station 9) appears to be the "same" water as at the upstream sample locations closer to Lakeshore Drive.

3. An extensive array of groundwater monitoring wells (piezometers) indicates that the lower Provo River within the study area is a losing reach during most times of the year (i.e., water surface elevations are slightly higher in the channel than adjacent wells).

4. Existing summertime water quality conditions in the lower Provo River downstream of the UDWR fish weir are poor for aquatic life due to warm water temperatures and extreme diurnal fluctuations of DO. This diurnal DO sag is likely associated with phytoplankton blooms, the daytime photosynthesis/ nighttime respiration patterns in this stagnant river/lake interface, and/or the SOD caused from deposition of silt and organic debris in this depositional reach of the river.

   The SOD study indicates that the upper portion of the lake-influenced reach has the highest SOD and that SOD decreases downstream. This finding indicates that the watershed is contributing the majority of organic matter causing high SOD and that local leaf litter is much less significant. Dissolved oxygen standards are currently not being met during extended periods of the hot summer months. Dissolved oxygen concentrations are below the lethal limits reported in scientific literature for most fish species (EPA 1988). Current conditions indicate an impairment of designated beneficial uses such as recreation, aesthetics, cold water fisheries, and warmwater fisheries. Nutrient sources causing water quality impairment are not well quantified at this time and are likely dynamically adjusting to variable inputs and/or anoxic sediments as described in the phosphorus cycle (Figure 3-11).

5. The majority of the lower Provo River and existing river/lake interface is protected by levees on both sides of the channel and lined with tall, mature trees. The water in this stagnant portion of the river/lake interface is well shaded and protected from the wind. Shade from the tall trees is a positive influence on water temperatures, but the lack of wind in the confined channel does not allow for diffusion and physical reoxygenation via wave action. Wave action would help aerate the water column.

6. Even under the most stagnant conditions modeled (high lake level, low river flow of only 10 cfs), calculated residence times for water in the lower Provo River are relatively short (less than 5 days). Even with a short residence time, the lower Provo River is currently experiencing extreme low DO sags due to a combination of high SOD during low flow and phytoplankton blooms during the hot summer months. The aerated river water in the flowing portions of the lower Provo River upstream of the UDWR fish weir does not adequately aerate the deep, stagnant water downstream of the weir, especially when flows are at their annual low levels.

7. The aeration feasibility study (Kling 2014) indicates that aeration is a viable solution to make significant water quality improvements in the lower Provo River, including meeting the State water quality standard for DO.

3.4.5 Impacts of the No-Action Alternative

No changes to the baseline water quality of Provo River or Utah Lake would occur under the No-Action Alternative. The water quality data collected in 2012 and 2013 indicate that DO concentrations in the lower 1.5 miles of the existing channel (downstream of the UDWR fish weir) may be more limiting to aquatic life than previously understood, especially for drifting larval fish that have limited abilities to escape to more oxygenated water. Lethal concentrations may be particularly damaging to June sucker recruitment potential given the fact that they occupy the river-lake interface in late spring and early summer when water quality conditions start to deteriorate. June sucker larvae drift during the night, and may collect in the stagnant low DO water during the period of the day when DO concentrations are at their lowest. During low flow periods they may get stuck in this portion of the river-lake interface for a number of days. Therefore, it is anticipated that June sucker recovery efforts would be hindered by the existing water quality problems in the channelized portions of the river-lake interface downstream of the UDWR fish weir under the No-Action Alternative.

3.4.6 Impacts of Action Alternatives on Water Quality

There are three distinct areas that need to be considered to determine impacts of action alternatives on water quality.

The three areas are as follows:

1. water quality in the existing channel,
2. water quality in the new delta (restored river-lake interface), and
3. water quality in Utah Lake proper.

Impacts on Water Quality in the Existing Channel

The three action alternatives have the same effect on water quality in the existing channel. There is a slight difference in diversion location between Alternatives A and C, and Alternative B, with Alternative B being approximately 500 feet upstream of Alternatives A and C.

The three action alternatives do not vary regarding their effects on water quality. Under any action alternative, the project would include installation and operation of an aeration system for the existing channel, and a minimum flow of 10 cfs (up to a maximum of 50 cfs) would pass by the new delta diversion and flow into and through the existing channel. The purpose of this flow would be to maintain water quality with a total residence time of less than 5 days, meaning that the entire pool of water in the existing channel would be replaced approximately every 5 days or less even under the lowest flow conditions. This instream flow combined with the aeration system would help prevent stagnant conditions in the existing channel under either of the two Options for the existing channel. Most of the flows in the Provo River would be diverted into the new channel and delta.

Water quality in the existing channel is most concerning during the hot summer months when water temperatures are warmest. Water temperatures and DO concentrations are most impaired when incoming flows drop to near zero. The aeration and minimum flows of 10 cfs would improve the existing water quality problems, especially during hot dry years like occurred in 2013. Dissolved oxygen levels would be maintained above State standards. Aeration would also reduce or eliminate blue-green algae and prevent the release of manganese, iron, nitrogen, and phosphorous from the streambed by preventing the bottom sediments from becoming anoxic.

As described previously, the water in the existing channel is not a mixture of Utah Lake, groundwater, and Provo River; the source of the water in the lower Provo River is essentially from inflow from the Provo River. The existing water density scenario would remain very similar under either Option, except for the occasional times that may occur when winds could push warmer more saline Utah Lake water east and into the existing channel under Option 1 (without a small dam). Therefore, the nutrient concentrations in lower Provo River would primarily be controlled by inflow rather than Utah Lake backwater.

The primary difference between the two existing channel options is whether the water in the existing channel is allowed to fluctuate up and down with Utah Lake as it currently does, or if a small dam would be constructed near the mouth of the existing river to stabilize the water in the existing channel at a constant elevation (or maybe within a desirable elevation range presumably between 4,489 and 4,490 feet).

Option 1: Fluctuating Water Elevations Open to Utah Lake

Under Option 1, the existing channel would be left "as is" and provided with a year-round flow as described in Chapter 2. Flows released to the existing river channel from the new delta diversion structure would vary from a minimum of 10 cfs up to 50 cfs. All peak flows, bedload sediment, most suspended sediments, and debris would be directed into the new channel and delta. Under Option 1, the connectivity (ability of fish, swimmers, boaters, and etc. to pass from the lake into the river, and vice versa) of the lower reach downstream of the UDWR fish weir with Utah Lake would not change.

The debris, suspended and bedload sediment, and pollutants associated with runoff events would be redirected into the new channel and delta. As a result, sediment, organics, and phosphorus loading would be reduced to the existing channel. With aeration and internal recycling of phosphorus from the existing fine-grained sediments (i.e., mud) and decomposing plants in the existing channel, the water quality would be expected to improve. While the aeration system is operated phytoplankton blooms would likely diminish during the hottest times of the year, and DO sags would be averted. Dissolved oxygen should remain above State standards. The aeration system would be shut down at the end of summer when it is no longer needed.

The water depth in the lower Provo River (from the UDWR fish weir downstream to Utah Lake State Park) is controlled by water surface elevations in Utah Lake. The existing confined channel causes the water in the Provo River to pond, and eventually flow into Utah Lake and mix. The colder Provo River water eventually flows under the warmer, less dense lake water, but not until the channel becomes unconfined. The south levee ends and opens to Utah Lake to the south, but even then, the existing jetty north of the river, between the river and marina, likely hinders mixing for another 1,200 feet or more.

Water elevation in Utah Lake (and subsequently in the lower Provo River) fluctuates approximately 3 feet annually, and over 10 feet over longer periods of draughts and floods (see Figure 3-5). When Utah Lake is high (4,489 feet or higher), the entire lower Provo River channel (downstream of the UDWR fish weir) is full of water up to the vegetation line. When Utah Lake gets low, the muddy banks of the existing channel become exposed, and the aesthetics of the river corridor become less desirable for fisherman and trail users, and impairs recreation such as canoeing and swimming.

Management of water levels in the existing channel different than what is occurring on Utah Lake would not be possible under Option 1. The water levels in the existing channel would follow similar annual and long term trends as shown in Figure 3-5. The ability to temporarily de-water the existing channel and make improvements to the bed and banks that could improve water quality and recreation would be extremely limited under Option 1.

Option 2: Managed Water Elevation Separate from Utah Lake

Under Option 2, a small dam would be constructed across the Provo River channel near the existing walking bridge approximately 600 feet downstream of Center Street Bridge. This location was picked because the channel and mouth of the river becomes unconfined with the termination of the south levee approximately 100 feet west of the existing walking bridge. The dam would be designed to allow for a stable water elevation of approximately 4,489 to 4,490 feet in the existing channel, with the ability to control water depths in the existing channel between this point and the upstream delta diversion structure, at an optimal elevation. The same 10 to 50 cfs would be released to the existing channel, same as Option 1.

As with Option 1, most peak flows would be directed into the new channel and delta. The debris and sediment associated with runoff events would be redirected into the new channel and delta. Sediment and phosphorus loading would be reduced as in Option 1. With the minimum flows of 10 cfs provided and the water depths maintained throughout the summer, water temperatures are expected to show minor improvement compared to what otherwise would have been extreme low flow conditions. As water temperature and DO are known to be correlated, the cooler water would in turn help improve DO concentrations. The extreme low DO concentrations associated with zero flows and stagnant conditions observed in 2013 (and many other dry years) are expected to be improved with the aeration features and established minimum flows. Water quality improvements (enhancements) due to the construction and operation of the aeration system are expected, same as Option 1.

The main difference between Option 1 and 2 is that the water elevation would be managed under Option 2, which makes a major difference in maintaining more desirable water elevations to benefit overall aesthetics for trail users, water recreation, and water quality. The graphs in Figure A-7 (Appendix A) illustrate the water surface width in the channel at various cross sections when Utah Lake is at 4,487 feet and 4,490 feet. On average, the water surface is 20 feet wider at 4,490 compared to 4,487. The average width of the water surface in the lower Provo River (downstream of the UDWR fish weir) when the water in Utah Lake is at 4,490 feet is 84 feet.

When the water elevation drops to 4,487 feet (a 3 feet drop), the average channel width is 64 feet, 24 percent narrower. This drop in water elevation leaves on average 20 feet of exposed muddy banks, ranging from as much as 60 feet on some gently sloping banks to as little as 5 feet on other steeper banks.

Water levels in the existing channel would be manageable under Option 2 as follows. First, the desired water surface elevation(s) could be determined and managed accordingly. Second, Option 2 would provide for the ability to release ponded water from the surface, bottom or a mixture, depending on what best maintains water quality in the existing channel. Third, Option 2 provides the ability to temporarily de-water the existing channel under emergency situations or to make improvements to the bed and banks that could improve water quality and recreation. And fourth, Option 2 provides the ability to better control undesirable aquatic species such as carp. Overall, Option 2 would likely provide improvements in water quality and aesthetics compared to existing and baseline conditions and Option 1. According to Kling (2014), aeration would be more effective under the Option 2 scenario as Option 2 creates deeper water with a greater residence time.

Impacts of Action Alternatives on Water Quality in the New Delta (River/Lake Interface) and Utah Lake Proper

Action alternatives are not anticipated to have long-term negative impacts on water quality in Utah Lake or the restored lower Provo River channel and delta. All proposed alternatives would likely have a positive improvement on water quality in Utah Lake on an annual basis because of the increase in wetlands and their associated filtering capabilities, floodplain connectivity, and the wetlands and riparian areas functions at the river/lake interface (Table 3-13). Currently, the existing channel is leveed on both banks, and the lake is diked throughout the study area. Most existing wetlands and floodplains are disconnected from the river and lake, and therefore do not function as a filter for sediments and associated pollutants. Wetlands and riparian forests can act as filters for and provide long term storage for sediments and other point and nonpoint sources of pollution. Turbidity, phosphorus, metals, temperature, TDS, and PCBs in fish tissue are addressed in this impacts analysis.

Table 3-13. Direct Impacts to water quality in Utah Lake Under the proposed and No-Action Alternatives.

ALTERNATIVE	WATER QUALITY ATTRIBUTES AND CONSTITUENTS				
	Connected Wetland and Riparian Forest Acres	Suspended Sediment	Total Phosphorus	Metals	PCBs[a]
No-Action	31.4	0[b]	0	0	unknown
A	443.7	++[c]	++	++	unknown
B	265.2	+	+	+	unknown
C	253.8	+	+	+	unknown

[a] Polychlorinated biphenyls.
[b] Indicates no change from baseline conditions.
[c] Indicates overall improvements associated with the filtering functions of wetlands and riparian forests.

Suspended Sediment

A short-term increase in turbidity and total suspended solids is expected when flows are initially turned into the newly constructed stream channel and delta. This impact to water quality is expected to last for no more than 1–2 days. No adverse construction-related impacts to water quality are anticipated because flows would remain in the undisturbed existing Provo River channel while the new channel and floodplain are constructed within the study area.

The new river channel would have low banks with a vegetated floodplain. Existing and predicted wetland and riparian forest areas would provide a long term reduction in suspended solid loads into Utah Lake. The delta is designed with enough room to accumulate sediments dynamically over hundreds of years. The delta plain and delta expansion zone is expected to adjust and grow over time with accumulations of coarse-grained sediments at the initial inflow area, and fine-grained sediments along the distributary channels farther west. Most alluvial sediments would deposit within the study area, east of the existing Skipper Bay dike.

Phosphorus

Under any alternative, increases in wetland acreage within the study area would reduce the amount of phosphorus entering Utah Lake. Based on available data, existing phosphorus loads in the lower Provo River are estimated to be 7.9 tons/year. Phosphorus load reductions into Utah Lake are expected to be significant under all action alternatives, ranging from 5.2 tons/year under Alternative A, and 5.1 tons/year under Alternatives B and C, approximately a 65 percent reduction Given that the existing phosphorus load estimated for the Provo River is likely an underestimate that does not fully account for peak runoff events and stormwater, the actual phosphorus reductions may be higher than estimated (more than 5 tons/year), but the percentage would likely be lower. All action alternatives would reduce phosphorus loads from Provo River to Utah Lake which is currently considered phosphorus impaired (UDWQ 2010).

Metals

Neither Utah Lake nor Provo River is impaired for metals. (UDWQ 2010). However, the proposed action alternatives would likely reduce metal loads to Utah Lake, improving overall water quality. Similar to phosphorus, the metals attached to sediments would settle out of the water column in the lower velocity wetland areas. The dissolved fraction may be biologically available and plants could uptake a portion of the dissolved metals. Dissolved metals may also bind to soil particles, also reducing the total metals load to Utah Lake (Mitsch and Gosselin 2007).

Total Dissolved Solids (TDS)

Utah Lake is currently listed as impaired for TDS. None of the proposed alternatives are expected to change the TDS loads to the lake.

Polychlorinated Biphenyls (PCBs)

It is difficult to determine the effect that implementing any of the proposed alternatives would have on PCBs in fish tissue, which is a listed impairment for Utah Lake. The source of PCBs for fish uptake is largely unknown (Wingert 2008).

3.4.7 Indirect and Cumulative Impacts

The increased surface roughness resulting from increased water-vegetation interaction during floods would cause sediment and associated nutrients to drop out and deposit on the floodplain, potentially reducing loads to Utah Lake over the long term. Each of the action alternatives includes multiple low-velocity wetland and backwater features, which would also serve as long-term nutrient "sinks." The increased acreage of marsh-type wetlands would also increase nutrient uptake relative to baseline conditions.

Deposition of sediments and organic matter is expected to occur throughout the delta over time, especially at the initial river/lake interface. Currently, this interface is narrow and deep and accumulates sediments and organic matter in a confined, deep channel. Deposition in the delta would be much different than in the existing channel, and it would not cause the same degree of water quality impairments and negative effects on young, drifting June sucker. The delta would be wide and shallow, with room for new channels to form in the event that one fills. These deltaic dynamics are important for creating and maintaining a variety of habitats, including a variety of water depths and temperatures accessible to young fish. The delta would be open to wind action and the atmospheric exchange of oxygen in the water. The unconfined and interconnected nature of the delta is expected to provide a variety of water temperatures, water depths, DO concentrations, and vegetation types available and accessible to young June sucker.

Each of the action alternatives would also increase the sinuosity and diversity of instream habitats (e.g., increased number of pools, riffles) in the lower Provo River within the study area. The resulting diversity of streambed habitats would improve conditions for benthic macroinvertebrates relative to the existing baseline conditions, potentially improving the taxa diversity of native macroinvertebrate species. Overall, the action alternatives are expected to result in improved water quality over the long term.

Trash and debris that accumulates in the existing river channel under baseline conditions would likely accumulate against the delta diversion structure or be carried into the delta with the main flow of the river. However, local sources of trash would continue to accumulate in the existing channel under either option. Utah County is expected to continue to grow, with an expected increase in trash at the mouth of the river, or in the delta under all action alternatives. Improved stormwater controls and treatment in Utah Valley would reduce the accumulation of trash in the lower Provo River/Utah Lake interface.

3.4.8 Mitigation Measures

Short-term Water Quality Impacts During Construction

Potential short-term water quality impacts associated with construction of stream channel and floodplain pond features will be mitigated through the use of appropriate stormwater and erosion-control best management practices. Most construction activities in the delta restoration portion of the project implementation area would occur prior to diverting water into the delta and prior to removal of Skipper Bay dike.

Long-term Water Quality Enhancement

The existing lower Provo River channel and corridor in the study area is used extensively by the local community for varied recreational and aesthetic activities. Poor water quality associated with low water levels has led to fish kills, odor problems, and unsightly experiences in the past, and is expected to become even more prevalent in the future as water rights purchased specifically for June sucker recovery are delivered to the new delta through the restored Provo River. Watershed contributors to poor water quality include untreated stormwater runoff, water temperature increases due to degraded riparian conditions, accumulation of sediment on the stream bottom leading to high sediment oxygen demands, and the flat gradient downstream of the UDWR fish weir that causes the river/lake interface to be stagnant. The commitment by the JLAs to provide a minimum flow of 10 to 50 cfs to the existing channel is an enhancement over baseline conditions during extreme low-flow events, under which there is no guaranteed or required minimum flow to be left in the lower Provo River channel under Utah State law or federal mandate.

However, recent experience with summertime low-flow conditions in 2012 and 2013 serve as a reminder that, even with a commitment of 10 cfs flow to the existing channel, water temperature and especially DO levels will not likely meet State standards during the hottest summer months. Therefore, as discussed in Chapter 2 Section 2.6.3, the JLAs propose to improve water quality in the existing lower Provo River channel if the proposed project is implemented. The JLAs would construct and install an aeration system in the lower Provo River channel that would be retained and managed for recreational, aesthetic and fishery uses. The aeration system would increase DO concentrations and improve water quality during the hot summer low flow months compared to existing baseline conditions. The aeration system would be intended for year-round use. Initially, it would be used to oxygenate the bottom sediments and improve conditions for beneficial microbes, which will reduce the muck layer that is currently on the channel bottom. The aeration system would then be operated as needed to maintain State water quality standards for DO. The aeration system would also reduce or eliminate blue-green algae and prevent the release of manganese, iron, nitrogen, and phosphorous from the streambed to eliminate anoxic conditions in the bottom sediments.

As a participating project under the Colorado River Storage Project Act, the Bonneville Unit of the Central Utah Project is authorized to utilize Colorado River Storage Project power for project purposes. Therefore, power for the proposed aeration facilities could be obtained from this power allocation.

Dredging the organic-rich sediment layer at the bottom of the existing channel would not likely be necessary to maintain State water quality standards for DO. However, portions of the organic-rich sediments would likely be removed during construction as the aeration system is installed. Other aesthetic and recreational improvements to the existing channel could also be made at that time. The JLAs will coordinate with Provo City, Utah County, and stakeholders in this regard during the final design phase.

The SOD study (Goel et al. 2014) indicates that the decay of organic matter from the watershed is the primary source of SOD in the lower Provo River. With implementation of the proposed project, most organic matter from the watershed would be diverted away from the existing channel and into the delta. Accumulations of both coarse and fine organic matter and sediments are anticipated in the delta. However, with enough space for the delta channels to adjust and migrate over time and with a delta that is more open to wind and the exchange of oxygen from the atmosphere, organic matter accumulations are not expected to cause the same DO problems throughout the water column and across the entire delta that occur in the existing channel.

The JLAs recommend that State and local governments and organizations develop a task force/study group to investigate sources of fine organic matter, nutrients, and other pollutants in the watershed that may degrade water quality conditions in the lower Provo River. The JLAs would participate with and support the efforts of such a group if it is formed.

3.4.9 Water Quality Summary

Recent water quality monitoring in the lower Provo River indicates that existing summertime water-quality conditions on the lower Provo River are poor for aquatic life due to low concentrations of DO during summer, when lake levels and river flow levels are at their lowest. Dissolved oxygen standards are currently not being met during extended periods of the hot summer months. In 2013 DO concentrations were below the lethal limits published in the scientific literature and State water quality standards for most fish species. Current conditions indicate an impairment of designated beneficial uses such as recreation, aesthetics, cold water fisheries, and warmwater fisheries. Measures for improving water quality in the existing channel (minimum instream flows and aeration of the water column) are included as part of the proposed action. The JLAs will continue to pursue additional measures, if needed, to meet these objectives.

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3.5 Wetlands

Wetlands and other "waters of the U.S." are regulated by the Corps under Section 404 of the Clean Water Act, and Executive Order 11990 directs federal agencies to take actions to minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands in carrying out agency responsibilities. Overall, the proposed action would enhance natural and beneficial acres and values of wetlands, as illustrated in the analysis included in this section of the EIS. The JLAs anticipate that the project will be permitted under a Nationwide Permit 27 for aquatic habitat restoration, establishment, and enhancement activities. Reasoning for permitting this project under a Nationwide Permit 27 is provided in Section 3.5.10. Due to the requirements of Section 404 Permitting the JLAs completed a wetland delineation for the study area and invited the Corps to become a cooperating agency in completing this EIS.

3.5.1 Issues Addressed in the Impact Assessment

Issues addressed in this section are concerned with wetlands as defined by Cowardin et al. (1979) and jurisdictional wetlands regulated under Section 404. Wetlands within the study area were assessed by type for acreage and for overall functionality in their existing condition as well as in their post project condition for each alternative and the No-Action Alternative. This was accomplished by modeling projected wetland changes using existing topography and historic lake levels combined with restoration features.

Study area wetlands were assessed by the following:

- coordinating with the Corps to obtain a preliminary jurisdictional determination of existing wetlands;
- obtaining existing wetland delineation data for locations within the study area that have been completed by other entities;
- utilizing elevation and hydrologic data in combination with conceptual project designs to predict changes in wetland types (estimated acres by type) for each alternative; and
- completing wetland functional assessments, in consultation with the Corps, the USFWS, and the UDWR.

3.5.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues that were raised related to wetlands were eliminated from further analysis in this EIS. Other sections of this document are related to and dependent upon the assessments made in this section including 3.7 (Fishery Resources), 3.8 (Wildlife Resources), 3.9 (Threatened and Endangered Species) and 3.16 (Public Health and Safety).

3.5.3 Area of Influence

The study area boundary was considered the area of influence for wetland impacts, with consideration of the Utah Lake watershed for cumulative effects.

3.5.4 Affected Environment (Baseline Conditions)

Soils

A field examination of soils was performed during study area visits to delineate wetlands. The Web Soil Survey (NRCS 2010) map of the study area was reviewed and used as a reference while on site. Fourteen soil types were identified within the study area (Table 3-14). All study area soils defined by the Natural Resources Conservation Service (NRCS) are listed as hydric soils. This means that study area soils were formed within lacustrine sediments and/or in association with alluvial deposits (NRCS 2010). The study area soils are also illustrated on Figure A-17 (Appendix A).

Table 3-14. Study area soils.

MAP SYMBOL	MAP UNIT NAME	HYDRIC SOIL	FORMED	REGIONAL OCCURRENCE	FARMLAND CLASSIFICATION
Br	Bramwell silty clay loam	Yes	silty alluvium and lacustrine sediments	moderately extensive	farmland of statewide importance
Bs	Bramwell silty clay loam, drained	Yes	silty alluvium and lacustrine sediments	moderately extensive	farmland of statewide importance
Ck	Chipman silty clay loam	Yes	lacustrine sediments	moderately extensive	prime farmland if irrigated
Cm	Chipman silty clay loam, moderately deep water table	Yes	lacustrine sediments	moderately extensive	farmland of statewide importance
Cn	Chipman silty clay loam, moderately saline	Yes	lacustrine sediments	moderately extensive	farmland of statewide importance
CU	Cobbly alluvial land	Yes	alluvium	N/A	not prime farmland
Hr	Holdaway silt loam	Yes	lacustrine sediments	limited	farmland of statewide importance
Lo	Logan silty clay loam	Yes	alluvium and lacustrine sediments	moderately extensive	not prime farmland
Mh	McBeth silt loam	Yes	stratified alluvium	limited	prime farmland if irrigated
Mn	McBeth silt loam, moderately saline	Yes	stratified alluvium	limited	prime farmland if irrigated
MU	Mixed alluvial land	Yes	alluvium	N/A	not prime farmland
Pf	Peteetneet peat	Yes	lacustrine	limited	not prime farmland
Pg	Peteetneet-Holdaway complex	Yes	lacustrine	limited	not prime farmland
BC	Beaches	Yes	beach deposits	limited	not prime farmland
W	Water	N/A	open water	N/A	not prime farmland

Source: NRCS 2010.

The more agriculturally productive loam soils are generally located in the southern and central portions of the study area, while peat soils are found to the east and north. Peat soils within the study area were formed as dead marsh vegetation was deposited into standing water on the edge of Utah Lake. Anaerobic conditions within the marsh kept the organic matter from fully decaying. This organic matter deposition accumulated over thousands of years. In recent decades, these soils have become generally dryer and degraded due to construction of river levees, lake dikes, and pumping, but are still capable of supporting rare wetland vegetation communities primarily in areas surrounding springs and seeps. In particular, raised peat mounds are identified in the wetland delineation and described in detail below.

Characteristics of Peat Wetlands in the Study Area

Significant areas of the eastern and northern parts of the study area soils are designated Peteetneet series peat soils by the National Cooperative Soil Survey (NRCS 2011). The soil mapping (Appendix A, Figure A-17) appears to be accurate based on numerous visits to the study area by BIO-WEST, Inc. (BIO-WEST) scientists between 2010 and the present. Peat wetlands are defined as wetlands with waterlogged substrates and at least 30 centimeters of peat accumulation (Bursik and Moseley 1992). As described in a statement regarding the wise use of peatlands by the International Peat Society and International Mire Conservation Group (2002a), peat wetlands "are important ecosystems for a wide range of wildlife habitats supporting important biological diversity and species at risk, freshwater quality and hydrological integrity, carbon storage and sequestration, and geochemical and paleo-archives" (International Peat Society and International Mire Conservation Group 2002a). Numerous wetland types can occur within peat wetlands, including fens and bogs (Chadde et. al. 1998).

The existing study area peat wetlands have been impacted by numerous hydrological alterations such as drainage ditches, diking, and annual mechanical pumping to prevent natural spring flooding. These areas are also impacted by cattle grazing. In the study area, a number of raised peat mounds are located within the greater area of peat wetlands. These mounds generally exhibit upwelling groundwater at the highest point in the center of the mound (even when the adjacent surrounding peat wetlands are dry) and a relatively diverse herbaceous plant community. In some cases the mounds provide habitat and support existing populations of the federally listed threatened Ute ladies'-tresses orchid (*Spiranthes diluvialis*). Due to the rarity of peat wetland habitats, including the raised peat mounds and the species they support, special consideration is warranted when considering impacts to these communities.

There has been very little, if any peer review of and cited research conducted on the peat wetlands surrounding Utah Lake. This, in conjunction with the existing anthropogenic hydrology modifications within study area peat wetlands, makes it difficult to classify the raised peat mounds within the study area as fens, bogs, or both. The U.S. Forest Service describes a fen as a concave to slightly raised peatland area that receives nutrients from groundwater or runoff from uplands flowing into a surface water source such as a creek that then enters the fen, whereas ombrotrophic or true bogs have a raised or convex surface and receive water and mineral nutrients from precipitation only (Chadde et. al. 1998). The raised peat mounds within the study area do not entirely meet the criteria of either description above because the primary water source is currently groundwater (like a fen), but the mounds exhibit a significantly raised convex surface area (like a bog). Additionally, prior to the anthropogenic hydrology alterations of the mid-20th century, the raised peat mounds would have been inundated by Utah Lake during high water events. The raised peat mounds located within the study area are surrounded by a larger area of peat wetlands that is reliant on surface water. This area has been hydrologically altered by diking, ditching, draining, and pumping to dry the area for grazing. Due to the overlapping characteristics of study area peat wetlands and their primary reliance on either groundwater, surface water, or both, restoration efforts will consider known techniques for fens, bogs, and peat wetlands in general.

The National Cooperative Soil Survey description of the Peteetneet soil series recounts the peat soil layer thickness over mineral soil ranging from 3 feet to over 6 feet deep (NRCS 2010). It is estimated that in temperate climates peat accumulates at a rate of approximately 2 centimeters/0.8 inch per century (Bursik and Moseley 1992). Given the existing Peteetneet soil thickness range of 3 feet to over 6 feet, the peat wetlands within the study area have likely taken between 4,500 and 9,000 years to reach current thickness. This estimate makes sense since Lake Bonneville drained a little over 10,000 years ago. The peat wetland formative processes would have included the variable levels of annual inundation by Utah Lake prior to mid-20th century anthropogenic hydrology modifications that continue to affect water elevations in the study area. The drainage of peat wetlands can cause subsidence or lowering of the soil surface (International Peat Society and International Mire Conservation Group 2002b). It is likely that the hydrologically altered peat wetlands within the study area has subsided significantly due to drying of the peat soils and cattle overgrazing and trampling. The raised peat mounds have not subsided to the same extent due to the continued influence of the upwelling groundwater providing continuous wetted conditions for the peat soils. Based on observations by BIO-WEST scientists, it appears that the peat soils within the study area are primarily sedge peat formed by vegetation growth flooded by surface water and not Sphagnum peat. This conclusion is supported by the existing vegetation communities of sedges and rushes. The Peteetneet soil series description includes a native vegetation community composed of sedges, cattails (*Typha latifolia*), rushes, and other water-loving plants (NRCS 2010).

The existing literature describing the formation and/or restoration of peat wetlands, including bogs and fens, revolves around the presence of water and the restoration of site hydrology if the peat wetland has been drained. Draining and dewatering have been described as the main threats to peat wetlands, including bogs and fens, which may be intentionally dewatered to mine peat fuel, enable grazing, or facilitate cultivation, particularly for forestry (Bursik and Moseley 1992, Joosten and Clarke 2002). Cooper et al. (1998) states that fens in the central and southern Rocky Mountains are extremely sensitive to hydrologic changes; fens in this region do not appear to be sustainable under the drought conditions produced by ditches, water diversions, or groundwater pumping, all of which would lower water tables. Heathwaite et al. (1993) describes water as the single most important factor in the raised bog environment and playing a critical role in its formation.

<u>Wetland Delineation</u>

Study area wetland acreages are summarized in Table 3-15 and illustrated in Appendix A, Figure A-18. These wetlands have been delineated through a number of separate efforts, including the Provo City wetland mitigation site delineated by K.A. Smith Consulting, Inc. and the Provo Lakeshore Parkway and Trail corridor delineated by SWCA, Inc. Two delineation reports were prepared by BIO-WEST for the JLAs and submitted to the Corps for verification. The first of these was verified by the Corps with a Preliminary Jurisdictional Determination on February 23, 2012, and the second was verified September 23, 2013. The following text provides a brief description of each study area wetland type. All of the wetlands within the study area have been

Table 3-15. Existing study area wetlands.

WETLAND TYPE OR FEATURE	EXISTING ACRES
Wet meadow (diked, ditched, and actively pumped)	102.4
Emergent marsh (diked, ditched, and actively pumped)	84.5
Emergent marsh (phragmites dominant)	38.7
Emergent ditch	7.9
Wet meadow/emergent marsh complex (ditched and actively pumped)	50.4
Saline wet meadow (diked, ditched, and actively pumped)	4.5
Raised peat mounds (diked and actively pumped)	11.4
Forested wetland/riparian shrubland (diked and actively pumped)	4.2
Total wetland acres	304.0

hydrologically altered through some combination of diking, draining by ditches, and draining by mechanical pumping and discharge into Utah Lake.

Wet Meadow

Wet meadows within the study area are hydrologically supported by a seasonally high groundwater table that does not normally drop below 12 inches of the ground surface. The wet meadows within the study area are grazed, mowed, or hydrologically altered for agricultural practices. Hydrologic alterations to the wet meadow include isolation from Utah Lake by the Skipper Bay dike, draining by ditches, and draining and drying by mechanically pumping water out of the wetlands during the growing season.

A portion of the wet meadow in the northeastern corner of the study area can be further classified as hydrologically altered peat wetlands due to the presence of the previously mentioned peat soils. Peat wetlands exhibit anaerobic, acidic, and nutrient-poor conditions that lead to the extensive accumulation of partially decayed organic matter (Chadde et al. 1998). The unique suite of environmental factors present within peat wetlands can support rare plant species that are specially adapted to survive under these conditions (Conservation Data Center 1992). The hydrologic alteration of the study area peat wetlands has resulted in drier conditions than those under which the peat soils formed. The decreased flooding and increased aeration of peatland soils results in increased rates of vegetation decomposition, preventing the formation of new peat soils. The drainage of peat wetlands can also cause subsidence or lowering of the soil surface (International Peat Society and International Mire Conservation Group 2002b). It is likely that the hydrologically altered peat wetlands within the study area have subsided significantly due to drying of the peat soils as well as overgrazing and trampling by cattle. Rates of subsidence of altered peat wetlands vary geographically and according to the degree of hydrologic alteration, but one study measured rates of subsidence in temperate zone study sites ranging from 0.2 to 2 inches per year (Lucas 1982). A rate of 0.2 inch of annual subsidence applied to the study area during approximately 60 years of hydrologic alterations equals a total soil subsidence rate of approximately 1 foot. In addition, heavy grazing, which is apparent from field observations, has the effect of reducing available organic matter for peat formation.

Species present within the study area wet meadows include Nebraska sedge (*Carex nebrascensis*), common ragweed (*Ambrosia artemisiifolia*), Arctic rush (*Juncus arcticus*), chairmaker's bulrush (*Schoenoplectus americanus*), redtop (*Agrostis gigantea*), spikerush (*Eleocharis* spp.), common paintbrush (*Castilleja exilis*), reed canarygrass (*Phalaris arundinacea*), Nuttall's sunflower (*Helianthus nuttallii*), scratchgrass (*Muhlenbergia asperifolia*), pickleweed (*Salicornia rubra*), and saltgrass (*Distichlis spicata*). Wet meadow portions of the study area total approximately 102.4 acres.

Emergent Marsh

Emergent marsh areas within the study area are hydrologically connected to the groundwater table and historically exhibited surface water connections to the Provo River and Utah Lake. It is common for these areas to be inundated with several feet of water in spring and early summer. These areas serve ecological functions similar to wet meadow environments; however, they provide additional benefits to aquatic species for longer periods due to prolonged saturation and inundation. Emergent marshes are found inside the flood-control dike and also outside the dike within Utah Lake. The areas inside the dike are grazed, mowed, or hydrologically altered for agricultural practices. Hydrologic alterations to the emergent marsh include isolation from Utah Lake by the Skipper Bay dike, draining by ditches, and draining and drying by mechanically pumping water out of the wetlands during the growing season. Parts of the emergent marsh in the northeastern corner of the study area can be classified as hydrologically altered peat wetlands. As with the wet meadow peat wetlands, these areas have subsided due to grazing and hydrologic alterations.

Typical wetland plant species present in emergent marsh areas include hardstem bulrush (*Schoenoplectus acutus*), chairmaker's bulrush, cattail, and common reed (*Phragmites australis*). Approximately 38.7 acres of emergent marsh located on the lake side of Skipper Bay dike were dominated by common reed at the time the wetland delineation was completed. Common reed is an invasive emergent weed that is conventionally referred to by its genus, *Phragmites*. Treatment efforts to control this weed throughout Utah Lake have subsequently been implemented by Utah County and were ongoing when this EIS was drafted. Other emergent marshes in the study area total 84.5 acres.

Emergent Ditch

Ditches within the study area convey water away from study area wetlands within the diked area for agricultural purposes and currently support emergent vegetation. Vegetation within the ditches includes emergent species such as hardstem bulrush, cattail, and phragmites. Emergent ditches in the study area may have stagnant water for long periods, resulting in poor water quality. Nonnative fish have also been observed within the ditches. The emergent ditches within the study area are maintained by the landowners to remove emergent vegetation and sediment and improve drainage capacity. The maintenance schedule varies; some ditches are maintained annually and others less frequently. The emergent ditch community represents 7.9 acres of wetland within the study area.

Wet Meadow/Emergent Marsh Complex

This mixed classification was used for a portion of the study area (50.4 acres) where wet meadow and emergent marsh exist in a patchwork that could not be spatially distinguished in a practical manner. Hydrologic conditions in this area are influenced by a combination of anthropogenic factors including dikes and levees, agricultural drainage ditches, and the incised condition of the Provo River. Historically, these and other study area wetlands would have been inundated seasonally by the Provo River and/or Utah Lake more frequently and for longer duration than is presently the case. Reduced inundation, combined with agricultural drainage and pumping, has degraded these wetlands and caused a transition to drier site conditions.

A portion of the wet meadow/emergent marsh complex wetlands can be further classified as hydrologically altered peat wetlands due to the presence of the previously mentioned peat soils. This area has subsided due to grazing and hydrologic alterations. The peat wetlands contain a mixture of emergent species in the wet meadow and the emergent marsh wetland communities.

Saline Wet Meadow

A small portion of the study area (4.5 acres) was delineated as a saline wet meadow. This small wetland is hydrologically connected to the groundwater table and was likely historically connected to Utah Lake. Hydrologic alterations to the saline wet meadow include isolation from Utah Lake by the Skipper Bay dike, draining by ditches, and draining and drying by mechanically pumping water out of the wetlands during the growing season. The plant community is dominated by herbaceous vegetation capable of tolerating above-average salinity levels. Species present include saltgrass, red swampfire (*Salicornia rubra*), five horn smotherweed (*Bassia hyssopifolia*), and marshland goosefoot (*Chenopodium rubrum*). This wetland was likely a lacustrine fringe marsh prior to construction of the Skipper Bay dike. Saline wet meadow represents 4.5 acres of wetland within the study area.

Forested Wetland/Riparian Shrubland

Five relatively small patches of wooded wetlands were identified, totaling 4.2 acres. The dominant vegetation observed in these patches consisted of eastern cottonwood (*Populus deltoides*), rough cocklebur (*Xanthium strumarium*), and water sedge (*Carex aquatilis*), along with common spikerush (*Eleocharis palustris*), arctic rush, and lambsquarters (*Chenopodium album*). The disturbance level for these areas was high due to heavy grazing and adjacent drainage ditches. With the exception of a small patch of forested wetland just east of the Lakeshore Drive bridge, the majority of the riparian forest surrounding the existing Provo River corridor is an upland plant community. These upland riparian communities are described and evaluated in Section 3.6.

Raised Peat Mounds

About 11.4 acres of study area wetlands were delineated as raised peat mounds. These unique, raised wetland features have formed over upwelling springs. The raised peat mounds exhibit a soil surface elevation ranging 1 foot or less to 3 feet higher than the surrounding landscape. This raised condition, which would have developed slowly over a very long historic period, is the result of partial decomposition of the dense annual emergent vegetation growth supported by the upwelling springs and Utah Lake floodwaters. Like other study area wetlands, these features have been hydrologically altered in more recent times by agricultural drainage and the construction of the Skipper Bay dike. Raised peat mounds outside the Provo City Wetland

Mitigation Site are grazed and exhibit a vegetation community similar to the wet meadow/emergent marsh complex; consequently, other degraded raised peat mounds may exist in the study area but were not apparent under existing conditions when wetland delineation field investigations were conducted. As discussed earlier, the surrounding peat wetlands have likely subsided due to hydrologic alterations (drying), making it difficult to determine the height to which the existing peat mounds would have been raised above the surrounding peat wetlands under natural saturated conditions. The raised peat mounds are primarily located along the historic shoreline of Utah Lake, which is the eastern side of the study area. The location of the raised peat mounds is due to the fact that they formed in conjunction with the natural annual flooding cycles of Utah Lake over the course of thousands of years.

3.5.5 Impacts of the No-Action Alternative

If no action alternative was implemented, existing study area wetland types would likely remain in a condition similar to the existing condition, assuming that pumping and maintenance of drainage ditches continues at current levels and the existing levees and dikes that protect the area from being flooded are maintained at current elevations. Agricultural drainage, farming, grazing, and associated hydrological alteration would likely continue for the reasonably foreseeable future, assuming that favorable economic conditions persist for livestock supported by pumping and ditch maintenance. If the pumping and draining of study area wetlands were stopped and no management was implemented, it is likely that the majority of the wetlands would be converted to a degraded emergent marsh confined by dikes and dominated by phragmites.

3.5.6 Impacts of Action Alternatives

Though action alternatives would not directly alter wetlands outside of the area acquired for the project, for consistency and assessment of indirect and cumulative effects, the same baseline study area was used to evaluate all action alternatives. This was the baseline study area described at the beginning of this chapter, which includes the existing river channel. A functional analysis of existing and predicted wetlands was also performed. Under any of the alternatives, total wetland area and function would increase as a result of restoring natural hydrology, vegetation structure, composition, and nativity. Existing wetlands currently dominated by nonnative or weedy species would be converted to wetlands dominated by native vegetation. Nonnative and invasive vegetation seed sources would be reduced through active treatment described in the Vegetation Management Plan (Appendix B). The discussion below provides a complete description of predicted wetland types and the wetland functional assessment.

Predicted Wetland Types

To quantify anticipated changes to the existing wetlands, each project alternative was modeled to predict the post-project condition of the wetland community using the following criteria:

- ground surface elevation less than 4,482.8 feet = deep water (5 or more feet below average lake elevation during growing season)

- ground surface elevation 4,482.8–4,485.8 feet = lacustrine vegetated aquatic bed (2–5 feet below average lake elevation during the growing season)

- ground surface elevation 4,485.8–4,489.5 feet = emergent wetland (2 feet below–1.7 feet (18 inches) above average lake elevation during the growing season)

- ground surface elevation 4,489.5–4,491.0 feet = riparian forest (associated with the restored Provo River channel and restored lakeshore areas above 4,489.5 feet)

- ground surface elevation greater than 4,491.0 feet = upland (all areas greater than 3 feet above average lake elevation during the growing season)

Lacustrine vegetated aquatic bed is a wetland type that is not currently present within the study area but is predicted to occur following restoration implementation. This wetland classification is from the *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin 1979). The specific classification of the restored lacustrine vegetated aquatic bed would be Lacustrine, Littoral, Aquatic Bed, Rooted Vascular, with a Water Regime Modifier of Intermittently Exposed. This type of wetland can be described as a shallow-water, vegetated wetland within the zone of influence of a freshwater lake that is dominated by submerged aquatic vegetation, with surface water present throughout the year except in years of extreme drought.

The analysis of predicted wetland response was accomplished by comparing baseline Utah Lake surface elevations using the Utah Lake Drainage Basin Water Delivery System (ULS) EIS proposed action hydrology for Utah Lake, as described in the hydrology section of this EIS (Section 3.2), and LiDAR elevation data. Baseline lake water surface elevation data from 1949 to 1999 determined from the ULS EIS (CUWCD 2004) indicates that during the growing season (April through October only), Utah Lake has a 50 percent probability of having a water surface elevation of 4,487.8 feet or higher. This lake surface elevation was compared with the existing study area ground surface elevations from the LiDAR survey to predict water levels and wetland types after dike modifications are made. This analysis assumed that surface water and groundwater levels (the general water table) within the property acquisition boundary for any of the alternatives could be directly represented by Utah Lake water surface elevations if the dike were modified. It is recognized that this assumption does not hold true in specific areas immediately surrounding various springs and seeps located along the eastern and northern portions of the study area. Water flow in the study area natural springs and seeps will not be changed.

In addition to using the lake level analysis, the preliminary channel design was overlaid onto wetland maps to predict wetland response in the restored riparian corridor and delta. Predicted wetland features located higher than the 4,489.5-foot contour are attributed to riverine corridor restoration and the associated overbank flooding of the Provo River, and the dynamic natural maintenance of riparian-wetland habitats. Two cover types were assumed to exist within the main channel above the 4,489.5-foot contour, riverine deep water and riverine wetland. These types were represented spatially by buffering the designed channel lines at the appropriate widths to obtain the cover types. Channels located below 4,489 feet are predicted to become lacustrine vegetated aquatic bed due to the influence of the lake on flow velocities and vegetation growth. Proposed oxbow ponds were assumed to contain deep water, lacustrine aquatic bed, and emergent marsh habitats. The digitized pond design buffers were created to represent nonoverlapping cover types, each representing approximately one third of the total pond area.

The proposed action design assumes the development of a mixed riparian forest, wet meadow, and upland grassland complex within the floodplain of the proposed channel's meander area. The width of this floodplain is expected to be approximately 800 feet wide, and to extend down to an elevation of 4,489.5 feet, where wetland habitat becomes dominated by lake hydrology. The channel lines and pond polygons within this corridor were buffered 400 feet on either side and acreages were calculated to obtain an area of the expected riparian forest, wet meadow, and upland grassland communities. The analysis also assumes the natural recruitment of riparian vegetation on the restored shoreline at an elevation band of 4489.5–4491.0 feet as seed is deposited on the lake shore.

Using the procedures outlined above, it was assumed that areas exhibiting greater than 5 feet of standing water throughout the growing season would develop into deep-water communities that would not support rooted vegetation. Areas exhibiting standing water between 2 and 5 feet deep during the growing season would develop rooted, submerged, aquatic vegetation communities, described here as lacustrine vegetated aquatic bed. Areas within an elevation range of 4,485.8 and 4,489.5 are classified as emergent wetlands. These areas would contain a complex of shallow, permanently flooded emergent wetlands, seasonally flooded emergent wetlands, and saturated but infrequently flooded emergent wetlands. Other factors that would likely contribute to post-restoration hydrologic conditions of emergent wetlands include the degree to which the peat wetlands rise when saturated by Utah Lake and Provo River overbank flooding and the location of the wetlands in relation to new Provo River channel alignments. The emergent wetlands were lumped together into one type because the factors described above make it difficult to accurately predict the exact nature of the post-restoration hydrology regime in these areas. Areas located above the 4,489.5-foot contour and exhibiting a groundwater table deeper than 1 foot below the ground surface throughout the growing season were assumed to remain as uplands. Areas above the 4,489.5-foot contour could still be classified as wetlands due to overbank Provo River flooding. The characteristics of all current and potential future associated wetland types are summarized in Table 3-16. Associated riparian characteristics are described and evaluated in Section 3.6.

Table 3-17 summarizes the predicted change in acreage of each wetland type under each of the action alternatives; figures illustrating predicted study area wetlands for each of the action alternatives are included with the subsequent assessments for each alternative. Table 3-18 presents the predicted wetland acreage creation summary by alternative and the impacts to wetlands due to the placement of fill material and subsequent conversion to uplands and the conversion of wetland to deep-water pond habitat.

Wetland Functional Assessment

The Utah Department of Transportation (UDOT) Wetland Functional Assessment Method (USU 2006) was used to classify the existing study area wetland conditions and to predict post-project wetland functions under the action alternatives. Use of this method for the EIS was approved by the Corps and required input from the USFWS and UDWR; a complete summary of the functional assessment and the required consultation and coordination is provided in Appendix D.

Table 3-16. Existing and predicted wetland characteristics.

EXISTING AND PREDICTED WETLAND TYPES	IDENTIFYING CHARACTERISTICS
Riverine wetland	Outer one-third of river channel width from first river branch downstream to 4,489 feet
Emergent wetland	Inundated or soil saturated during the growing season, includes a complex of permanently flooded shallow emergent wetlands, seasonally flooded emergent wetlands, and infrequently flooded saturated emergent wetlands depending on topography, soil type, and lake and river levels.
Emergent marsh (diked, ditched, and actively pumped)	Commonly inundated with several feet of water during the growing season, actively ditched and pumped to allow for maximum grazing potential. Diked off from the influence of Utah Lake to keep in a drier-than-normal condition.
Emergent marsh (phragmites dominant)	Inundated during the growing season and dominated by phragmites.
Wet meadow/emergent marsh complex (ditched and actively pumped)	Wetland complex with variable groundwater and surface water depths that supports emergent wetland vegetation. Drained by ditches and active pumping to keep the area as dry as possible during the growing season to allow grazing.
Lacustrine vegetated aquatic bed[a]	Inundated with 2–5 feet of water during the growing season at a lake elevation of 4,487.8 feet, supports rooted, submerged aquatic vegetation
Wet meadow (diked, ditched, and actively pumped)	Actively pumped to prevent flooding, soils saturated within 12 inches of the surface during the growing season. Diked off from the influence of Utah Lake to keep in a drier-than-normal condition.
Raised peat mound	Mounded peat wetland above an upwelling spring influenced naturally by Utah Lake flood cycles.
Raised peat mounds (diked and actively pumped)	Diked off from the influence of Utah Lake to keep in a drier-than-normal condition. Drained by ditches and pumping.
Saline wet meadow (diked, ditched, and actively pumped)	Actively pumped to prevent flooding, soils saturated within 12 inches of the surface during the growing season. Diked off from the influence of Utah Lake to keep in a drier-than-normal condition. Agricultural drainage pools here and evaporates, creating high soil salinity dominated by high-salinity-tolerant emergent vegetation.
Forested wetland	Wetland dominated by mature riparian trees
Forested wetland/riparian shrubland (diked and actively pumped)	Actively pumped to prevent flooding. Diked off from the influence of Utah Lake to keep in a drier-than-normal condition.

[a] Not currently present but predicted to be present under all but the No-Action Alternative.

The existing wetlands were divided into wetland assessment areas based on existing conditions as described in the UDOT manual. The wetland assessment areas were classified by type and scored using the specific criteria described for that wetland type. The post-project predicted wetland conditions were analyzed using the UDOT Wetland Functional Assessment Method to estimate the changes in the levels of wetland functions. For this analysis it was assumed that the post-project predicted wetlands (as previously described in the predicted wetlands analysis) would result in significant increases in several different function variables. These assumptions included increased threatened and endangered species habitat, improved plant community composition, low levels of disturbance, improved wildlife habitat, and increased water storage capabilities. The results of the functional unit change by alternative are summarized in Table 3-19.

Table 3-17. **Predicted changes in landscape classes by alternative.**

LANDSCAPE CLASSES	BASELINE (EXISTING) CONDITIONS (Acres)	ALTERNATIVE A		ALTERNATIVE B		ALTERNATIVE C	
		Acres	Change (Acres)	Acres	Change (Acres)	Acres	Change (Acres)
Wetland Landscape Classes							
Natural-Functioning Wetlands (no hydrologic alterations, naturally influenced by Utah Lake and the Provo River)							
Emergent wetland	0	404.0	+404.0	258.0	+258.0	253	+253.0
Forested wetland	0	4.2	+4.2	4.2	+4.2	0.6	+0.6
Raised peat mound	0	11.4	+11.4	11.4	+11.4	0.8	+0.8
Riverine wetland	0	2.4	+2.4	0.2	+0.2	1.1	+1.1
Lacustrine vegetated aquatic bed	0	35.7	+35.7	28.9	+28.9	22.2	+22.2
Phragmites dominant emergent marsh	38.7	0	-38.7	0	-38.7	0	-38.7
Natural wetlands (subtotal)	**38.7**	**457.7**	**+419.0**	**302.7**	**+264.0**	**277.7**	**+239.0**
Percent change to natural wetlands	**-**	**-**	**+1,083%**	**-**	**+782%**	**-**	**+618%**
Altered Wetlands (hydrologic alteration by dike, ditch and/or pumping)							
Emergent marsh	84.5	3.0	-81.5	4 .0	-80.5	67.5	-17.0
Ditch (emergent)	7.9	0	-7.9	0	-7.9	4.0	-3.9
Raised peat mound	11.4	0	-11.4	0	-11.4	10.6	-0.8
Wet meadow	102.4	18.0	-84.4	18.0	-84.4	49.3	-53.1
Saline wet meadow	4.5	0	-4.5	4.5	0	0	-4.5
Wet meadow/ emergent marsh complex	50.4	0	-50.4	0	-50.4	46.4	-4.0
Forested wetland	4.2	0	–4.2	0	-4.2	3.6	-0.6
Altered wetlands (subtotal)	**265.3**	**21.0**	**-92%**	**26.5**	**-90%**	**181.3**	**-32%**
Wetlands total[a]	**304.2**	**478.7**	**+174.6**	**329.2**	**+25.2**	**459.1**	**+154.9**
Percent change in wetland acreage	**-**	**-**	**+57%**	**-**	**+8%**	**-**	**+51%**
Water and Upland Landscape Classes							
Riverine	29.1	34.8	+5.7	34.5	+5.4	34.5	+5.4
Deep water (ponds)	0	4.6	+4.6	3.6	+3.6	3.2	+3.2
Upland riparian forest	21.8	55.7	+36.6	38.5	+19.4	46.4	+27.3
Other upland forested	0	5.7	+5.7	6.2	+6.2	8.1	+8.1
Non-forested upland	352.9	128.5	-227.4	296.0	-83.4	156.7	-196.2
Total study area acres	708.0	708.0	–	708.0	–	708.0	–

[a] Subtotal and total acres and acreage changes were calculated in a spreadsheet before rounding and may not exactly match totals and acreage changes for the rounded numbers shown in this table.

Table 3-18. Wetland impact summary.

IMPACTS	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
Wetlands filled and converted to uplands[a]	0	0.5	1.6
Wetlands converted to deep water ponds[b]	1.1	3.6	0
Uplands converted to wetlands	+175.6	+29.4	+156.7

[a] Alternative B fills 0.87 acre of altered wet meadow, and 0.37 acre of the toe of slope fill will revert to wetland for a net wetland conversion to upland of 0.5 acre. Alternative C fills a total of 1.6 acres of wetlands composed of a combination of 0.7 acre of altered wet meadow, 0.7 acre of altered emergent marsh, and 0.2 acre of forested wetland.
[b] Alternative A converts 1 acre of altered wet meadow and 0.1 acre of altered emergent marsh to deep water ponds. Alternative B converts 1.7 acres of altered wet meadow, 0.3 acre of emergent ditch, and 1.6 acres of altered emergent marsh to deep water ponds.

Table 3-19. Predicted functional unit change.

ALTERNATIVES	EXISTING WETLAND FUNCTIONAL UNITS	PREDICTED FUNCTIONAL UNITS	TOTAL FUNCTIONAL UNIT GAIN	PERCENT FUNCTIONAL UNIT GAIN
No-Action	1,235.7	1,235.7	0	0
Alternative A	1,235.7	3,112.4	1,876.7	+152
Alternative B	1,235.7	2,075.0	839.3	63
Alternative C	1,235.7	2,488.9	1,253.2	101

Alternative A

Alternative A would not require placement of fill in wetlands other than partially filling existing drainage ditches to restore site hydrology. Figures A-19 and A-20 (Appendix A) illustrate existing and predicted wetlands for Alternative A. The implementation of Alternative A would convert 175.6 upland acres to wetlands and have a functional unit gain of 1,876.7 units. Alternative A would also convert 1.1 acres of existing wetland to deep water pond habitat that is critical for the June sucker. The restoration of a more natural hydrologic regime in the study area and conversion of wetland types would benefit the endangered June sucker. Approximately 7,676 cubic yards of fill would be removed from Utah Lake (a jurisdictional water of the United States) associated with partial removal of Skipper Bay dike.

Raised peat mounds within the study area would be preserved and avoided during implementation of Alternative A. Hydrologic restoration resulting from the project would restore the raised peat mounds to the conditions under which they were formed and functioned prior to the construction of Skipper Bay dike and draining and pumping of the area. Areas that exhibit raised peat mound characteristics would be mapped during the final project design. No fill would be placed in areas potentially containing raised peat mounds. All fill areas would be deliberately located within uplands on soils where peat wetland communities would not exist. The restoration of peat wetlands is described in further detail later in this section.

The wet meadow/emergent marsh complexes on the eastern portion of the study area are mostly on peat soils and higher in elevation and would not be directly affected by modifications to Skipper Bay dike. Improvements to these existing wetlands are anticipated under Alternatives A through improved land use practices and improved hydrology due to reduced drainage (see Section 3.5.8).

Additionally, Alternative A would route the river channel through a small portion of the wet meadow/emergent marsh complex on the eastern portion of the study area. This community is higher in elevation and would not be affected by modifications to Skipper Bay dike. However, over time the proximity of the proposed river channel may provide for some expansion of wet meadow associated with this complex due to reconnection with an active floodplain.

Alternative B

Alternative B routes the Provo River channel through the wetland-dominated eastern and northern portions of the study area, as described and illustrated in Chapter 2. A new berm would be reconstructed through the center of the study area to avoid acquisition of upland agricultural lands south of the constructed berm. Alternative B would require the placement of fill in 0.87 acre of existing wetlands to allow for the berm to be placed on the southern boundary of the proposed delta. However, the lower part of the toe of slope would be flooded or saturated frequently enough to revert 0.37 acre of the fill to wetlands resulting in a net conversion of wetlands to uplands of 0.5 acre. Alternative B would also convert 3.6 acres of existing wetland to deep water pond habitat that is critical for the June sucker. Approximately 6,382 cubic yards of fill would be removed from jurisdictional waters of the United States in Utah Lake associated with partial removal of Skipper Bay dike.

Figures A-21 and A-22 (Appendix A) illustrate existing and predicted wetlands for Alternative B. The implementation of Alternative B would convert 29.4 upland acres to wetlands, would have a total net gain of 25.2 wetland acres, and would have a functional unit gain of 839.3 units. Because Alternative B primarily acquires lands that are currently wetlands and eliminates pumping activities, this alternative also results in the conversion of some existing artificial wet meadow to wetter habitats, particularly emergent marsh. The restoration of a more natural hydrologic regime in the study area and associated restoration of emergent marsh and lacustrine vegetated aquatic bed would benefit the endangered June sucker. Under Alternative B the river channel follows a contour adjacent to and immediately west of the wet meadow/emergent marsh complex. It is likely that over time the natural migration of the river channel and potential development of side channels would influence and potentially enhance and expand this wetland complex, particularly wet meadow. This secondary potential increase in wetland is not accounted for in Table 3-17.

As with Alternative A, raised peat mounds within the study area would be preserved during implementation of Alternative B. Hydrologic restoration and cessation of grazing resulting from the proposed project should restore the raised peat mounds to the conditions under which they were formed and functioned prior to the construction of Skipper Bay dike and other anthropogenic hydrologic alterations of the mid-20th century. Areas that exhibit raised peat mound characteristics would be mapped and avoided during the final project design. No fill would be placed in areas containing raised peat mounds. All fill areas would be deliberately located within uplands or on soils where peat wetland communities would not exist. The restoration of peat wetlands is described in further detail in Section 3.5.7.

Alternative C

Alternative C routes the Provo River channel with the same initial alignment as Alternative A, north of Boat Harbor Drive, but an additional berm would be constructed through the middle of the study area. As described and illustrated in Chapter 2, Alternative C excludes peat wetlands located on the east and north sides of the study area from the area of land that would be acquired for the project, while still meeting June sucker spawning and rearing habitat improvement needs by using lands to the south of these wetlands. However, this would require construction of a berm through wetlands. The preliminary design for this berm has a footprint of 1.6 acres in jurisdictional wetlands. Wetlands have been avoided with other project design features (recreation access and realignment of Boat Harbor Drive), which are consistent with the design for Alternative A. Approximately 7,367 cubic yards of fill would be removed from jurisdictional waters of the United States in Utah Lake associated with partial removal of Skipper Bay dike.

Figures A-23 and A-24 (Appendix A) illustrate existing and predicted wetlands with Alternative C. The implementation of Alternative C would convert 156.7 upland acres to wetlands, have a total net gain of 154.9 wetland acres, and have a functional unit gain of 1,253.2. The restoration of a more natural hydrologic regime in the study area and associated conversion of habitat would benefit the endangered June sucker. As with the other action alternatives, raised peat mounds within the study area would be preserved and avoided during implementation of Alternative C. The majority of the raised peat mound areas would remain cut off from Utah Lake under Alternative C, and this alternative would not afford the opportunity to restore peat wetland areas. Areas that exhibit raised peat mound characteristics would be mapped and avoided during the final project design. No fill would be placed in areas potentially containing peat wetlands.

For the riparian zone of Alternative C, the placement of the north-side berm would limit the migration of the river channel and active floodplain; in particular, the existing wet meadow/emergent marsh community is isolated from the proposed riparian corridor. Therefore, any potential wetland enhancements from connection to the riverine hydrology and via improved land use practices would not be expected for the wet meadow/emergent marsh complex with implementation of Alternative C. Also, while the concept of Alternative C was to exclude existing peat wetlands from the project the berm constructed through wetlands under Alternative C would likely pond water on the upslope side and make this area wetter (see indirect and cumulative effects, Section 3.5.8).

Existing Channel Option 1

There are no delineated wetlands within the existing channel. Approximately 2,250 cubic yards of fill would be placed below the ordinary high-water mark in the existing channel as part of the delta diversion structure. This feature would impact approximately 0.20 acre in jurisdictional waters of the United States. In addition, the riparian wet meadow with small a channel feature below the delta diversion structure would likely require approximately 2 feet of soil to be placed on the existing streambed 30 feet wide and approximately 250 feet long for Alternative A or C, and approximately 600 feet long for Alternative B. Therefore, approximately 556 cubic yards of fill would be placed below the ordinary high-water mark for Alternatives A or C and approximately 1,340 cubic yards for Alternative B. The riparian wet meadow with a small channel feature would be built to better accommodate the new 10–50 cfs flow regime below the delta diversion structure. In acreage, the placement of fill below the ordinary high-water mark for the riparian wet meadow feature and new crossing for Boat Harbor Drive would impact an additional 0.17 acre for Alternative A or C and approximately 0.41 acre for Alternative B. Any additional alterations to the existing channel would be detailed during the final design and included in the Section 404 and stream alteration permit application process. Lands adjacent to the existing channel are primarily upland riparian forest and would not be affected by changes in stream hydrology. There are two nearby wetland communities, an “oxbow” emergent marsh, and a wet meadow area. These wetlands would not be affected by implementation of Option 1 or by any of the project action alternatives (A, B, or C.)

Existing Channel Option 2

Approximately 2,250 cubic yards of fill would be placed below the ordinary high-water mark in the existing channel as part of the delta diversion structure and approximately 4,000 cubic yards would be placed at the outlet dam. These structures combined would impact approximately 0.40 acre in jurisdictional waters of the United States. Fill below the ordinary high-water mark associated with the riparian wet meadow with small channel feature to better accommodate the new 10–50 cfs flow regime downstream of the delta diversion structure and new crossing for Boat Harbor Drive will be the same as under Option 1. Any additional alterations to the existing channel would be detailed during the final design and included in the Section 404 and stream alteration permit application process. Lands adjacent to the existing channel are primarily upland riparian forest and would not be affected by changes in stream hydrology. Option 2 would not have any effect on wetlands, the same as Option 1.

3.5.7 Peat Wetland Restoration

Alternative A or B would include opportunities to restore study area peat wetlands. Given the information available in the existing literature, it is reasonable to assume the single most important factor in restoring the study area peat wetlands would be to restore the hydrology conditions under which the soils formed (i.e., natural fluctuations of Utah Lake water levels, seasonal flooding from Provo River, and groundwater discharges) beginning between 4,500 and 9,000 years before present up until the mid-20th century anthropogenic changes. The construction of Skipper Bay dike, construction of levees along Provo River, construction of drainage ditches in the study area, and the annual mechanical pumping of surface and groundwater to dry the peat wetlands and allow for grazing have dried the peat wetlands significantly. Studies in Ireland conclude that the restoration of peat wetland habitat is likely to be feasible if there is a reasonably deep peat layer remaining at the site (e.g., >0.5 meter) and restoring wetland hydrology is possible (Northern Ireland Peat Wetlands and Uplands Biodiversity Delivery Group 2010). The majority of viable seeds are found in the surface soil layer of a peat wetland and retaining this upper layer could increase potential for successful colonization of a restored peat wetland (Northern Ireland Peat Wetlands and Uplands Biodiversity Delivery Group 2010).

Given that an extensive surface peat layer remains intact within the study area, it should be an appropriate site to restore the natural wetland types associated with study area peat wetlands, primarily by removing the existing hydrologic alterations and overgrazing. The existing study area wetlands are dominated by native sedges and rushes that should provide an excellent natural seed source as well as existing root layer for project related disturbance areas.

In addition to restoring site hydrology to the study area peat wetlands, the proposed project includes implementation of a proactive vegetation management plan (Appendix B). Grazing is included in the vegetation management plan as a potential weed-control option that could be used on a site-specific basis within the study area. Currently, grazing in the study area is likely beneficial to Ute ladies'-tresses because grazing provides some control over other plant species that would likely compete with Ute ladies'-tresses, particularly phragmites. Following restoration, focused grazing may continue to be helpful in areas suitable for Ute ladies'-tresses.

The restoration of the hydrologic conditions under which the study area peat wetlands formed, combined with the vegetation management plan, would be expected to increase the level of wetland function provided by the raised peat mounds and the other peat wetlands. The restoration would also be expected to provide increased suitable habitat for the federally listed threatened Ute ladies'-tresses orchid, particularly along nonspring fed, seasonally flooded wetland areas that will dry out as the lake recedes over the summer. Post-restoration monitoring will provide insight into the effectiveness of the restoration and the results can be used to improve management techniques.

3.5.8 Indirect and Cumulative Impacts

Study area wetland functional level would be raised by improving hydrology, reducing human impact, and creating new, high quality wetlands from existing uplands. Public safety issues associated with wetland restoration are addressed in Section 3.16.

Existing drains and pumping activities currently impacting wetlands would be significantly modified or eliminated in the study area. Under Alternative A or B, the two existing wetland mitigation sites within the study area (Provo City and BLB Drywall) would be maintained as wetland, and incorporated into the overall restoration project. Under Alternative C, a berm would be constructed through existing wetlands, isolating the Provo City and BLB Drywall mitigation sites on the upslope side of the berm. This action may indirectly change site hydrology by ponding water on the upslope side of the berm and making the wetlands wetter. Private lands outside the Alternative C project area and the existing mitigation sites could continue to be used for grazing and, if so, it is likely that landowners would continue to pump water out of this area in the springtime to increase grazing opportunity. These lands are unlikely to be developed due to their flooding regime and because of the existing conservation easement on the Despain Ranch. If grazing and pumping was discontinued, however, it is likely that these lands outside of the Alternative C project area would become wetter and existing wetlands would convert to wetter wetland types, similar to what would occur under Alternatives A or B, except that these wetlands would not be available as June sucker habitat due to construction of the berm. Additionally, these wetlands would not receive active management (for example, treatment of invasive species) as would have been the case with implementation of Alternative A or B.

The cumulative impacts to the watershed would be a net increase in available wetland function. The intent of the proposed action is to restore the project implementation area to a more naturally functioning condition to support the endangered June sucker.

3.5.9 Mitigation Measures

The JLAs anticipate that the project will be permitted under a Nationwide 27 permit (aquatic habitat restoration, establishment, and enhancement activities). A detailed survey of the property acquisition area would be completed as part of the final design and Clean Water Act Section 404 compliance process. An effort would be made to identify any degraded raised peat mounds that may exist; these would be avoided to the extent feasible with any project fill or excavation and construction staging areas associated with the selected alternative. The overall impact of any action alternative would be an increase in the quantity and quality of aquatic habitat, restoring wetlands in the study area to a more natural condition with a significant increase in wetland functions provided. An increase in weedy vegetation is possible immediately following project implementation of any action alternative, especially prior to establishment of native vegetation (this is further discussed and evaluated in Section 3.12). Aggressive measures contained within the Vegetation Management Plan (Appendix B) would be followed to control spread of invasive species.

With implementation of either Alternative A or B, the Provo City Wetland Mitigation Site would be maintained as a high-quality wetland within the overall restoration area, with an added function of June sucker rearing habitat. The BLB Drywall Mitigation site would also be maintained as a wetland within the overall restoration area, but is higher in elevation and therefore would not be anticipated to function as June sucker rearing habitat. The intent of the JLAs is that both Provo City and BLB Drywall would be "kept whole" with respect to their wetland mitigation sites within the delta restoration project (Alternative A or B). If the Corps determines there is an adverse effect on the credits achieved by either site, the JLAs would work cooperatively with the parties involved to achieve an acceptable solution.

3.5.10 Qualification for Nationwide Permit 27

Nationwide Permit 27 (77 FR 10275–10276, Feb. 21, 2012) is designated for projects with a primary purpose of aquatic habitat restoration, establishment, and enhancement activities. Specific language within the Nationwide Permit 27 description that applies to the proposed project includes the following:

> Activities in waters of the United States associated with the restoration, enhancement, and establishment of non-tidal wetlands and riparian areas, the restoration and enhancement of non-tidal streams and other non-tidal open waters, provided those activities result in net increases in aquatic resource functions and services. (NWP 27)

The primary purpose of the proposed project is to restore natural, emergent vegetation and increase aquatic habitat for juvenile June sucker, a federally listed endangered species. These goals require restoring the river delta at the mouth of the Provo River (where the majority of June sucker spawn), as well as restoring large expanses of flooded emergent wetland and shallow ponds that have been drained and degraded by grazing livestock. The resulting submerged aquatic vegetation is expected to help larval and juvenile fish avoid predators and provide overwintering habitat under the ice. Prior to creation of the flood-control dike around Utah Lake, the channelization of the Provo River, and the installation of the drainage ditches, the study area was part of the Provo River delta and exhibited the habitats described above. The study area is artificially drained annually during the growing season using pumps and active management to discharge accumulated surface and groundwater to Utah Lake. In addition to artificially converting emergent wetland to wet meadow, this pumping impacts existing raised peat mound wetland types. These areas are further degraded due to being heavily grazed by cattle under existing conditions. In addition to restoring habitat for a federally endangered species, the proposed project will restore the hydrologic conditions under which the raised peat mound wetland types formed. Peat wetlands that have subsided and been damaged due to drying and cattle grazing should rebound to some extent following the restoration of natural hydrologic conditions and removal of livestock. The existing artificially altered and actively managed conditions versus projected wetland functional assessment conditions results in a significant net increase in post-restoration aquatic resource functions and, most importantly, restoration of natural wetland conditions, which is the primary purpose of NWP 27.

> Activities authorized by NWP 27 include, but are not limited to: the installation, removal, and maintenance of small water control structures, dikes, and berms, as well as discharges of dredged or fill material to restore appropriate stream channel configurations after small water control structures, dikes, and berms, are removed; the installation of current deflectors; the enhancement, restoration, or establishment of riffle and pool stream structure; the placement of in-stream habitat structures; modifications of the stream bed and/or banks to restore or establish stream meanders; the backfilling of artificial channels; the removal of existing drainage structures, the filling, blocking, or reshaping of drainage ditches to restore wetland hydrology; the installation of structures or fills necessary to establish or re-establish wetland or stream hydrology; and the re-establishment of submerged aquatic vegetation in areas where those plant communities previously existed. (NWP 27)

The proposed project involves removing Skipper Bay dike and restoring the mouth of the Provo River into a braided channel/river delta form (not deeply incised as it currently is) within an appropriately sized floodplain and distributary channel patterns common to deltas. The influence of seasonal lake inundation and spring season overbank flooding of the Provo River will restore natural hydrology, including emergent wetlands and submerged aquatic vegetation areas. Shallow water ponds with submerged aquatic vegetation (river oxbows) will also be created initially to restore overwintering habitat for juvenile June sucker and will continue to develop and evolve naturally over time as well.

> Changes in wetland plant communities that occur when wetland hydrology is more fully restored during wetland rehabilitation activities are not considered a conversion to another aquatic habitat type. (NWP 27)

Wetland hydrology will be more fully restored to natural conditions by this wetland rehabilitation. In the absence of such restoration the natural habitat will continue to be grazed and artificially drained through active management including ongoing use of fuel and other resources to continue pumping. Without a restoration effort including removal of dikes, levees, and drainage ditches, the pumped area will not naturally revert to a more fully functioning hydrologic system connected to the river delta or provide accessible habitat for the endangered June sucker.

> Compensatory mitigation is not required for activities authorized by this NWP since these activities must result in net increases in aquatic resource functions and services. (NWP 27)

The proposed project will result in a net increase in wetland acreage, habitat restored to a more natural system, and improved aquatic resource functions as exhibited by the wetland functional assessment results. The primary purpose of the proposed project is to restore natural habitat that will increase available aquatic habitat for juvenile June sucker. The proposed project meets the terms and goals of Nationwide Permit 27 as outlined in the Federal Register.

3.5.11 Wetlands Summary

Implementation of action alternatives would restore the natural surface water hydrologic connection between the project implementation area, Provo River, and Utah Lake, and would benefit June sucker. The results of the alternatives analyses indicate that project implementation would cause a significant net increase in wetland acreages and functions under each alternative. Existing wetlands within the study area would be restored to a more natural condition. Long-term management of the developing vegetation community would be required to prevent further spread of invasive phragmites and other weeds. Indirect wetland impacts would create a higher quantity and quality of wetlands under each action alternative. The cumulative impacts to the watershed would be a net increase in available wetland function.

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3.6 Existing Channel Vegetation Community

3.6.1 Issues Addressed in the Impact Assessment

Concerns were expressed in public comments regarding the potential effects of the project on trees that provide shading along the lower Provo River and Provo River Trail. To evaluate this issue, the riparian corridor within the study area was assessed for vegetation composition, approximate age, general health, and distribution along the existing lower Provo River channel. A series of groundwater monitoring wells were installed and monitored to determine relationships between surface water elevations in the channel and groundwater elevations along the existing channel. Depth-to-groundwater maps were generated to help evaluate tolerances of existing vegetation to water level fluctuations. Extensive literature review was conducted to assess the potential effects of the project on the existing riparian vegetation types that currently occur in the study area.

3.6.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to the existing channel vegetation community were eliminated from further analysis in this EIS. Other sections of this document are related to and dependent upon the assessments made in this section including 3.5 Wetland Resources, 3.7 Fishery Resources, 3.8 Wildlife Resources, and 3.9 Threatened and Endangered Species.

3.6.3 Area of Influence

The study area boundary was considered the area of influence for riparian corridor impacts, with consideration of the Utah Lake watershed for cumulative effects.

3.6.4 Affected Environment (Baseline Conditions)

The riparian forest along the lower Provo River is an entirely upland plant community dominated by eastern cottonwood, crack willow (*Salix fragilis*), and boxelder (*Acer negundo*), with mature stands of a few riparian species including coyote willow (*Salix exigua*), and Fremont cottonwood (*Populus fremontii*) (Figure A-25 in Appendix A and Table 3-20). Table 3-21 includes canopy layer terms and definitions. Tree stands east of the oxbow were generally smaller and more dissected than the larger, more contiguous stands west of the oxbow. The riparian forest on river-right (north) of the lower Provo River is intersected by a recreation trail that parallels the river along its entire length downstream to Utah Lake State Park. Vegetation between the recreation trail and the river generally consists of a moderately diverse collection of mature, native and nonnative trees. There are some native riparian shrub species in areas with floodplain features (e.g., gravel and sand bars). Occasionally, dense native willow communities can be found in these areas. However, much of this section of the Provo River is incised with steep banks of native soils and fill intermixed with riprap. There is little or no understory or shrub growth.

Table 3-20. Lower Provo River tree species list.

COMMON NAME	SCIENTIFIC NAME	NATIVE OR INTRODUCED
American elm	*Ulmus americana*	native
American sycamore	*Platanus occidentalis*	native
Bebb willow	*Salix bebbiana*	native
Bigtooth maple	*Acer grandidentatum*	native
Box elder	*Acer negundo*	native
Chokecherry	*Prunus virginiana*	native
Coyote willow	*Salix exigua*	native
Crack willow	*Salix fragilis*	introduced
Eastern cottonwood	*Populus deltoides*	native
Fremont cottonwood	*Populus fremontii*	native
Gray alder	*Alnus incana*	native
Green ash	*Fraxinus pennsylvanica*	native
Narrowleaf cottonwood	*Populus angustifolia*	native
Peachleaf willow	*Salix amygdaloides*	native
Redosier dogwood	*Cornus sericea*	native
Rocky Mountain juniper	*Juniperus scopulorum*	native
Russian olive	*Elaeagnus angustifolia*	introduced
Saltcedar	*Tamarix ramosissima*	introduced
Siberian elm	*Ulmus pumila*	introduced
Skunkbush sumac	*Rhus trilobata*	native
Wax currant	*Ribes cereum*	native
Weeping willow	*Salix ^{x} sepulcralis Simonkai*	introduced
Woods' rose	*Rosa woodsii*	native

Table 3-21. Canopy layer definitions.

CANOPY TERMS AND DESCRIPTIONS		
Upper Level	**Mid Level**	**Lower Level**
Trees greater than 15 feet in height	Small trees and shrubs less than 15 feet but greater than 5 feet in height	Tree saplings and shrubs less than 5 feet in height

The paved Provo River Trail follows the bank of the Provo River on the north levee. The vegetation north of the trail is detached from the rest of the riparian forest, and is bordered by agricultural fields and irrigation canals. Narrow strips of mature cottonwood and willow stands have established along the irrigation canals. These linear populations are usually monotypic stands and low in diversity. A secondary loop of the recreation trail circles a pond that may be a remnant oxbow of the river but is now isolated by the north levee (labeled the Oxbow Pond on Figure A-25). This moderately disturbed area supports a boxelder forest, a mature cottonwood forest, and several dense native willows. In some places the oxbow pond is invaded by nonnative species such as Russian olive (*Elaeagnus angustifolia*) and Siberian elm (*Ulmus pumila*). The Utah Lake State Park section on river right contains sparse native willow stands, which are interrupted by developed day-use areas. A map of the vegetation polygons can be found in Figure A-25, Appendix A.

General Riparian Forest Description, River Right

Lakeshore Drive to Oxbow along River Bank

This section consists mainly of an upper canopy forest with eastern cottonwood, American elm (*Ulmus americana*), and boxelder along the river bank with intermittent but well-established coyote willow. Some tree-sized willows (e.g., Bebb willow [*Salix bebbiana*] and peachleaf willow [*Salix amygdaloides*]) along with green ash (*Fraxinus pennsylvanica*) and coyote willow make up a small amount of the composition. A few scattered individuals of Russian olive are also present along the bank. The herbaceous layer is variable but in most cases sparse. Where the herbaceous layer is present, it consists primarily of weedy or introduced species such as reed canary grass (*Phalaris arundinacea*) and intermediate wheatgrass (*Thinopyrum intermedium*). Dyer's woad (*Isatis tinctoria*), a noxious weed in the State of Utah, was also observed (Belliston et al. 2009). Coyote willow and other willows are present wherever there are sandbars, point bars or small streamside shelves. The mid-canopy layer makes up only 10–20 percent of total composition, and evidence of some cottonwood and willow recruitment exists (e.g., the presence of saplings less than 10 feet tall). The upper canopy contains moderate-to-high species diversity in places.

The north side of the recreation trail is characterized by narrow strips of large, mature cottonwood and willow species, which line irrigation canals and agricultural lands. These communities are dominated by mid-canopy shrubs (e.g., coyote willow), upper canopy Fremont cottonwood, and eastern cottonwood forests. There is also a mature, monotypic Fremont cottonwood stand in this area. Populations lining this canal seem to be homogenous in age structure and species; they may have been planted as farmland windbreaks.

Oxbow Area

The pond contains a mixture of open water and islands of vegetation. Riparian communities on islands within the pond consist primarily of dense patches of coyote willow bordering the oxbow pond, with a smaller component of Bebb willow. On the northeast edge there is a stand of boxelder with a dense herbaceous understory of reed canary grass. At one point on the north side of the pond there is a stand of Russian olive, which also has a thick reed canary grass understory. Another recreational trail encircles the oxbow pond. Along eastern border of the trail, tree communities consist of a sparse, upper-canopy coyote willow and peachleaf willow forest. To the south there is a mix of upper-canopy trees including boxelder, American elm, peachleaf willow with a shrub layer of coyote willow, Wood's rose (*Rosa woodsii*), and skunkbush sumac (*Rhus trilobata*). To the northeast there is a mature eastern cottonwood forest with a layer of various mid-canopy willow. The willow stands surrounding the oxbow pond may be the most established willow communities along the lower Provo River.

Alligator Park (Big Bend) to Utah Lake State Park

This section of the lower Provo River is more disturbed downstream and is characterized primarily by a mature, even-aged eastern cottonwood/crack willow forest with a subordinate mix of native willows (e.g., peachleaf willow and Bebb willow) and nonnative trees (e.g., saltcedar [*Tamarix* spp.] and Russian olive). The mid-canopy layer along this reach is nearly nonexistent with the exception of a sparse collection of coyote willow, Bebb willow, and green ash. The understory is generally sparse but consists of weedy species such as reed canary grass, brome grasses (*Bromus* spp.), and a State of Utah noxious species, whitetop (*Cardaria draba*).

Utah Lake State Park

Small, narrow strips of riparian forest line the lower portion of the river and are bordered by developed picnic and parking areas. The dominant vegetation in these stands is dense coyote willow at the mid-canopy layer with other native willows interspersed throughout. The upper canopy consists of scattered, younger-aged (less than 20 feet in height) eastern cottonwood that are sparse and do not comprise more than 25 percent of the overall community.

General Riparian Forest Description, River Left

The riparian forest lining the lower Provo River on the river-left (south) bank is intersected by a levee that parallels the river to its outlet at Utah Lake. The south levee is several feet higher (greater than 4,498 feet) and built to a higher standard than the north levee and trail. There is a primitive, two-track dirt road on top of the levee. The bank drops steeply to the river-left edge. The levee is immediately bordered to the south by agricultural fields, some private homes, businesses, and Lakeside RV Campground. Development abutting the riparian forest has most likely limited its ability to expand and the forest is reduced to a narrow strip on both sides of the levee. There are a few floodplain features and point bars along the upstream section that support established willow stands.

Lakeshore Drive to Across River from Oxbow Pond

The riparian forest in this section of the lower Provo River is a collection of even-aged, upper-canopy mature species, which are dominated by a mix of native and nonnative trees (e.g., eastern cottonwood, boxelder, Siberian elm, and crack willow). Russian olive is also present here. Mid-canopy shrubs and small trees are sparse to nonexistent, with little or no understory species. In some isolated places along the river-left there are small gravel bars and streamside features that support small native stands of coyote willow and Bebb willow. Occasionally, native peachleaf willow dominates the upper canopy.

Across River from Oxbow Pond to Provo Center Street Crossing

The riparian forest becomes increasingly disturbed in the river-left section leading downstream to Utah Lake. The vegetation consists of mature, native and nonnative upper-canopy species including eastern cottonwood, crack willow, boxelder, and peachleaf willow. The introduced crack willow is increasingly dominant and the trees approach their maximum height of 65 feet (USDA 2006) in this section. The mid-canopy shrub layer is very sparse or completely absent in most of this section. The small, infrequent shrub layer includes coyote willow, Bebb willow, and Russian olive. Along this section the forest is mostly constrained to narrow stands by adjacent agricultural and private development.

Provo Center Street Crossing to Provo Airport Levee Road

This section of the riparian forest is a collection of native, introduced, and ornamental vegetation, which is influenced by construction of a narrow road leading to the Provo Airport Levee and nearby private property development. The upper canopy is large and even-aged along the north and south sides of the road and consists mainly of eastern cottonwood, crack willow, and Bebb willow. Some species, such as Rocky Mountain juniper (*Juniperus scopulorum*) and weeping willow (*Salix* ^{x}*sepulcralis Simonkai*), were most likely planted as ornamentals. The forest becomes sparse as the river flows into Utah Lake, transitioning into herbaceous species dominated by reed canary grass in the private property section. The shrub layer is sparse and consists of small stands of Russian olive.

Stand Age

Tree core samples were collected from three eastern cottonwoods and two Fremont cottonwoods within the riparian corridor. The core samples were removed from the center of the tree trunk at a height of approximately 4.5 feet. The cores were collected in a manner to allow removal of a sample including the center of the tree. Tree growth rings were counted from each core using a stereo microscope. Cottonwood is a fast-growing species known to create multiple growth rings within a single growing season. Special care was taken to determine the annual growth ring within each sample; however ages should be considered approximate.

Assessment of the three eastern cottonwood core samples indicates the trees are aged approximately 33, 48, and 51 years. The trees sampled were visually selected to represent the youngest and oldest of the mature tree classes for that species within the riparian corridor. Given the locations of the selected trees, it appears the tree stands increase in age closer to the Utah Lake confluence. The two younger trees were sampled from stands on the river side of the north levee, while the oldest was sampled from the fence line on the far side of the north levee.

There are two stands of Fremont cottonwood within the riparian corridor, each located on the north side of the levee. The two trees sampled are estimated to be 62 and 64 years old. All individuals within each stand appear to be from the same age class. There is no evidence of multiple age classes or any juvenile recruitment within either population. Several scattered Fremont cottonwoods within eastern cottonwood stands also appear to be from the same age class as the sampled Fremont cottonwoods. These observations indicate that the Fremont cottonwoods on the lower Provo River may all be from the same recruitment event. It further indicates that there has either been no subsequent recruitment, or that any recruitment following this class has since been lost. Given the location of these stands, it is likely that these cottonwood stands were isolated from the river by the construction of the levee and trail, preventing any further recruitment. It is also possible that these trees were planted along the levee. The ages of the mature trees also correspond with levee construction following the flood of record on the lower Provo River, which happened in 1952.

3.6.5 Impacts of the No-Action Alternative

If an action alternative were not implemented, the existing study area riparian forest would likely remain in its current condition. It is likely that some part of the existing single-aged tree stands will begin to die off with age and it is expected that a lack of natural recruitment will continue along the entire corridor under existing conditions. With a lack of connectivity to the river channel throughout much of the corridor natural recruitment of native riparian species will continue to be limited. Nonnative and invasive species may take advantage of the current conditions and spread throughout areas where native species are unable to recruit. The riparian corridor will continue to be limited to a narrow band adjacent to the current river channel.

3.6.6 Impacts of Action Alternatives

Impacts to the riparian corridor in response to each of the alternatives would be a net increase in riparian communities throughout the study area. Project designs call for the construction of the Provo River channel and connected floodplain within the study area with a proposed riparian corridor associated with these features. It is expected that, through restoration efforts and natural recruitment, an extensive riparian forest composed of native riparian trees and shrubs would result from project implementation. In addition, restoring the natural river processes and floodplain interactions would allow natural recruitment of cottonwood and willow species throughout the corridor.

Predicted Response in the Existing Provo River Channel Corridor

Minimal loss of riparian trees may result from construction of the diversion dam that is included with both Option 1 and Option 2 and the construction of the downstream dam in Option 2. Impacts would be limited to the dam footprint and construction access areas and estimated to be less than 0.25 acres.

Predicted Response in the Restored Riparian Corridor

The analysis of predicted response in riparian and wetland vegetation communities was accomplished by comparing historic Utah Lake surface elevations using the ULS EIS Proposed Action hydrology for Utah Lake, and LiDAR elevation data. Baseline lake water surface elevation data from 1949–1999 determined from the ULS EIS (CUWCD 2004) indicates that during the growing season (April through October only), Utah Lake has a 50 percent probability of having a water surface elevation of 4,487.8 feet or higher. This lake surface elevation was compared with the existing study area ground surface elevations from the LiDAR survey to predict water levels and wetland types on the study area after dike removal. This analysis assumed that the study area surface water and groundwater levels could be directly represented by Utah Lake water surface elevations if the dike were removed.

The proposed action design assumes the development of a mixed riparian forest, wet meadow, and upland grassland complex within the floodplain of the proposed channel's meander area. The width of this floodplain is expected to be approximately 800 feet wide, from the proposed Lakeview Parkway and Trail crossing down to an elevation of 4,489.5 feet. The analysis also assumes the natural recruitment of this riparian corridor at an elevation band of 4,489.5–4,491.0 feet as seed is deposited on the lake shore. The channel lines and pond features within this corridor were buffered 400 feet on either side and acreages were calculated to obtain an area of riparian forest, wet meadow, and upland grassland communities expected to develop.

Additional analysis was conducted in association with the *Riparian Vegetation Technical Memorandum* (URMCC 2013) to determine the potential response to water level changes in the existing channel as a result of project implementation. This was accomplished by mapping and identifying the existing riparian vegetation and conducting an extensive literature search to document each species' likely response to changes in water availability. Water level response to the two diversion options was modeled spatially using measured water elevation data at 31 locations across the study area to determine the extent of water elevation rise or drop within the existing channel. Depth-to-groundwater was determined by comparing water elevations with very accurate land surface elevations using LiDAR.

Project Alternative Riparian Response

The post-project predicted riparian forest conditions were analyzed in context of the predicted conditions model. For this analysis it was assumed that the post-project riparian community would exhibit increases in size, age structure, and quality. These assumptions included improved plant community composition, reduced levels of disturbance, and increased water storage capabilities. The change in total riparian corridor acreage by alternative is described in Table 3-22.

Table 3-22. Predicted riparian corridor change.

ALTERNATIVES	EXISTING RIPARIAN FOREST ACREAGE	POST-RESTORATION RIPARIAN FOREST ACREAGE	NET GAIN
No-Action	19.1	19.1	0
Alternative A	19.1	55.7	+36.6
Alternative B	19.1	38.5	+19.4
Alternative C	19.1	46.4	+27.3

Alternative A

Project Alternative A routes the river channel north of Boat Harbor Drive with channel braids and meanders extending north and west throughout the study area. The distribution of side channels and channel features in this manner provides for a more extensive riparian floodplain and associated riparian corridor. It is predicted that at least 36.6 acres of native riparian forest would be gained from this alternative both through active restoration of the riparian community and natural recruitment of riparian forest along the northern project boundary as a result of restored hydrologic conditions. Alternative A provides for the greatest gain in total riparian forest acreage.

No change in the vegetation along the existing channel downstream of the new delta diversion would be expected as a result of implementation of this alternative.

Alternative B

Alternative B routes the river channel north of a newly constructed berm in the center of the study area. It is expected that a minimum of 19.4 acres of native riparian forest would be gained through implementation of this alternative. The amount of riparian forest acreage gained under Alternative B is much less than Alternative A because it is more constrained laterally, and has a shorter distance to the delta and deeper water restoration areas.

No change in the vegetation along the existing channel downstream of the new delta diversion would be expected as a result of implementation of this alternative.

Alternative C

Alternative C would route the river channel north of Boat Harbor Drive at the same location as Alternative A. The restoration area would be restricted to the north by a newly constructed berm running though the center of the study area. This alternative is also narrower than Alternative A. However, the project design is expected to result in a minimum of 27.3 acres of additional native riparian forest. Alternative C limits the proposed channel from any interaction with existing riparian communities along the northern project boundary restricting the potential for improved native recruitment.

Existing Channel Option 1

Option 1 would result in a loss of approximately 100 feet of riparian vegetation on each side of the channel (0.23 acre total) for construction of the delta diversion structure in existing channel, assuming that the width of riparian vegetation is approximately 50 feet on each side of the channel.

Existing Channel Option 2

Option 2 would result in a loss of approximately 200 feet of riparian vegetation on each side of the channel (0.46 acre total) for construction of the delta diversion structure and small dam at the bottom of the existing channel, assuming that the width of riparian vegetation is approximately 50 feet on each side of the channel.

3.6.7 Indirect and Cumulative Impacts

Indirect riparian community impacts would create a higher quantity and quality of riparian corridor within the study area. Newly created riparian forest would have a more natural age structure, allow for natural recruitment of riparian vegetation, and support natural river processes.

The cumulative impacts to the watershed would be a net increase in riparian forest acreage, including riparian forest, wet meadow, and grassed uplands. The intent of the proposed action is to restore the study area to a more naturally functioning condition to benefit June sucker. The loss or conversion of some existing grazed wetland and upland areas is required to restore the area and improve the overall watershed surrounding Utah Lake.

3.6.8 Mitigation Measures

The only losses of existing riparian forest that would result from any of the alternatives would be associated with installation of the diversion dam, the need for a new Boat Harbor Drive crossing, and a second small dam associated with Option 2 for the existing channel. Mitigation measures for these project features would include minimizing the footprint and impacts to riparian trees to the extent practicable. Mitigation would include planting of native riparian vegetation within the restored construction footprint following completion of dam installation.

There would be no other loss of existing riparian forest associated with implementation of the project; in fact, there would be a net increase in riparian forest acreage associated with any of the alternatives with construction of a new channel. Under either of the existing channel options, the existing riparian corridor would remain intact similar to the No-Action Alternative. A newly created native riparian corridor with Alternative A, B, or C would increase the total acreage of riparian forest within the study area. As there would be no net loss of riparian corridor, no other mitigation measures are proposed for riparian vegetation communities affected by construction activities.

3.6.9 Existing Channel Vegetation Summary

The majority of existing riparian forests along the existing channel are disconnected from water in the channel. The vegetation composition is a mixture of native, invasive, and introduced species. Many of the existing trees have presumably been planted. Alteration of the natural river processes resulting from channelization and flood control measures have prevented natural recruitment of native riparian species within the corridor. The result is large, single-aged stands of riparian vegetation. Lack of recruitment over time can lead to extensive loss of trees due to age and allows invasive species to expand. Implementation of an action alternative would not resolve issues with the existing riparian forest. Implementation of either of the existing channel options would be expected to preserve the existing conditions for the riparian forest. The existing riparian corridor does provide considerable recreational benefit to the public in its existing condition, but without recruitment or replanting in the future, the existing trees are expected to slowly die off.

Restoration of natural river processes within the riparian zone of the restored river channel would support restored riparian forest communities as well as encourage natural recruitment of native riparian species. Such communities help to reduce the encroachment of nonnative and invasive vegetation and help support a healthy floodplain.

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3.7 Fishery Resources

This section provides a detailed assessment of existing and predicted fishery resource conditions. Relevant issues include possible changes in quantity or quality of habitat, direct mortality to fish, and general disturbance during project construction. Additionally, indirect effects could occur from possible changes in water quality in Utah Lake or the Provo River.

3.7.1 Issues Addressed in the Impact Assessment

The proposed action would create new fishery habitat, with emphasis on habitat conditions beneficial to June sucker. Other species would benefit as well. Existing fishery resources in the lower Provo River-Utah Lake interface were characterized by reviewing recent studies and monitoring reports by the UDWR, JSRIP, and by consulting regional fisheries biologists.

3.7.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to fishery resources were eliminated from detailed analysis in the EIS. Section 3.9, Threatened and Endangered Species, provides additional analysis specifically related to compliance with the ESA.

3.7.3 Area of Influence

Potential impacts were evaluated by examining the fish communities in the Provo River upstream of the study area, the Provo River-Utah Lake interface, and Utah Lake proper.

3.7.4 Affected Environment (Baseline Conditions)

Under existing conditions, the Provo River and Utah Lake support existing populations of both native and nonnative fish species (Table 3-23). Detailed discussions of existing conditions for the lower Provo River, the Provo River-Utah Lake interface, and Utah Lake follow.

Lower Provo River

Fisheries of the lower Provo River—from Provo Canyon to Utah Lake—are managed under several designations according to State and federal laws. Sections of the lower Provo River upstream of the study area are managed under a Special Fish Species concept by UDWR. Under this management strategy, focus is on conservation and population enhancement for genetically unique special fish species within their historic habitats and their use for recreation in the sportfish program. Additionally, this section of the Provo River is classified as a Class 4 Wild Fish Water, which means that sportfish species are maintained by natural reproduction only. The lower 4.9-mile section of the Provo River (below Lower City Dam) is designated as Critical Habitat for June sucker, and management focuses on conservation and enhancement of the species relative to guidelines outlined in the June Sucker Recovery Plan (USFWS 1999a).

The UDWR periodically monitors fish populations in the lower Provo River. In recent sampling downstream of the Fort Field Diversion, mottled sculpin (*Cottus bairdii*) and brown trout (*Salmo trutta*) made up approximately 68 percent of the total abundance of fish captured, with mottled sculpin being the most abundant species (Landress and Watson 2008). Additional fish species that have been observed in this section of the river include speckled dace (*Rhinichthys osculus*), Utah sucker (*Catostomus ardens*), mountain sucker (*Catostomus platyrhynchus*), Bonneville cutthroat trout (*Oncorhynchus clarkii utah*), mountain whitefish (*Prosopium williamsoni*),

Table 3-23. Provo River and Utah Lake fish species.

COMMON NAME	SCIENTIFIC NAME	SPECIAL STATUS[a]	GROUP (FAMILY NAME)
NATIVE SPECIES			
Utah chub	*Gila atraria*	None	minnows (Cyprinidae)
Redside shiner	*Richardsonius balteatus*	None	
Speckled dace	*Rhinichthys osculus*	None	
June sucker	*Chasmistes liorus*	Endangered	suckers (Catostomidae)
Utah sucker	*Catostomus ardens*	None	
Mountain sucker	*Catostomus platyrhynchus*	None	
Bonneville cutthroat trout	*Oncorhynchus clarkii utah*	CS	trouts (Salmonidae)
Mountain whitefish	*Prosopium williamsoni*	None	
Mottled sculpin	*Cottus bairdii*	None	sculpins (Cottidae)
NONNATIVE SPECIES			
Common carp	*Cyprinus carpio*	None	minnows (Cyprinidae)
Fathead minnow	*Pimephales promelas*	None	
Black bullhead	*Ameiurus melas*	None	catfishes (Ictaluridae)
Channel catfish	*Ictalurus punctatus*	None	
Rainbow trout	*Oncorhynchus mykiss*	None	trouts (Salmonidae)
Brown trout	*Salmo trutta*	None	
Western mosquitofish	*Gambusia affinis*	None	livebearers (Poeciliidae)
White bass	*Morone chrysops*	None	temperate basses (Moronidae)
Green sunfish	*Lepomis cyanellus*	None	sunfishes (Centrarchidae)
Pumpkinseed	*Lepomis gibbosus*	None	
Bluegill	*Lepomis macrochirus*	None	
Smallmouth bass	*Micropterus dolomieu*	None	
Largemouth bass	*Micropterus salmoides*	None	
Black crappie	*Pomoxis nigromaculatus*	None	
Yellow perch	*Perca flavescens*	None	perches (Percidae)
Walleye	*Sander vitreus*	None	
Northern pike	*Esox lucius*	None	pikerels (Esocidae)

[a] Candidate – candidate species for listing under the Endangered Species Act (ESA); Endangered – endangered species under the ESA; CS – species receiving special management under a Conservation Agreement in order to preclude the need for federal listing.
Sources: SWCA 2002, Watson and Landress 2011.

common carp (*Cyprinus carpio*), white bass (*Morone chrysops*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), and walleye (*Sander vitreus*) (SWCA 2002, Landress and Watson 2008, Watson and Landress 2011).

Provo River-Utah Lake Interface

Habitat of the lower Provo River (downstream of the existing UDWR fish weir) can be characterized as deep and slow. Electrofishing samples by UDWR reveal that brown trout are the most common species in this segment of the river (Hepworth and Wiley 2004). However, this section of the river is largely influenced by Utah Lake and has many transient species that move upstream from the lake, often seasonally, including many of the nonnative species managed as part of the Wild Fish Water designation. In addition to brown trout, the deeper water habitat favors largemouth bass, channel catfish (*Ictalurus punctatus*), and walleye. This type of habitat is not typical for river-lake interfaces, which should also have shallow, off-channel areas—braided channels, oxbows, backwaters, and low-gradient shorelines. Currently, the Provo River inflow into Utah Lake is lacking this habitat diversity.

Trap netting is conducted annually in Utah Lake, and during 1999–2001 nets were set near the mouth of the Provo River. The results of these efforts give an indication of which fish species are associated with the most downstream section of the lower Provo River (though not all species captured in the river mouth travel up into the river in significant numbers). The species collected from these efforts were virtually all nonnative species, primarily black bullhead (*Ameiurus melas*) and common carp. Other nonnative species included bluegill (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*), white bass, and yellow perch (*Perca flavescens*). Other native fish species included Utah sucker and redside shiner (*Richardsonius balteatus*). In recent trap netting at the mouths of several Utah Lake tributaries (including the Provo River), white bass, black crappie, common carp, and bluegill made up nearly 90 percent of the total catch (Watson and Landress 2011).

As discussed in the water quality section of this chapter, at times DO levels in the lower Provo River channel drop below levels that are capable of supporting fish. At such times, fish would only survive by seeking refuge higher in the Provo River or in Utah Lake. Other aquatic species not capable of escaping these unsuitable conditions under their own power would be impacted.

Utah Lake

Utah Lake was once known to have 14 native species; however, most of these are now extirpated or extinct due to overharvest, habitat degradation, and the introduction of nonnative species (Brotherson 1981, Sigler and Sigler 1996, SWCA 2002, Hines 2010). Today, the majority of fish found in Utah Lake are nonnative (Sigler and Sigler 1996, SWCA 2002, Hines 2010, Watson and Landress 2011). Though common carp comprise the overwhelming majority of biomass in the lake, numerous sportfish species, as well as native species, are present (Watson and Landress 2011). In recent trap netting conducted by the UDWR, white bass were the most numerous fish species collected (33 percent), followed by common carp (27 percent) June sucker (17 percent), channel catfish (8 percent), black bullhead (4 percent), and black crappie (4 percent) (Watson and Landress 2011). Northern pike (*Esox lucius*) have also recently been documented in Utah Lake.

Nearly all of the Utah Lake native species feed on invertebrates and have relatively few predator defense adaptations—in particular, they lack defensive spines, are diurnal, and give little to no care to their offspring (Sigler and Sigler 1996). Consequently, as predatory sportfish species have been introduced, they have had substantial impacts on the native fish populations (USFWS 1999a). Largemouth bass, walleye, and white bass are just a few of the introduced fishes that feed primarily on other fish from an early age (Sigler and Sigler 1996) and have been shown to directly prey upon native species in Utah Lake (Kraft 2009; J. Watson 2011, pers. comm.). Northern pike would also have the potential to consume native species within Utah Lake.

Perhaps of greater concern for June sucker recovery is a very large population of common carp. The common carp population was estimated to be 5.8 million carp of age 2 or older (Valdez et al. 2006), which was thought to represent more than 90 percent of Utah Lake's fish biomass (JSRIP 2011). Carp destroy aquatic vegetation that provides cover and protection for young June sucker in the presence of predators. Therefore, the fisheries management focus with respect to June sucker recovery involves proactive removal of carp from Utah Lake (USFWS 2010a).

3.7.5 Impacts of the No-Action Alternative

In its current form, the lower Provo River downstream of the UDWR fish weir offers little ecological function for any fish species. The inflow, as it currently functions, simply delivers water to the lake. Water quality in the Provo River-Utah Lake interface, particularly DO levels, is frequently inadequate during late summer for supporting any fish species. At these times, adult fish likely seek refuge higher up in the Provo River or in Utah Lake. Under the No-Action Alternative, aquatic habitat within the Utah Lake-Provo River interface would continue to be of limited use for native fishes and nonnative sportfishes, particularly in times when stream flows are low. In the absence of the proposed action, the Provo River would remain a system lacking in suitable rearing habitat for native suckers.

3.7.6 Impacts of Action Alternatives

Any of the action alternatives would have a positive impact on the fish community of Utah Lake, with certain alternatives favoring individual species or guilds. In general, the various alternatives differ in the form of acreage, point of initial diversion, type of habitat included in inundation, and the initial pathway of Provo River channel braids.

Table 3-24 presents the aquatic habitat types and total quantities projected to be created for each alternative. Descriptions for predicted aquatic habitat types are as follows:

- ***Riverine:*** the center two thirds of the proposed river channel beginning at the first branching of the river and extending to Utah Lake. Prior to the first branching of the river, the full width of the channel is assumed to be deep water.

- ***Deep Water:*** inundated areas expected to be 5 feet deep or deeper at a lake elevation of 4,487.8 feet. Also includes the center one third of the proposed ponds.

- ***Lacustrine Vegetated Aquatic Bed:*** inundated areas expected to be 2 to 5 feet deep at a lake elevation of 4,487.8 feet where submerged aquatic vegetation is expected. Also includes the middle "ring" of the proposed ponds (approximately one third of each pond's area).

- ***Riverine Wetland:*** the outer one third of the proposed Provo River channel beginning at the first branching of the river and extending to Utah Lake.

- ***Emergent Wetland:*** inundated areas expected to be 0 to 2 feet deep at a lake elevation of 4,487.8 feet and the outer one third of the proposed ponds. Also includes existing emergent wetland habitat.

Table 3-24. Baseline and predicted aquatic habitat acreage available to fish.

AQUATIC HABITAT TYPES	BASELINE CONDITION (Existing Channel)[a]	PROJECT ALTERNATIVES			EXISTING CHANNEL OPTIONS	
		A	B	C	Option 1	Option 2
Riverine	0	34.8	34.5	34.5	0	0
Deep water	29.1	4.6	3.6	3.2	13.3	16.3
Lacustrine vegetated aquatic bed	0	35.7	28.9	22.2	0	0
Riverine wetland	0	2.4	0.2	1.0	0	0
Emergent wetland[b]	0	404.0	258.0	253.0	0	0
Total aquatic habitat	29.1	481.5	325.2	313.9	13.3	16.3

[a] The portion of the existing Provo River channel that is within the study area is characterized as deep water. Other study area wetlands under baseline (existing) conditions are not considered to be accessible to fish or—in the case of the phragmites-dominant emergent marsh—were not providing fish habitat.
[b] Includes portions of predicted emergent wetlands that would only be available as fish habitat during spring high flows/high lake levels, and areas that are inundated periodically from floods.

Table 3-25 provides a qualitative summary of the relative and projected detriments, neutrality, or benefits for fish species groups. Each alternative is discussed below to provide the rationale behind the development of Table 3-25.

Table 3-25. Qualitative assessment of fish group responses.

SPECIES GROUPS	BASELINE CONDITION[a]	PROJECT ALTERNATIVES[a]			EXISTING CHANNEL[a]	
		A	B	C	Option 1	Option 2
Native minnows (Utah chub)	–	++	++	+	0	0
Native suckers (June sucker, Utah sucker, mountain sucker)	–	++	+	+	0	0
Trouts and sculpins (brown trout, mottled sculpin)	0	0	0	0	0	0
Nonnative minnows (common carp, fathead minnow, western mosquitofish)	0	++	++	+	+	–
Nonnative sunfishes (bluegill, largemouth bass)	0	++	++	+	0	+
Nonnative catfishes (black bullhead, channel catfish)	0	++	+	++	0	0
Nonnative temperate basses, pickerel, and perches (white bass, walleye, northern pike)	0	++	+	++	0	+

[a] – = relative detriment, + = relative benefit, ++ = more relative benefit, 0 = relatively no change or neutral.

Existing Channel Option 1

As fish communities are often driven in part by habitat, Options 1 and 2 are likely to structure fish species presence and abundance somewhat differently. Under Option 1 (without impoundment), the lower Provo River would remain open to Utah Lake and function similarly to current conditions. With improving summer water quality (DO levels) the habitat and environmental conditions would become more suitable for brown trout, as well as warmwater fishes (e.g., channel catfish, white bass, bluegill, largemouth bass), but would also likely provide excellent habitat for common carp at times and given open connection to the lake. The presence of the delta diversion structure would eliminate the possibility for fish to move upstream, but fish could still move to Utah Lake at will; however, annual spawning movements of nonnative game fish (e.g., white bass) would likely prefer the restored river delta habitat area created with implementation of an action alternative.

Existing Channel Option 2

Under Option 2 (with impoundment), conditions would be altered similarly to those of Option 1; with a small impoundment, however, the lower Provo River could be selectively managed as a semi-separate water body that could support a more managed fishery. The placement of an impoundment on the lower Provo River would normally significantly alter the fish community and natural dynamics of a flowing system. However, due to upstream diversion for the proposed delta and the amount of water that would subsequently be delivered downstream, the ponding of a roughly 1.5-mile section would likely have no further effect on the fish community. Because much of the change in habitat and environmental conditions would come from shifting the Provo River northward, an impoundment could provide a means to manage warmwater fishes in a smaller system with the potential for greater bank angler opportunity. Under Option 2, by excluding upstream movement of undesirable fishes from Utah Lake into this channel segment, a community fishery could be maintained at the management discretion of the UDWR. With improvements in summer water quality and DO levels, maintenance of a trout fishery might also be possible.

Alternative A

With a more naturally functioning river delta under Alternative A, a more diverse and naturally functioning fish community would be expected. Alternative A would result in a predicted sixteen-fold increase in aquatic habitat compared to baseline (481.5 acres compared to 29.1 baseline). Total aquatic habitat includes some higher elevation emergent wetlands that would only be inundated during spring/summer high water and periodic floods. Much of the new aquatic/wetland habitat (greater than 200 acres) created under this alternative would be less than 2 feet deep during the average summertime water elevation. Such shallow habitats are important for young fishes to find refuge from predators and flow. Much of the primary productivity and nutrient filtering is conducted in these shallow water areas. The increase in the Provo River braiding in the delta area would allow nutrients and sediment to be dispersed across a larger floodplain/delta area, in turn decreasing turbidity and increasing primary production for aquatic macroinvertebrates and juvenile fishes. The increases in productivity and available forage would benefit juvenile fishes, including June sucker, as well as native minnows (e.g., Utah chub [*Gila atraria*]) and the nonnative western mosquitofish (*Gambusia affinis*).

In addition to this shallow-water habitat, Alternative A provides abundance and diversity in habitat depth. This diversity in depth would provide habitat for groups of fish such as the sunfishes (e.g., bluegill and largemouth bass) and catfishes (e.g., black bullhead and channel catfish). Bluegill are known to utilize shallow depths with sand substrates and aquatic vegetation for reproduction, as do numerous other warmwater sportfish (Sigler and Sigler 1996). Though many species of introduced sportfish have a wide array of habitats that they can potentially occupy, deeper sections (more than 3 feet deep) adjacent to shallow areas are often preferred for summer foraging and reproduction (Sigler and Sigler 1996). Bluegill will often occupy shallow areas while larger predatory sportfish (e.g., largemouth bass) will utilize habitat a bit deeper, waiting to prey upon the smaller sunfish. Largemouth bass currently comprise only a small percentage of the overall fish community in Utah Lake (Watson and Landress 2011). Under Alternative A, this popular sportfish would likely see increases in abundance and quality of individuals for recreational anglers as habitat created would be more suitable for summer foraging as well as for reproduction. The main braids of the Provo River under Alternative A would also provide increases in the amount of habitat for Utah suckers to reproduce and seasonally forage. In contrast, these habitat increases would likely not provide much benefit for trout and sculpin (e.g., brown trout and mottled sculpin, which occur in the existing Provo River channel). However, these species as well as the native Bonneville cutthroat trout are present further upstream in the Provo River drainage, which provides more suitable habitat.

The major fisheries issue for Alternative A is that improved and accessible habitat would also benefit nonnative common carp, western mosquito fish, and fathead minnows (*Pimephales promelas*). Common carp are considered an invasive species and are ubiquitous in Utah Lake (Sigler and Sigler 1996, Watson and Landress 2011). As common carp forage, they typically uproot aquatic vegetation (Sigler and Sigler 1996). Without management control of this species, the project implementation area would be susceptible to habitat degradation, with reduced cover and structure. Efforts to remove carp from Utah Lake are expected to continue under Alternative A and all alternatives, including the No Action, as an ongoing component of the JSRIP.

<u>Alternative B</u>

Alternative B would provide increases in all aquatic habitat types and would benefit the same species as Alternative A. Overall, there would be about an eleven-fold increase in aquatic habitat compared to baseline (325.2 acres compared to 29.1 baseline). Total aquatic habitat includes some higher elevation emergent wetlands that would only be inundated during spring/summer high water and during periodic floods. These increases would be anticipated to benefit native cyprinids and suckers as well as resident sportfish. While smaller in scale than Alternative A, Alternative B was designed to provide enough habitat to meet the project need, as discussed in Chapter 2. Overall, a more naturally functioning river delta under Alternative B would be anticipated when compared to baseline conditions and the No-Action Alternative, and with it would come a more diverse and more naturally functioning fish community. As with Alternative A, habitat improvements with Alternative B would also benefit nonnative common carp and nonnative fathead minnows. Efforts to remove carp from Utah Lake are expected to continue under Alternative B as an ongoing component of the JSRIP.

Alternative C

Alternative C would provide increases in all aquatic habitat types and would benefit the same species as Alternatives A and B. Overall there would be about an eleven-fold increase in aquatic habitat compared to baseline. This quantity is lower compared to Alternatives A and B because a substantial portion of the existing emergent wetland habitat would continue to be isolated from use by fish due to the north berm. Nonetheless, the habitat areas that would be available to fish under Alternative C would be anticipated to benefit native cyprinids and suckers as well as resident sportfish. While smaller in scale than Alternative A, Alternative C was designed to provide enough habitat to meet the project need, as discussed in Chapter 2. Overall, a more naturally functioning river delta under Alternative C would be anticipated when compared to baseline conditions and the No-Action Alternative, and with it would come a more diverse and more naturally functioning fish community. As with Alternatives A or B, habitat improvements with Alternative C would also benefit nonnative common carp and nonnative flathead minnows. Efforts to remove carp from Utah Lake are expected to continue under Alternative C as an ongoing component of the JSRIP.

3.7.7 Indirect and Cumulative Impacts

The overall effect of any of the three action alternatives would be to partially offset some of the past, present, and reasonably foreseeable impacts on fishery resources that have resulted from past actions and that would result from other future actions within the Utah Lake watershed. Positive effects of the project would combine with other efforts being pursued by multiple entities to improve the ecological condition of Utah Lake, including in particular the carp removal effort implemented by the JSRIP and efforts to control invasive phragmites by Utah County, the Utah Lake Commission, the Division of Forestry Fire and State Lands, and other partners.

Within the study area, many of the environmental and habitat changes expected with any of the action alternatives may not be realized immediately after the restoration project is complete. Close observation of fish community structure would be necessary and adjustments to current management priorities regarding the fisheries in the Provo River and Utah Lake may be necessary. Under any of the action alternatives, recreational angling opportunity would likely improve over time. With improvements to existing habitat and expansion of available habitat, as predicted with any of the three action alternatives, sportfish quality would likely improve, which would likely attract more anglers to Utah Lake and the Provo River delta. For example, sunfish species do not currently comprise a majority of Utah Lake fish species, but these species are often sought by anglers (J. Watson 2012, pers. comm.). With additional habitat, refuge, and forage, sunfish would likely increase in abundance and benefit anglers who target these species. Temperate basses and perches, also popular with anglers, would also likely see increases in quantity and quality of individuals.

3.7.8 Mitigation Measures

General benefits to fisheries would occur under any of the action alternatives. Because the main flow of the Provo River would be diverted to a new location, it will be necessary for the JLAs to incorporate components into the proposed action or to make mitigation commitments to implement and maintain one of the two proposed existing channel options.

Under either of the two options, commitments would be made to:

- maintain a flow between 10–50 cfs in the existing river channel
- improve water quality in the existing channel through aeration
- work cooperatively with Utah County, the State of Utah , and other partners to make improvements to the existing channel.

3.7.9 Fishery Resources Summary

Any of the action alternatives would have overall positive effects on fishery resources by restoring a naturally functioning river-lake interface and increasing acreage of open water (deep water, riverine, lacustrine vegetated aquatic bed) delta and wetland habitats. Action alternatives have been specifically designed to benefit June sucker, but would benefit other species as well, with some benefitting more than others. As a generalist species, common carp would likely take advantage of the restored delta area; thus, an ongoing effort to reduce this species to a manageable level in Utah Lake is important to success of the proposed action.

Positive effects of the project would combine with other efforts being pursued by multiple entities to improve the ecological condition of Utah Lake and this would benefit the Utah Lake fishery. Overall, angling opportunities would be expanded and improved over existing conditions as a result of any of the three action alternatives.

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3.8 Wildlife Resources

This section describes wildlife habitats and species known to exist in the study area, including discussions of federal and State regulations and land use designations protecting wildlife. Impacts of alternatives are assessed, including reasonably foreseeable indirect and cumulative impacts.

Change in wildlife habitat was determined to be a relevant issue for detailed evaluation in this EIS. Projects involving modification and conversion of habitats for wildlife can cause impacts to species that rely on the existing conditions. Federal and State regulations protecting wildlife also require assessments to determine that projects are consistent with legal protections for species. At the federal level, these regulations include the ESA (7 USC 136; 16 USC 1531 *et seq*. 1973), the Bald and Golden Eagle Protection Act (16 USC 668a-d) and the Migratory Bird Treaty Act (16 USC 703-712). At the State level, the Utah Sensitive Species List and the Comprehensive Wildlife Conservation Strategy (UDWR 2005) identify “wildlife species of concern” for which conservation actions are needed to preclude the future need to list these species under provisions of the ESA.

3.8.1 Issues Addressed in the Impact Analysis

The proposed action would convert portions of the existing landscape, which is primarily agricultural (including both wetlands and uplands), to a diversity of native habitat communities. This conversion would have generally positive effects for some wildlife, though some species would benefit more than others. The relative effects for various species are evaluated in this impact assessment. This assessment is based on a literature review of general habitat requirements for species common to Utah County and site visits by a wildlife resources specialist to identify existing habitats and habitat conditions. Database sources, such as the Utah Conservation Data Center (UDWR 2015) and eBird.org (National Audubon Society and Cornell Lab of Ornithology 2011) provided additional information about habitats and species occurrences.

3.8.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to wildlife were eliminated from analysis. Other sections of this EIS help to address issues related to general wildlife habitat. A more complete analysis of bird communities and bird-aircraft strike risk are evaluated in Section 3.16. The evaluation of impacts to federally listed threatened and endangered species is evaluated in Section 3.9. Impacts to fish and other aquatic life are evaluated in Section 3.7. The wildlife habitat analysis relied upon the estimation of wetland habitat conversion presented in Section 3.5.

3.8.3 Area of Influence

The study area was investigated for potential effects to wildlife. There is little potential to affect wildlife beyond this area, except that implementation of an action alternative may to a limited extent attract various wildlife species from surrounding environments, particularly lower-quality habitat within the region, as discussed in Section 3.8.7, Indirect and Cumulative Impacts.

3.8.4 Affected Environment (Baseline Conditions)

Wildlife Habitats

Wetland and upland wildlife habitats are presently found in the study area (Figure A-26, Appendix A). Wetlands are discussed at length in the wetlands section of this EIS (Section 3.5). While there were nine different classes of wetlands identified in the wetlands delineation, in terms of wildlife use, these habitats can be grouped into two broader categories: wetland and open water. Two distinct types of upland habitats are also present: agricultural fields and upland grasslands. A sixth habitat class, riparian woodlands, occurs in both wetland and upland portions of the study area but provides similar wildlife habitat throughout. In general, all six wildlife habitat types in the study area are fragmented to varying degrees by roads, trails, agricultural activity, and invasive weeds, resulting in reduced carrying capacity, lower reproductive success, and higher susceptibility to predation for most wildlife species. Each habitat type is now described in greater detail along with wildlife species that have been observed or are likely to occur in each.

Open Water

At present, the open water habitat is found only on the stretch of the lower Provo River which flows along the southern boundary of the study area. The portion of the river corridor located within the study area is approximately 29.1 acres in size. Diving ducks, including common merganser (*Mergus merganser*), lesser scaup (*Aythya affinis*), and redhead (*Aythya americana*) forage in open water, along with waterbirds such as the eared grebe (*Podiceps nigricollis*) and western grebe (*Aechmophorus occidentalis*). The lower Provo River also hosts aquatic mammals, including muskrat (*Ondatra zibethicus*) and an occasional beaver (*Castor canadensis*) (Pritchett et al. 1981). Two special-status species, bald eagle (*Haliaeetus leucocephalus*) and American white pelican (*Pelecanus erythrorhynchos*) (pelican), may also forage in the open water habitat.

Wetland

Study area wetlands encompass about 300.0 acres of the study area. [6] This acreage includes a matrix of more frequently flooded emergent marsh habitats and less frequently flooded wet meadow environments.

Common plant species found in the emergent marsh areas include: spikerush, Nebraska sedge, reed canarygrass, redtop, creeping bentgrass (*Agrostis stolonifera*), phragmites, Canada goldenrod (*Solidago canadensis*), Arctic rush, cattail, hardstem bulrush, and chairmaker's bulrush. Undesirable weedy species are a dominant component within some of the study area marsh habitats and include: annual rabbitsfoot (*Polypogon monspeliensis*), annual ragweed (*Ambrosia artemisiifolia*), and lambsquarters. Annual ragweed is especially prevalent in

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[6] Wildlife habitat categories do not match with jurisdictional wetland categories from Section 3.5. In particular, open water, wetland, and woodland wildlife habitat categories do not match directly with how jurisdictional wetlands are officially delineated under Section 404 of the Clean Water Act, and as presented in Section 3.5 of this EIS. For example, the predicted wetland landscape class of "lacustrine vegetated aquatic bed" is delineated as a type of wetland under Section 404, but in terms of wildlife habitat would be considered a type of aquatic habitat (i.e., included in the open water category). Also only portions of the woodland wildlife habitat category are delineated as forested wetland in the jurisdictional wetland analysis.

wetlands on the west end of the study area. Canada thistle (*Cirsium arvense*) can also be found within study area wetlands, and although it is not common, it is considered a noxious species for the State of Utah and Utah County. Typical bird species using the marsh community include common yellowthroat (*Geothlypis trichas*), song sparrow (*Melospiza melodia*), marsh wren (*Cistothorus palustris*), red-winged blackbird (*Agelaius phoeniceus*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), sora (*Porzana carolina*), and Virginia rail (*Rallus limicola*). Muskrat may be found in deeper, open areas of emergent marshes, and several waterfowl species, like redhead and gadwall (*Anas strepera*), nest in emergent vegetation.

Slightly higher in elevation, the less frequently flooded wet meadow portions of the study area are important breeding habitat for both waterfowl and amphibians. Common wet meadow nesting birds include northern pintail (*Anas acuta*), cinnamon teal (*Anas cyanoptera*), and Canada goose (*Branta canadensis*). The plentiful bird eggs and nestlings found in these areas in the springtime likely attract predators such as the striped skunk (*Mephitis mephitis*) and northern raccoon (*Procyon lotor*). The western chorus frog (*Pseudacris triseriata*) and northern leopard frog (*Rana pipiens*) would be the most common amphibians that are likely to occur in these areas, and may attract predators such as the red-sided garter snake (*Thamnophis sirtalis parietalis*) (Pritchett et al. 1981).

Woodland

Woodland areas are relatively scarce in the study area at approximately 23.3 acres. This includes the tree canopy surrounding the existing river channel, which is an upland plant community, as well as some smaller patches of forested wetlands/riparian shrublands that were included in the wetland delineation (Section 3.5). Study area woodland habitats are dominated by eastern cottonwood and crack willow with scattered green ash, Russian olive, and saltcedar. Common plant species found in the lower strata layers include coyote willow, grey alder (*Alnus incana*), reed canarygrass, phragmites, and various weedy species including the mildly toxic, nonnative bittersweet nightshade (*Solanum dulcamara*). Bittersweet nightshade occupies the bank slopes of the river channel and is often associated with anthropogenic disturbance (Waggy 2011). Most of the overstory canopy is closed while the understory is generally underdeveloped, perhaps due to active maintenance of access along the river corridor trail as well as off-trail disturbances by fishermen and other recreationists. Phragmites and saltcedar occur within study area woodland habitat and are considered noxious weeds in Utah County (UWCA 2011).

Many bird species not found elsewhere in the study area occur within the woodland communities, including several species of warblers, woodpeckers, and vireos. The profusion of small birds also attracts predators, such as the western yellow-bellied racer (*Coluber constrictor mormon*) (Pritchett et al. 1981). Bald eagles may use mature cottonwood trees as hunting perches, nest trees, and night roosts (Steenhof et al. 1980). Many bat species forage in riparian areas at night and are likely present in the study area; the California myotis (*Myotis californicus*), silver-haired bat (*Lasionycteris noctivagans*), and big brown bat (*Eptesicus fuscus*) have all been reported from lowland riparian areas in Utah County (Oliver 2000).

Upland Grassland

Upland grassland areas, comprising 88.4 acres of the study area, are also used for grazing but are distinguished from other agricultural lands by being interspersed with wetland areas, with the boundary between these habitat classes changing with rising and falling water levels. These uplands are found in the northern half and eastern third of the study area. Plant diversity is low within these communities and they primarily consist of nonnative species. The most common plants found in upland grasslands within the study area are: meadow fescue (*Festuca pratensis*), foxtail barley (*Hordeum jubatum*), intermediate wheatgrass, annual ragweed, lambsquarters, prickly lettuce (*Lactuca serriola*), and various *Bromus* species. The high amount of weedy species within these communities is likely due to current and historical agricultural activity, altered hydrology, grazing, nearby development, and heavy recreational use of nearby areas. Upland areas close to wetlands are important for nesting waterfowl; 25 waterfowl species have been documented in the study area. Upland grasslands also provide habitat for western meadowlarks (*Sturnella neglecta*), horned larks (*Eremophila alpestris*), California quail (*Callipepla californica*), and one State species of concern, the long-billed curlew (*Numenius americanus*).

Both upland grassland and agricultural areas support robust terrestrial insect populations, as well as abundant grass seeds. These resources are likely utilized by small mammals such as the deer mouse (*Peromyscus maniculatus*) and the western harvest mouse (*Reithrodontomys megalotis*), which in turn could be preyed on by garter snake (*Thamnophis elegans vagrans*), striped skunk, and long-tailed weasel (*Mustela frenata*) (Pritchett et al. 1981). Several raptor species may exploit these small mammal populations as well, including one State species of concern, the short-eared owl (*Asio flammeus*).

Agricultural

The most abundant and most disturbed habitat class is agricultural, comprising approximately 261.4 acres of the study area. This upland area consists of grazed pastures and alfalfa with some outbuildings present. Species composition of noncultivated grazing fields is similar to that found within the study area upland grassland communities with the addition of red clover (*Trifolium pratense*), five horn smotherweed and saltgrass. Due to the high level of disturbance from grazing, this habitat is dominated by nonnative, weedy vegetation or species with a preference for disturbed locations such as broom snakeweed (*Gutierrezia sarothrae*) (Tirmenstein 2011). More broadly from a wildlife habitat standpoint, the study area agricultural communities differ from upland grassland communities in that the disturbance is extensive enough that the community no longer resembles or functions as a natural system. The presence of saltgrass within these communities, for example, may be evidence of high soil salt content. Even with these disturbance factors, however, agricultural areas provide habitat for ring-necked pheasant (*Phasianus colchicus*) and several species of swallow. Agricultural fields within the study area are seasonally inundated with water in the springtime and/or when irrigated. The presence of standing water may periodically attract flocks of white-faced ibis (*Plegadis chihi*), numerous species of waterfowl, and shorebirds. However, during dry periods, suitable habitat for these species is lacking. Generally, habitat during dry period supports a large number of birds across a small number of species, resulting in low species richness.

Wildlife Species

Table 3-26 provides a broader characterization of wildlife species known or likely to occur in the study area and their habitat types. The table also shows special status species in the State of Utah. Bird species are listed in Table 3-27 along with their season of occurrence in the study area. Three hundred twenty-five bird species are known to occur in Utah County; Table 3-27

Table 3-26. Wildlife species observed, known, or likely to occur in study area habitats.

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE	SPECIAL STATUS[a]
		Mammals	
Big brown bat	*Eptesicus fuscus*	agriculture, riparian woodlands, upland grasslands	-
Botta's pocket gopher	*Thomomys bottae*	agriculture, upland grasslands	-
Brush mouse	*Peromyscus boylii*	agriculture	-
California myotis	*Myotis californicus*	agriculture, riparian woodlands, upland grasslands	-
Coyote	*Canis latrans*	agriculture, upland grasslands	-
Deer mouse	*Peromyscus maniculatus*	agriculture, riparian woodlands, upland grasslands	-
House mouse	*Mus musculus*	agriculture, riparian woodlands, upland grasslands	-
Long-tailed weasel	*Mustela frenata*	agriculture, riparian woodlands, upland grasslands	-
Meadow vole	*Microtus pennsylvanicus*	agriculture, upland grasslands, wetlands	-
Mule deer	*Odocoileus hemionus*	agriculture, riparian woodlands, upland grasslands, wetlands	Tier III
Muskrat	*Ondatra zibethicus*	open water, wetlands	-
Northern grasshopper mouse	*Onychomys leucogaster*	agriculture, upland grasslands	-
Northern pocket gopher	*Thomomys talpoides*	agriculture, upland grasslands	-
Northern raccoon	*Procyon lotor*	agriculture, riparian woodlands, upland grasslands, wetlands	-
Norway rat	*Rattus norvegicus*	agriculture, riparian woodlands, upland grasslands, wetlands	-
Nutria	*Myocastor coypus*	open water, wetlands	-
Red fox	*Vulpes vulpes*	agriculture, riparian woodlands, upland grasslands, wetlands	-
Rock squirrel	*Spermophilus variegatus*	agriculture, upland grasslands	-
Striped skunk	*Mephitis mephitis*	agriculture, riparian woodlands, upland grasslands, wetlands	-
		Reptiles	
Common gartersnake	*Thamnophis sirtalis*	Riparian Woodlands, Wetlands	-
Eastern racer	*Coluber constrictor*	agriculture, riparian woodlands, upland grasslands	-
Gophersnake	*Pituophis catenifer*	agriculture, upland grasslands	-
Striped whipsnake	*Masticophis taeniatus*	riparian woodlands, upland grasslands, wetlands	-
Terrestrial gartersnake	*Thamnophis elegans*	agriculture, riparian woodlands, upland grasslands, wetlands	-

Table 3-26. Continued.

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE	SPECIAL STATUS[a]
Amphibians			
American bull frog	*Rana catesbeiana*	open water, wetlands	-
Great Basin spadefoot	*Spea intermontana*	agriculture, riparian woodlands, upland grasslands, wetlands	-
Columbia spotted frog	*Rana luteiventris*	open water, riparian woodlands, wetlands	CAS
Northern leopard frog	*Rana pipiens*	open water, riparian woodlands, upland grasslands, wetlands	Tier III
Tiger salamander	*Ambystoma tigrinum*	riparian woodlands, upland grasslands, wetlands	-
Western chorus frog	*Pseudacris triseriata*	agriculture, riparian woodlands, upland grasslands, wetlands	-
Western (boreal) toad	*Bufo boreas*	riparian woodlands, upland grasslands, wetlands	SPC
Woodhouse's toad	*Bufo woodhousii*	agriculture, riparian woodlands, upland grasslands, wetlands	-
Mollusks			
California floater	*Anodonta californiensis*	open water, wetlands	SPC

[a] State of Utah status: CAS=conservation agreement species; SPC=wildlife species of concern; SS=sensitive species; Tier III = species of conservation concern because they are linked to at-risk habitat, have a substantial decrease in population size, or have little information available regarding the species' life history, population, status, and threats (UDWR 2005).

Table 3-27. Bird species observed or known to occur in study area habitats.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
American avocet	*Recurvirostra americana*	Summer (breeding)	wetlands	Tier III
American coot	*Fulica americana*	Year-round	open water, wetlands	-
American crow	*Corvus brachyrhynchos*	Year-round	riparian woodlands	-
American goldfinch	*Spinus tristis*	Year-round	agriculture, riparian woodlands, upland grasslands	-
American kestrel	*Falco sparverius*	Year-round	agriculture, upland grasslands	-
American pipit	*Anthus rubescens*	Migration	agriculture, upland grasslands	-
American redstart	*Setophaga ruticilla*	Migration	riparian woodlands	-
American robin	*Turdus migratorius*	Year-round	agriculture, riparian woodlands, upland grasslands	-
American tree sparrow	*Spizella arborea*	Winter (nonbreeding)	agriculture, riparian woodlands, upland grasslands	-
American white pelican	*Pelecanus erythrorhynchos*	Summer (breeding)	open water, wetlands	SPC
American wigeon	*Anas americana*	Summer (breeding)	agriculture, upland grasslands, wetlands	-

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Ash-throated flycatcher	*Myiarchus cinerascens*	Summer (breeding)	riparian woodlands, upland grasslands	
Bald eagle	*Haliaeetus leucocephalus*	Winter (nonbreeding)	open water, riparian woodlands, wetlands	SPC
Bank swallow	*Riparia riparia*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Barn owl	*Tyto alba*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Barn swallow	*Hirundo rustica*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Belted kingfisher	*Megaceryle alcyon*	Year-round	open water, riparian woodlands, wetlands	-
Black-billed magpie	*Pica hudsonia*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Black-capped chickadee	*Poecile atricapillus*	Year-round	riparian woodlands	-
Black-chinned hummingbird	*Archilochus alexandri*	Summer (breeding)	riparian woodlands, upland grasslands	-
Black-crowned night-heron	*Nycticorax nycticorax*	Summer (breeding)	riparian woodlands, wetlands	-
Black-headed grosbeak	*Pheucticus melanocephalus*	Summer (breeding)	riparian woodlands	-
Black-necked stilt	*Himantopus mexicanus*	Summer (breeding)	wetlands	Tier III
Black-throated gray warbler	*Dendroica nigrescens*	Summer (breeding)	riparian woodlands	Tier III
Blue grosbeak	*Passerina caerulea*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands	-
Blue-gray gnatcatcher	*Polioptila caerulea*	Summer (breeding)	riparian woodlands	-
Blue-winged teal	*Anas discors*	Summer (breeding)	upland grasslands, wetlands	-
Bobolink	*Dolichonyx oryzivorus*	Summer (breeding)	agriculture, upland grasslands, wetlands	SPC
Brewer's blackbird	*Euphagus cyanocephalus*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Brewer's sparrow	*Spizella breweri*	Summer (breeding)	upland grasslands	Tier III
Broad-tailed hummingbird	*Selasphorus platycercus*	Summer (breeding)	riparian woodlands	Tier III
Brown creeper	*Certhia americana*	Year-round	riparian woodlands	-

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Brown-headed cowbird	*Molothrus ater*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands	-
Bufflehead	*Bucephala albeola*	Winter (nonbreeding)	riparian woodlands, wetlands	-
Bullock's oriole	*Icterus bullockii*	Summer (breeding)	riparian woodlands	-
Burrowing owl	*Athene cunicularia*	Summer (breeding)	agriculture, upland grasslands	SPC
Bushtit	*Psaltriparus minimus*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	
Cackling goose	*Branta hutchinsii*	Migration	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
California gull	*Larus californicus*	Year-round	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
California quail	*Callipepla californica*	Year-round	riparian woodlands, upland grasslands	-
Canada goose	*Branta canadensis*	Year-round	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Canvasback	*Aythya valisineria*	Summer (breeding)	agriculture, open water, wetlands, upland grasslands	-
Caspian tern	*Hydroprogne caspia*	Summer (breeding)	open water, wetlands	Tier III
Cassin's vireo	*Vireo cassinii*	Migration	riparian woodlands	-
Cattle egret	*Bubulcus ibis*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Cedar waxwing	*Bombycilla cedrorum*	Year-round	agriculture, riparian woodlands, upland grasslands	-
Chipping sparrow	*Spizella passerina*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands	-
Cinnamon teal	*Anas cyanoptera*	Summer (breeding)	open water, upland grasslands, wetlands	-
Clark's grebe	*Aechmophorus clarkii*	Summer (breeding)	open water, wetlands	-
Cliff swallow	*Petrochelidon pyrrhonota*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Common goldeneye	*Bucephala clangula*	Winter (nonbreeding)	open water, wetlands	-
Common grackle	*Quiscalus quiscula*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Common loon	*Gavia immer*	Migration	open water, wetlands	-
Common merganser	*Mergus merganser*	Winter (nonbreeding)	open water, riparian woodlands, wetlands	-

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Common nighthawk	*Chordeiles minor*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Common raven	*Corvus corax*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Common Yellowthroat	*Geothlypis trichas*	Summer (breeding)	riparian woodlands, wetlands	-
Cooper's hawk	*Accipiter cooperii*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Cordilleran flycatcher	*Empidonax occidentalis*	Summer (breeding)	riparian woodlands	-
Dark-eyed junco	*Junco hyemalis*	Year-round	agriculture, riparian woodlands, upland grasslands	-
Double-crested cormorant	*Phalacrocorax auritus*	Summer (breeding)	open water, riparian woodlands, wetlands	-
Downy woodpecker	*Picoides pubescens*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Dusky flycatcher	*Empidonax oberholseri*	Summer (breeding)	riparian woodlands	-
Eared grebe	*Podiceps nigricollis*	Summer (breeding)	wetlands	-
Eastern kingbird	*Tyrannus tyrannus*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Eurasian collared-dove	*Streptopelia decaocto*	Year-round	agriculture, upland grasslands	-
European starling	*Sturnus vulgaris*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Forster's tern	*Sterna forsteri*	Summer (breeding)	open water, wetlands	-
Franklin's gull	*Leucophaeus pipixcan*	Summer (breeding)	agriculture, open water, upland grasslands, wetlands	-
Gadwall	*Anas strepera*	Year-round	agriculture, upland grasslands, wetlands	-
Gray catbird	*Dumetella carolinensis*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Golden eagle	*Aquila chrysaetos*	Year-round	agriculture, open water, riparian woodlands, upland grasslands, wetlands	
Grasshopper sparrow	*Ammodramus savannarum*	Summer (breeding)	upland grasslands	SPC
Gray flycatcher	*Empidonax wrightii*	Summer (breeding)	riparian woodlands, upland grasslands	-
Great blue heron	*Ardea herodias*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Great horned owl	*Bubo virginianus*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Greater scaup	*Aythya marila*	Migration	open water, wetlands	
Greater White-fronted Goose	*Anser albifrons*	Migration	agriculture, upland grasslands, wetlands	-
Greater yellowlegs	*Tringa melanoleuca*	Migration	riparian woodlands, wetlands	-
Great-tailed Grackle	*Quiscalus mexicanus*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Green-tailed Towhee	*Pipilo chlorurus*	Summer (breeding)	riparian woodlands, upland grasslands	-
Green-winged teal	*Anas crecca*	Year-round	upland grasslands, wetlands	-
Hairy woodpecker	*Picoides villosus*	Year-round	riparian woodlands	-
Harris's sparrow	*Zonotrichia querula*	Migration	agriculture, riparian woodlands, upland grasslands	-
Hermit thrush	*Catharus guttatus*	Summer (breeding)	riparian woodlands, wetlands	-
Herring gull	*Larus argentatus*	Migration	agriculture, open water, upland grasslands, wetlands	-
Hooded merganser	*Lophodytes cucullatus*	Migration	riparian woodlands, wetlands	-
Horned grebe	*Podiceps auritus*	Migration	wetlands	-
Horned lark	*Eremophila alpestris*	Year-round	agriculture, upland grasslands	-
House finch	*Carpodacus mexicanus*	Year-round	agriculture, riparian woodlands, upland grasslands	-
House sparrow	*Passer domesticus*	Year-round	agriculture	-
House wren	*Troglodytes aedon*	Summer (breeding)	agriculture, riparian woodlands, wetlands	-
Killdeer	*Charadrius vociferus*	Year-round	agriculture, wetlands, upland grasslands	-
Lark sparrow	*Chondestes grammacus*	Summer (breeding)	agriculture, upland grasslands, wetlands	
Lazuli bunting	*Passerina amoena*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands	
Least sandpiper	*Calidris minutilla*	Migration	riparian woodlands, wetlands	-
Lesser goldfinch	*Spinus psaltria*	Summer (breeding)	riparian woodlands	-
Lesser scaup	*Aythya affinis*	Winter (nonbreeding)	open water, wetlands	-
Lesser yellowlegs	*Tringa flavipes*	Migration	riparian woodlands, wetlands	-
Lincoln's sparrow	*Melospiza lincolnii*	Migration	riparian woodlands, wetlands	-

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Long-billed curlew	*Numenius americanus*	Summer (breeding)	agriculture, upland grasslands, wetlands	SPC
Long-billed dowitcher	*Limnodromus scolopaceus*	Migration	agriculture, wetlands	
Long-eared owl	*Asio otus*	Year-round	agriculture, riparian woodlands, upland grasslands	-
MacGillivray's warbler	*Oporornis tolmiei*	Summer (breeding)	riparian woodlands	-
Mallard	*Anas platyrhynchos*	Year-round	agriculture, upland grasslands, wetlands	-
Marbled godwit	*Limosa fedoa*	Migration	agriculture, wetlands	
Marsh wren	*Cistothorus palustris*	Year-round	wetlands	-
Merlin	*Falco columbarius*	Winter (nonbreeding)	agriculture, riparian woodlands, upland grasslands, wetlands	
Mountain bluebird	*Sialia currucoides*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands	-
Mountain chickadee	*Poecile gambeli*	Year-round	riparian woodlands	-
Mourning dove	*Zenaida macroura*	Year-round	agriculture, riparian woodlands, upland grasslands	-
Mute swan	*Cygnus olor*	Winter (nonbreeding)	open water, riparian woodlands	
Nashville warbler	*Oreothlypis ruficapilla*	Migration	riparian woodlands, upland grasslands	-
Northern flicker	*Colaptes auratus*	Year-round	riparian woodlands, upland grasslands	-
Northern harrier	*Circus cyaneus*	Year-round	agriculture, upland grasslands, wetlands	-
Northern mockingbird	*Mimus polyglottos*	Year-round	agriculture, riparian woodlands, upland grasslands	
Northern pintail	*Anas acuta*	Year-round	upland grasslands, wetlands	-
Northern rough-winged Swallow	*Stelgidopteryx serripennis*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Northern shoveler	*Anas clypeata*	Year-round	upland grasslands, wetlands	-
Northern shrike	*Lanius excubitor*	Winter (nonbreeding)	agriculture, riparian woodlands, upland grasslands, wetlands	
Northern waterthrush	*Parkesia noveboracensis*	Migration	riparian woodlands	-
Olive-sided Flycatcher	*Contopus cooperi*	Summer (breeding)	riparian woodlands	-
Orange-crowned Warbler	*Oreothlypis celata*	Summer (breeding)	riparian woodlands	-

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Osprey	*Pandion haliaetus*	Summer (breeding)	open water, riparian woodlands, wetlands	Tier III
Peregrine falcon	*Falco peregrinus*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	Tier III
Pied-billed grebe	*Podilymbus podiceps*	Year-round	wetlands	-
Pine siskin	*Spinus pinus*	Year-round	agriculture, riparian woodlands, upland grasslands	-
Plumbeous vireo	*Vireo plumbeus*	Summer (breeding)	riparian woodlands	-
Prairie falcon	*Falco mexicanus*	Year-round	agriculture, upland grasslands	-
Red-breasted Merganser	*Mergus serrator*	Migration	open water, riparian woodlands, wetlands	-
Redhead	*Aythya americana*	Year-round	open water, wetlands	-
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Summer (breeding)	riparian woodlands	-
Red-tailed hawk	*Buteo jamaicensis*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Red-winged blackbird	*Agelaius phoeniceus*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Ring-billed gull	*Larus delawarensis*	Winter (nonbreeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Ring-necked duck	*Aythya collaris*	Winter (nonbreeding)	open water, wetlands	-
Ring-necked pheasant	*Phasianus colchicus*	Year-round	agriculture, upland grasslands, wetlands	-
Rock pigeon	*Columba livia*	Year-round	agriculture, upland grasslands	-
Rock wren	*Salpinctes obsoletus*	Year-round	agriculture, riparian woodlands, upland grasslands	
Ross's goose	*Chen rossii*	Migration	agriculture, upland grasslands, wetlands	-
Rough-legged hawk	*Buteo lagopus*	Winter (nonbreeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Ruby-crowned Kinglet	*Regulus calendula*	Summer (breeding)	riparian woodlands, upland grasslands	-
Ruddy duck	*Oxyura jamaicensis*	Year-round	open water, wetlands	-
Sage thrasher	*Oreoscoptes montanus*	Summer (breeding)	agriculture, upland grasslands	Tier III
Sandhill crane	*Grus canadensis*	Summer (breeding)	agriculture, upland grasslands, wetlands	-
Savannah sparrow	*Passerculus sandwichensis*	Summer (breeding)	agriculture, upland grasslands, wetlands	-

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Say's phoebe	*Sayornis saya*	Summer (breeding)	agriculture, upland grasslands	-
Short-eared owl	*Asio flammeus*	Year-round	agriculture, upland grasslands, wetlands	SPC
Semipalmated plover	*Charadrius semipalmatus*	Migration	agriculture, wetlands	
Sharp-shinned Hawk	*Accipiter striatus*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	
Snow bunting	*Plectrophenax nivalis*	Winter (nonbreeding)	agriculture, upland grasslands	-
Snow goose	*Chen caerulescens*	Migration	agriculture, open water, upland grasslands, wetlands	-
Snowy egret	*Egretta thula*	Summer (breeding)	riparian woodlands, wetlands	-
Solitary sandpiper	*Tringa solitaria*	Migration	riparian woodlands, wetlands	-
Song sparrow	*Melospiza melodia*	Year-round	agriculture, riparian woodlands, upland grasslands, wetlands	-
Sora	*Porzana carolina*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Spotted sandpiper	*Actitis macularius*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Spotted towhee	*Pipilo maculatus*	Year-round	riparian woodlands	-
Steller's jay	*Cyanocitta stelleri*	Year-round	riparian woodlands	
Surf scoter	*Melanitta perspicillata*	Migration	open water, wetlands	-
Swainson's hawk	*Buteo swainsoni*	Summer (breeding)	agriculture, upland grasslands, wetlands	-
Swainson's thrush	*Catharus ustulatus*	Migration	riparian woodlands	-
Townsend's solitaire	*Myadestes townsendi*	Year-round	riparian woodlands	
Tree swallow	*Tachycineta bicolor*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Tundra swan	*Cygnus columbianus*	Winter (nonbreeding)	agriculture, open water	
Turkey vulture	*Cathartes aura*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Vesper sparrow	*Pooecetes gramineus*	Summer (breeding)	agriculture, upland grasslands	-
Violet-green Swallow	*Tachycineta thalassina*	Summer (breeding)	agriculture, open water, riparian woodlands, upland grasslands, wetlands	-
Virginia rail	*Rallus limicola*	Summer (breeding)	riparian woodlands, wetlands	-
Virginia's warbler	*Oreothlypis virginiae*	Summer (breeding)	riparian woodlands	Tier III

Table 3-27. Continued.

COMMON NAME	SCIENTIFIC NAME	SEASON	HABITAT TYPE	SPECIAL STATUS[a]
Warbling vireo	*Vireo gilvus*	Summer (breeding)	agriculture, riparian woodlands, wetlands	-
Western grebe	*Aechmophorus occidentalis*	Summer (breeding)	open water, wetlands	-
Western kingbird	*Tyrannus verticalis*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands	-
Western meadowlark	*Sturnella neglecta*	Year-round	agriculture, upland grasslands, wetlands	-
Western screech-owl	*Megascops kennicottii*	Year-round	riparian woodlands	-
Western scrub-jay	*Aphelocoma californica*	Year-round	riparian woodlands	-
Western tanager	*Piranga ludoviciana*	Summer (breeding)	riparian woodlands	-
Western wood-pewee	*Contopus sordidulus*	Summer (breeding)	riparian woodlands	-
White-breasted nuthatch	*Sitta carolinensis*	Year-round	riparian woodlands	-
White-crowned sparrow	*Zonotrichia leucophrys*	Year-round	agriculture, riparian woodlands, upland grasslands	-
White-faced ibis	*Plegadis chihi*	Summer (breeding)	agriculture, upland grasslands, wetlands	-
White-throated swift	*Aeronautes saxatalis*	Summer (breeding)	agriculture, riparian woodlands, upland grasslands, wetlands	-
Willet	*Tringa semipalmata*	Summer (breeding)	upland grasslands, wetlands	-
Willow flycatcher	*Empidonax traillii*	Summer (breeding)	riparian woodlands	-
Wilson's phalarope	*Phalaropus tricolor*	Summer (breeding)	open water, wetlands	
Wilson's snipe	*Gallinago delicata*	Year-round	riparian woodlands, upland grasslands, wetlands	-
Wilson's warbler	*Wilsonia pusilla*	Migration	riparian woodlands, wetlands	-
Wood duck	*Aix sponsa*	Winter (nonbreeding)	riparian woodlands, wetlands	-
Yellow warbler	*Dendroica petechia*	Summer (breeding)	riparian woodlands, wetlands	-
Yellow-breasted Chat	*Icteria virens*	Summer (breeding)	agriculture, riparian woodlands, wetlands	-
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Summer (breeding)	agriculture, upland grasslands, wetlands	-
Yellow-rumped warbler	*Dendroica coronata*	Summer (breeding)	riparian woodlands	-

[a] State of Utah status: CAS = conservation agreement species; SPC = wildlife species of concern; SS = sensitive species; Tier III = species of conservation concern because they are linked to at-risk habitat, have a substantial decrease in population size, or have little information available regarding the species' life history, population, status, and threats (UDWR 2005). Data Sources: National Audubon Society and Cornell Lab of Ornithology 2011 and BIO-WEST, Inc. field collected data from 2012 and 2013.

includes bird observations available from the eBird online database for study area birding hot spots which identified a total of 184 species observed during the period beginning in 2009 and ending in 2012. An additional eight species have been observed by a field biologist during surveys specific to this project, for a total of 192 species observed or known to occur in the study area. State-listed, special-status species include wildlife species designated by the State of Utah as a conservation agreement species, a wildlife species of concern, or a wildlife sensitive species. In addition, the Utah Comprehensive Wildlife Conservation Strategy includes listings of Tier III species of conservation concern because these species are linked to at-risk habitat, have experienced a substantial decrease in population size, or have little information available regarding the species' life history, population, status, and threats (UDWR 2005). As shown on Tables 3-26 and 3-27, there are 22 State-listed, special-status species with potential for occurring in the study area.

One State- and federally protected species, the yellow-billed cuckoo (*Coccyzus americanus*), has historically occurred in the vicinity of the study area (UDWR 2015). Generally, the riparian communities in the study area are not considered ideal for this species. In particular, the narrowness of the riparian corridor and the lack of a well-developed understory are not consistent with nesting habitat characteristics for this species (UDWR 2015).

3.8.5 Impacts of the No-Action Alternative

Under the No-Action Alternative, existing conditions would persist. Habitat within the study area would remain fragmented by such things as roads, agriculture, and nonnative plant species. Habitat fragmentation typically reduces total habitat area; size of individual habitat patches and proximity of individual habitat patches can increase the amount of habitat edge (Stephens et al. 2003). A reduction in the area of suitable habitat can result in the decline of populations by reducing the amount of adequate space for establishment of territories, nest sites, and other important resources. As suggested by Forman and Gordon (1986), the structure of habitat has a close relationship with abundance and diversity of wildlife. Consequently, low native plant abundance, persistence of nonnative species, agricultural uses, and presence of roads throughout the study area under the No-Action Alternative would not promote a healthy wildlife community. Rather, rates of predation are likely high, resulting in low rates of reproduction (particularly for avian species). Wildlife uses likely are restricted to ubiquitous species that have adapted to high disturbance levels that occur in proximity to human activity. These conditions would likely persist under the No-Action Alternative. Under this alternative, seasonal flooding would be expected to continue as it does under existing conditions, which involve active draining by agricultural landowners. During periods of inundation, habitat would be very attractive for large numbers of waterfowl and shorebirds. The existing conditions are however very attractive to nesting waterfowl during the spring as described in more detail in Section 3.16. However, these species disperse quickly in the summer and fall as conditions become dryer and the habitat is less attractive.

3.8.6 Impacts of Action Alternatives

The impact evaluation for each action alternative considers the amount of habitat that is converted from one habitat type to another, which species would likely be negatively or positively affected by habitat conversion, habitat fragmentation, and a qualitative description of whether species diversity could improve or decline. Other factors considered include implications to species that are protected under the Migratory Bird Treaty Act and how suitable or potentially suitable habitat for State and federally protected species or species of concern might be affected. Analyses of changes to bird abundance resulting from implementation of each alternative are presented in Section 3.16 and cross-referenced in this analysis.

The habitat conversion analysis was based on the anticipated hydrologic changes and design features for each alternative. Results are summarized in Table 3-28. Implications for wildlife species are included in a discussion of each alternative.

Table 3-28. Predicted change in wildlife habitat acreage by alternative.

WILDLIFE HABITAT TYPES[a]	BASELINE (EXISTING) CONDITIONS, ACRES	ALTERNATIVE A		ALTERNATIVE B		ALTERNATIVE C	
		Acres	Change (Acres)	Acres	Change (Acres)	Acres	Change (Acres)
Open water	29.1	75.0	+45.9	67.0	+37.9	59.9	+30.8
Wetland	300.0	438.9	+138.9	298.0	-2.0	432.7	+132.7
Woodland	23.3	65.7	+42.4	49.0	+25.7	58.7	+35.4
Upland grassland	88.4	76.1	-12.3	56.9	-31.5	86.6	-1.8
Agricultural	261.4	44.5	-216.9	223.6	-37.8	55.2	-206.2
Roads, parking, and berm/trail	5.8	7.9	+2.1	13.8	+8.0	15.0	+9.2
Total[b]	708.0	708.0	–	708.0	–	708.0	–

[a] Wildlife habitat categories do not match with jurisdictional wetland categories from Section 3.5. In particular, open water, wetland, and woodland wildlife habitat categories do not match directly with how jurisdictional wetlands are officially delineated under Section 404 of the Clean Water Act, and as presented in Section 3.5 of this Environmental Impact Statement. For example, the predicted wetland landscape class of "lacustrine vegetated aquatic bed" is delineated as a type of wetland under Section 404, but in terms of wildlife habitat would be considered a type of aquatic habitat (i.e., included in the open water category). Also only portions of the woodland wildlife habitat category are delineated as forested wetland in the jurisdictional wetland analysis.

[b] Predicted acreages by habitat type shown in this table may not total exactly to 708.0 due to rounding to the nearest tenth of an acre.

Alternative A

Overall, habitat under Alternative A would provide a more natural suite of physical characteristics than does habitat under existing conditions. Although one might expect that such changes would promote an increase in overall avian abundance, the analyses presented in Section 3.16.10 suggests that predicted bird abundances are highly variable across seasons and species. Species such as ducks and geese would experience decreases in abundance during the spring while abundances would increase or remain unchanged throughout the remainder of the year. State sensitive species such as the American white pelican, would likely benefit from the creation of habitat during the spring, summer, and fall. However, the increase in pelican abundance resulting from the implementation of Alternative A would not likely increase regional abundances of the species. Rather, created habitat would attract pelicans from other areas around Utah Lake. Potentially suitable habitat for Columbia spotted frog (*Rana luteiventris*) and other amphibians would be expected to increase as well.

Small mammal communities would also benefit from the implementation of Alternative A. Long-tailed vole (*Microtus longicaudus*) would benefit from the creation of riparian woodlands. Meadow vole (*Microtus pennsylvanicus*) would benefit from the restoration of emergent wetlands. Silver-haired bat would benefit from the creation of riparian woodlands.

Although no federally listed wildlife species would be negatively impacted by habitat conversion resulting from the implementation of Alternative A, there are several Utah County-specific, State-listed species that could be affected by the conversion of agricultural areas to other habitat types. These include the bobolink (*Dolichonyx oryzivorus*), short-eared owl, and burrowing owl (*Athene cunicularia*). Although the bobolink, which may occur in the study area during the breeding season, historically preferred habitat consisting of a mixture of grasses and broad-leaved forbs, much of the species' historically preferred habitat has been converted to agriculture. The species is now known to occupy agricultural areas with relatively low amounts of overall cover (Martin and Gavin 1995). Despite losing much of the agricultural areas within the study area under Alternative A, impacts to the bobolink are not considered significant for the following reasons: (1) About 44.5 acres of agricultural habitat would remain, and (2) wet meadow would likely increase, which is also known to serve as suitable habitat for the species. Generally, the density of breeding bobolinks would increase when the amount of suitable habitat exceeds 25 acres (Martin and Gavin 1995). Both of these habitat types would serve as suitable breeding habitat for the bobolink. The bobolink is listed by the State of Utah as a species receiving special management under a conservation management agreement in order to preclude the need for federal listing.

Listed by the State as a wildlife species of concern, the short-eared owl, if present within the study area, would occur during the nonbreeding season provided that a suitable prey base is present. Generally, nonbreeding habitat is similar to breeding habitat, which is defined as open areas, grasslands, shrublands, and agricultural areas. During the nonbreeding season, the short-eared owl is also known to use freshwater marshes (Wiggins et al. 2006). Although large agricultural areas would be lost under Alternative A, adverse effects to the short-eared owl are not considered significant. While agricultural and upland grassland habitats would decrease, an increase in wet meadow also provides spatial and structural requirements to support short-eared owls and at least partially offsets these losses.

The burrowing owl, a State-listed wildlife species of concern, is often associated with high densities of burrowing mammals and can often be found in gently sloping areas with low, sparse vegetation. The species is also frequently found in human-made areas such as agricultural fields, golf courses, cemeteries, road allowances, airports, vacant urban lots, and fairgrounds (Poulin et al. 2011). The conversion of habitat would not likely adversely affect the burrowing owl because the species probably does not occur within the study area under existing conditions. The burrowing owl is not known to excavate its own burrows; rather the species occupies mammal burrows that have been abandoned. Such burrows are critical for nesting (Poulin et al. 2011) and are not likely to be found within the study area.

Alternative B
Because Alternative B is restricted primarily to the northern and eastern portions of the study area, it would be topographically less diverse than Alternative A. The lack of topographic diversity would create abrupt habitat edges rather than gradual transitions from one habitat type to another. Although habitat edges such as those created under Alternative B promote an abundance and diversity of wildlife, rates of predation and nest parasitism generally increase in these areas. Consequently, such things as reproductive success may decrease depending upon the size of individual habitat patches (Robinson and Bolen 1989).

Because the size of the project implementation area would be considerably smaller under Alternative B and the fact that the majority of that area is already wetland, there would be less conversion of habitat from one type to another. The greatest amount of conversion would occur with the establishment of additional wetlands, riparian woodlands, and open water habitats.

As described for Alternative A, the implementation of Alternative B would promote an increase in the abundance and diversity of wildlife in general; however, such changes would occur at a smaller scale than would be realized under Alternative A and would be restricted primarily to the northern and eastern portions of the study area. Additionally, nearly all agricultural lands in the southern portions of the study area would remain. Because these are highly disturbed agricultural areas dominated by invasive and weedy vegetation species, the number of wildlife species present would not increase over baseline and the most abundant species present would likely remain nonnative species (VanDruff et al. 1994). These types of highly disturbed areas typically favor granivores, medium-sized omnivores, ground feeders, and sedentary species. The remaining agricultural areas would not support many cavity nesters, ground nesters, and insectivores (VanDruff et al. 1994).

Wildlife species that would benefit from created habitat in northern portions of the study area are as described for Alternative A. However, because the amount of restored habitat is smaller and less diverse, and with more abrupt habitat edges, the overall abundance and diversity would be lower under Alternative B than they would be under Alternative A. As described for Alternative A, changes in the abundance of birds would be highly variable across seasons under Alternative B. Ducks would experience the greatest declines in abundance, primarily during the spring and winter while State sensitive species such as the American white pelican would experience only slight increases during the spring, summer, and fall. Nonnative species such as European starlings (*Sturnus vulgaris*) would experience declines in abundance across all seasons. Changes in the abundance of birds resulting from the creation of habitat under Alternative B (detailed descriptions and tables are found in Section 3.16.10) would not likely affect regional bird abundances. Pelicans, for example, would likely be drawn to created habitat from other portions of Utah Lake provided adequate foraging opportunities are present. Primary pelican prey species in Utah Lake include carp (Flannery 1988).

Alternative C
Alternative C was developed with the idea of excluding the existing peat wetlands located on the east and north sides of the study area from the delta restoration project, while still meeting June sucker spawning and rearing habitat improvement needs for the project by using lands to the south of these wetlands. A berm would be constructed along the north property acquisition

boundary to prevent lake inundation and river channel migration onto the lands that would not be acquired. A berm along Boat Harbor Drive would also be necessary to prevent surface water from intruding south of the property acquisition area.

The existing agricultural areas would be the primary habitat type affected by conversion from one type to another. Although similar to Alternative A, Alternative C differs because of the berm construction on the north side of the study area and along Boat Harbor Drive.

Existing Channel Option 1

Implementation of Option 1 would not likely change wildlife species composition, abundances, or habitat from existing conditions.

Existing Channel Option 2

Implementation of Option 2 would not likely change wildlife species composition, abundances, or habitat from existing conditions.

3.8.7 Indirect and Cumulative Impacts

No significant indirect impacts on wildlife would result from any of the action alternatives. No project-related negative cumulative impacts would result from implementation of any action alternative when combined with other past, present, and reasonably foreseeable actions. An important indirect impact of wildlife changes in the project area is how these changes affect airport safety. A thorough evaluation of airport safety is described in Section 3.16.

3.8.8 Mitigation Measures

Any construction or other related activities that would disturb lands within the study area under any of the action alternatives would likely have a temporary effect on wildlife. Construction of berms under each of the action alternatives would likely be disruptive during construction and could be disruptive to avian species in particular during the nesting/brooding-rearing season (spring and summer months). To comply with the Migratory Bird Treaty Act:

- Complete any vegetation clearing between August 30 and April 1, which is outside the typical nesting/brood rearing period for migratory birds.

- Alternatively, have a qualified wildlife biologist perform a nest clearance survey immediately prior to construction activities if any nesting trees/artificial structures have to be removed during the nesting/brood rearing season. Appropriate spatial buffers (generally 100 feet) should be established around any active nests and nests should not be touched until the young have fledged. To comply with conservation commitments of the Section 7 consultation process (Chapter 3, Section 3.9.17), particular attention would be paid to surveying riparian disturbance areas for potential occurrence of yellow-billed cuckoo, a threatened species.

- Survey for raptor nests within the range of disturbance of project activities (refer to the USFWS *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* [2002]). Identify nests prior to trees leafing out and surveying again after nesting has begun to determine which nests are active, and what species are utilizing them. If the construction will occur during the nesting season, then surveys would be conducted again prior to construction activity to determine nesting activity. If an active raptor nest is identified, establish appropriate buffer distances and duration given the species and nest location.

3.8.9 Wildlife Resources Summary

Generally, the action alternatives are very similar to one another, the primary difference being the size of the study area and the amount of habitat conversion that would occur. The majority of habitat conversion under any of the action alternatives would result from the conversion of agricultural areas to native vegetation communities. Under any of the action alternatives, the conversion of agricultural areas to wetlands, riparian areas, upland grasslands, open water, wetlands, and wet meadows would promote an increase in the abundance and diversity of some species of wildlife. However, as would be expected, the abundance and diversity of birds under any of the action alternatives would be highly variable across seasons. Habitat throughout much of the study area during the winter months would be largely unavailable except for channels of open water where water currents are maintained. Open water areas with no current would likely freeze. Snow cover in other habitat types would render habitat unavailable to most bird species. Bird abundances would likely be highest during the spring and fall when the study area would likely provide stopover or staging habitat during the migration. During the summer, the abundance of species including shorebirds, and swallows would generally be only slightly higher than under existing conditions. Certain species would be affected adversely by changes in habitats, likely not affecting population levels on a regional scale, but causing downward shifts in local abundance.

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3.9 Threatened and Endangered Species

This section of the EIS provides species accounts for three federally listed threatened or endangered species known to occur in the study area and includes determinations of effect.

3.9.1 Issues Addressed in the Impact Assessment

Under Section 7 of the ESA (16 USC § 1531 *et seq*.), federal agencies are required to ensure that their actions do not jeopardize the continued existence of species listed as either endangered or threatened, or result in the destruction or adverse modification of designated critical habitats used by those species. Federally listed species known or likely to occur in or near the study area are indicated in Table 3-29.

Table 3-29. Endangered, threatened, or candidate species with potential to occur in the study area.

SPECIES	STATUS	POTENTIAL FOR OCCURRENCE
June sucker (*Chasmistes liorus*)	Endangered species	Inhabits Utah Lake and tributaries. The lower 4.9 miles of the Provo River is designated critical habitat.
Ute ladies'-tresses (*Spiranthes diluvialis*)	Threatened species	Known to occur in wetland areas around Utah Lake including the study area.
Yellow-billed cuckoo (*Coccyzus americanus*)	Threatened species	Known to occur in the existing riparian forest along the existing lower Provo River.
Least chub (*Iotichthys phlegethontis*)	Candidate species	Last observed in Utah Lake in 1931. Thought to be functionally extirpated from the Utah Lake drainage.

Sources: USFWS 2010b, UDWR 2015.

As discussed in multiple parts of this document, the June sucker is an endangered fish species whose population is endemic to Utah Lake. The fish is named for the timing of its annual spawning migration, which typically occurs sometime around June. It is one of three surviving *Chasmistes* (lake sucker) species within the family *Catostomidae* (USFWS 1999a). The proposed action evaluated in this EIS is a federal action aimed at restoring spawning and rearing habitat for June sucker.

The Ute ladies'-tresses is an insect-pollinated orchid plant species (Sipes and Tepedino 1995) found in isolated wet meadows, abandoned oxbow meanders, marshes, raised bogs, and along streambanks at elevations of 4,500 to 6,900 feet (Welsh et al. 2003, Fertig et al. 2005). Populations of this plant species are known to occur in the study area and other similar wetland environments surrounding Utah Lake, as well as many other locations in the western United States.

A threatened species, the yellow-billed cuckoo is a bird that historically occurred in the vicinity of the study area, and based on consultations with the USFWS is known to occasionally occur in the lower Provo River area. Territory size can range from 8 to 40 hectares (20 to 100 acres); however, there are known populations that occupy smaller territories measuring about 4 hectares (10 acres) (Laymon 1998). Typically, tree density in ideal nest and forage habitat is greater than 150 trees per hectare (Anderson and Laymon 1989).The riparian communities in the study area (see Section 3.6: Riparian Vegetation) are not consistent with known nesting habitat characteristics for this species (UDWR 2015); in particular, the lower Provo River riparian forest has little or no understory or shrub growth.

Another candidate species, the least chub (*Iotichthys phlegethontis*) is a small fish species that was last observed in Utah County in 1931 (UDWR 2015). It is thought to be functionally extirpated from the Utah Lake drainage (USFWS 2010b) but still occurs in two other Wasatch Front drainages and in some spring complexes in Utah's West Desert.

3.9.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to threatened and endangered species were eliminated from analysis. State-listed sensitive species are discussed and evaluated in the wildlife sections of this chapter (Section 3.8). Because least chub (*Iotichthys phlegethontis*) is a candidate species and is thought to be extirpated from the Utah Lake drainage, no determination of effect is made.

Other pertinent information related to June sucker and Ute ladies'-tresses are included in other sections of this EIS:

- Background regarding the listing of June sucker, June Sucker Recovery Plan requirements, and June sucker life history are discussed in Chapter 1.
- Section 3.7 evaluates general fishery habitat conditions in the study area, including discussions of aquatic resource conditions for June sucker and other fish species.
- Section 3.5 evaluates wetland impacts, including a functional assessment which was directly relevant to the evaluation for Ute ladies'-tresses in this section.

3.9.3 Area of Influence

The area of influence related to June sucker is Utah Lake and the lower Provo River below the Tanner Race Diversion/Lower City Dam. This portion of the Provo River is designated Critical Habitat (51 FR 10857, April 30, 1986).

The area of influence for Ute ladies'-tresses is the study area within which one of the three action alternatives would be implemented.

The area of influence for yellow-billed cuckoo is the existing Provo River channel riparian corridor as described in Section 3.6 of this EIS.

3.9.4 June Sucker – Affected Environment (Baseline Conditions)

Species Status

The June sucker is a long-lived lake sucker whose population is unique (endemic) to Utah Lake. Its mouth is adapted to filter out zooplankton from the middle of the water column, rather than bottom feeding, which is more typical for suckers. Each spring, adult June sucker migrate into Utah Lake tributary streams for spawning. A study by Buelow (2006) tracked 60 sonic-tagged adult June sucker from 2004 to 2006. The study found that June sucker tend to congregate in

Provo Bay at certain times of the year, which, based on another study (Radant et al. 1987), may be associated with elevated zooplankton densities present in the shallower, warmer waters found there. However, the study by Buelow (2006) found that adult June suckers are highly mobile throughout the lake environment. They tend to aggregate near the mouths of all major tributary streams during both the pre-spawning and post-spawning time periods. The same individual fish have been observed in multiple tributaries during the same year, suggesting that they are adaptable with respect to tributaries where they will spawn, seeking out available/functional habitat.

A best estimate is that there are currently between 10,000 and 100,000 June sucker in Utah Lake. Data indicates that an extremely high proportion of the existing June sucker in Utah Lake did not naturally recruit in the lake, but have been hatched and raised elsewhere and then released into the lake at a size of approximately 8 inches. There are likely less than 1,000 June sucker in Utah Lake that are a product of natural recruitment, with the majority being approximately 30 years old or older.

Spawning Habitat Needs

Quality spawning habitat occurs in river areas over large deposits of clean, coarse gravel and small cobble substrate in run and riffle habitats. Preferred spawning areas are characterized by water velocities up to 3.2 feet per second, water temperatures ranging from 52–60 degrees Fahrenheit, and water depths between 1–3 feet (Radant et al. 1987). Adult fish also need deep, low-velocity pool resting habitat near spawning areas and staging pools in and around the river mouth where adult fish aggregate prior to spawning.

Provo River is the largest tributary to Utah Lake and the primary June sucker spawning tributary. Based on observations of cui-ui (*Chasmistes cujus*) spawning behavior, it is thought that June sucker would have historically accessed upwards of 20 miles of the Provo River for spawning (USFWS 1999a). Because of diversion structures that block migration, critical habitat on Provo River is currently limited to the lower 4.9 miles below Lower City Dam/Tanner Race Diversion (USFWS 1999a). At the time the June Sucker Recovery Plan was written, Provo River was the only tributary to Utah Lake shown to have consistent use by June sucker for spawning. At that time, adult June sucker had been observed exhibiting pre-spawning/staging behavior at the mouth of the Spanish Fork River, another Utah Lake tributary, but no larval fish or actual spawning activity were observed (Radant and Sakaguchi 1981, Radant and Shirley 1987). Recent research (Landom and Crowl 2010, Watson and Landress 2011) has documented the presence of spawning adult June sucker and larval suckers (either *Catostomus ardens* or *Chasmistes liorus*) at several other Utah Lake tributaries (e.g., American Fork, Battle Creek, Spring Creek near Lehi, Hobble Creek).

A feasibility analysis completed in 2002 examined all Utah Lake tributaries to determine the optimal strategy for reestablishing successful spawning runs (Stamp et al. 2002). That study recommended modification of the Fort Field diversion on the Provo River, modification of the Tanner Race Diversion, and establishment of a secondary spawning run (as required by the June Sucker Recovery Plan), on either the American Fork River or Hobble Creek. Subsequently Hobble Creek was determined to be the most feasible location for supporting a secondary spawning run and in 2008 a habitat restoration project was completed on lower Hobble Creek.

Successful spawning runs have been subsequently documented in Hobble Creek (UDWR 2012); overall numbers of juvenile fish remain quite low, but suggest that supplemental flows combined with the habitat restoration is promoting successful recruitment. Additional spawning habitat improvements and flows to support June sucker in Hobble Creek have been subsequently slated for implementation (Interior et al. 2013). On the Provo River, the Fort Field Diversion was modified in 2008 to provide for fish passage (URMCC et al. 2008).

Rearing Habitat Needs

After June sucker larvae incubate and hatch, they emerge and drift downstream (Shirley 1983). The drift occurs relatively quickly and primarily at night (Modde and Muirhead 1990). Studies of young-of-year June sucker have shown that the species selectively feeds on small-bodied zooplankton (USFWS 1999a, Kreitzer et al. 2010). It is also known that growth rates of young-of-year June sucker are higher for fish that feed on small-bodied zooplankton in open water (Crowl et al. 1998). Laboratory experiments using June sucker indicate that warmer water temperatures are linked to improved growth rates and survival of larval fish (Kappenman et al. 2010).

Various studies have documented the significance of delta habitats to aquatic ecosystems and fish populations (Killgore and Baker 1996; Sommer et al. 2001; Belk et al. 2004; Cooperman and Markle 2004; Kaemingk et al. 2007; Albrecht et al. 2010a, 2010b; Burdick and Brown 2010; Erdman and Hendrixson 2010; Kappenman et al. 2010). Collectively, these studies demonstrate that when larval fish are able to access shallow, warm, productive habitats, their likelihood of successfully recruiting to the adult population will be maximized. Delta habitats provide unique conditions that can support large numbers of species and life stages, presumptively through habitat diversity. Furthermore, abundance of young fish can reasonably be expected to be greater with a larger spatial extent of such habitats.

Modeling studies (Belk et al. 2004) indicate that June sucker population numbers may be particularly sensitive to the abundance and survivorship of June sucker during their first year of life. Relative to model runs of improved survival during later life stages, model runs of improved year-one survival predict population increases that are approximately three to four times greater (Belk et al. 2004). These modeling results suggest that investing in restored rearing habitat is worthwhile in terms of population growth and ultimate species recovery.

3.9.5 June Sucker – Impacts of the No-Action Alternative

Under the No-Action Alternative, June sucker would continue to face a recruitment bottleneck as larvae drift downstream and are eaten or starve in the backwaters of Utah Lake near the mouth of the Provo River. Without the largest tributary of Utah Lake providing habitat for June sucker larvae to survive to adulthood, it is likely that persistence of the June sucker would continue to depend on stocking of fish from the hatcheries that were developed to ensure that June sucker would not go extinct. In addition, the No-Action Alternative would not provide any additional spawning habitat and there would be no enhancements to habitat used by other life stages of this endangered species.

3.9.6 June Sucker – Impacts of Action Alternatives

Each action alternative for restoration of the lower Provo River delta was evaluated for potential impacts to habitat for June sucker. Given the recruitment bottleneck for early life stages of June sucker, the alternatives were evaluated primarily on the relative availability and provision of potential June sucker rearing habitat and aquatic vegetative cover types currently lacking within the lower Provo River. It is also anticipated that each of the action alternatives would also provide increased access to spawning sites by providing target flow regimes for management of supplemental flows in the Provo River and by providing additional spawning substrates in newly created areas.

As mentioned previously, the lower 4.9 miles of the Provo River are currently designated as critical habitat for the June sucker. Each of the action alternatives would result in the relocation of the mouth of the river and a portion of the lower river. As such, the area designated as critical habitat may be relocated to include the areas of the Provo River and its interface with Utah Lake as modified for the proposed action.

Table 3-30 summarizes four assessment factors that were used to differentiate the relative benefit of each of the action alternatives in relation to June sucker recruitment opportunity. The basic ecological principle driving this comparison is that delta habitats provide unique conditions that can support large numbers of this species and all life stages, presumptively through habitat diversity and the associated increases in niche availability/opportunity (e.g., Kaemingk et al. 2007).

Assessment Factor 1 provides an evaluation of potential rearing habitat complexity associated with the spawning channel and sustainability that may be provided by each action alternative. This was measured as the width perpendicular to the central spawning channel thread alignment at a point midway between the start of braiding and Skipper Bay dike. This metric is intended to provide an indication of how much lateral space would be available for dynamic deltaic processes such as channel avulsion and distributary channel shifting. An alternative providing more space for these processes would have a greater likelihood of providing a heterogeneous mix of habitat types that would be sustainable.

Assessment Factor 2 provides insight into the relative opportunity for June sucker recruitment within lake-dominated habitat connected to the spawning channel. Assessment Factor 2 was derived by calculating the portion of the study area that would be typically inundated by Utah Lake during the spring spawning period. This assessment factor was determined through geo-spatial analysis as the portion of study area that would be at or below the average May-June lake level elevation (4,488.35 feet). Given the limited amount of area, habitat, and opportunity for June sucker recruitment under current conditions, greater acreages provided by the action alternatives would serve to increase niche space and opportunity for June sucker recruitment.

Assessment Factor 3 provides insight into important aquatic cover types that would serve to increase overall habitat diversity and complexity and evaluates alternatives based on their projected likelihood of providing the structure and cover to allow June sucker to escape predation pressures imparted primarily by nonnative fishes. Similar to the previous assessment factors, Assessment Factor 3 was derived using geo-spatial analysis and is expressed as the sum

Table 3-30. Assessment factors for June sucker habitat, baseline condition and action alternatives.

ASSESSMENT FACTOR	ASSESSMENT METHOD	BASELINE (EXISTING CONDITIONS)	ACTION ALTERNATIVES		
			A	B	C
1. Rearing habitat complexity and sustainability	Relative width available for dynamic deltaic processes (feet)[a]	100	5,225	3,030	3,285
2. Relative opportunity for June sucker recruitment within lake-dominated habitat	Area typically inundated by Utah Lake during spring spawning period (acres)[b]	NA[c]	281.0	192.0	154.0
3. Relative provision of vegetative cover (to promote habitat diversity, complexity, structure, and cover opportunity for use by early life stage June sucker)	Total amount of vegetative cover acreage at May-June flows/lake level (including riverine wetland, submerged, and emergent aquatic vegetation, acres)	NA	240.8	171.5	113.2
4. Enhanced spawning habitat within the study area portion of the lower Provo River	Riverine channel length in spawning reach of the new river channel (feet)	2,180[d]	2,600	2,360	2,600

[a] For the action alternatives, width available for dynamic delta processes was determined by measuring the width perpendicular to the central channel thread alignment at the point midway between the start of braiding and Skipper Bay dike; for existing conditions, it is the approximate average width between levees on either side of the existing channel.
[b] Values determined based on existing study area topography only; values do not take into account areas that could be altered by earthwork/grading that would occur to construct the new channel, side channels, and floodplain pond areas which could create additional habitat. Area calculations were determined by the acres within the property acquisition boundary that would be at or below the average May-June Utah Lake elevation, 4,488.35 feet.
[c] NA = none, or minimal and incalculable.
[d] A portion of the existing river channel provides suitable spawning habitat, approximately between the Lakeshore Drive Bridge and the UDWR fish weir (these locations are shown in Figure A-9, Appendix A). This does not include additional spawning habitat in the Provo River upstream of the study area for the current project. Creation and enhancement of spawning habitat, while valuable, is not the focus of the current project.

of the number of acres of vegetative cover associated with the spawning channel that is projected to be present within each of the action alternatives. Vegetative cover for purposes of this June sucker assessment factor was derived by summing acreage values of riverine wetland vegetation, lacustrine vegetated aquatic bed and emergent wetland vegetation (Table 3-31) and is based on background information, lake levels, and methodological techniques presented within the wetlands section of this document (Section 3.5). Cover is thought to be limiting under the existing conditions and as such, alternatives that serve to increase aquatic habitat diversity, particularly cover, are thought to provide direct benefit to June sucker by increasing recruitment opportunity (through increasing niche space), reducing predatory pressures, and ultimately helping in achieving greater opportunity for June sucker recovery through natural recruitment.

Assessment Factor 4 indicates the amount of enhanced spawning habitat that would be created with each action alternative. As indicated in Table 3-30, a portion of the existing river channel below the diversion point for each action alternative provides suitable spawning habitat. The study area topography provides some opportunity to replace and enhance available riverine-influenced spawning habitat in the lower Provo River prior to the point where lake processes would dominate the delta area (rearing habitat zone).

Table 3-31. **Baseline and predicted June sucker rearing habitat.**

REARING HABITATS [a]	BASELINE (Existing Conditions)	PROJECT ALTERNATIVES		
		A	B	C
Lacustrine vegetated aquatic bed	NA [b]	35.7	28.9	22.2
Riverine wetland	NA	2.4	0.2	1.0
Emergent wetland	NA	404.0	258.0	253.0
Total aquatic habitat with vegetative cover	NA	442.1	287.1	276.2

[a] Predicted cover type descriptions (from Wetlands assessment section of this document): Riverine wetland = the outer one third of the proposed Provo River channel beginning at the first branching of the river and extending to Utah Lake; lacustrine vegetated aquatic bed = inundated areas expected to be 2–5 feet deep at a lake elevation of 4,487.8 feet. This type also includes the middle “ring” of proposed oxbow pond features (approximately one third of each pond’s area).
[b] NA = none, or minimal and incalculable.

Alternative A

With a more naturally functioning river delta under Alternative A, a more diverse and more naturally functioning native fish community would be expected. Native fishes, and particularly June sucker, would benefit greatly from increases in these types of habitat that are currently lacking. The delta width (assessment factor 1) with Alternative A would be 5,225 feet, stretching from the natural topographic rise on the northeast side of the study area to the new berm that would be constructed along Boat Harbor Drive. The preliminary design for Alternative A would divide the Provo River into four main braids. The increase in the Provo River braiding in the delta area would allow nutrients and sediment to disperse across the floodplain/delta area, in turn decreasing turbidity and increasing primary production for aquatic macroinvertebrates and all juvenile fishes, including June sucker.

Some off-channel oxbow ponds would be constructed, initially, and more off-channel features would be expected to form over time. Assessment Factor 2 estimates that the spring inundation area for Alternative A would be 281.0 acres. This area would serve as a staging area for adult fish prior to and following the spawning run. An estimated 442.1acres of aquatic habitat including emergent wetland would be suitable rearing habitat for larval fish (Assessment Factor 3).

The preliminary design of Alternative A shows 2,600 feet of enhanced spawning habitat (Assessment Factor 4). This occurs in the portion of the new river channel that would be above the typically lake-influenced portion of the delta. This riverine environment would increase the quantity of spawning habitat in the lower Provo River by about 19 percent (compared to the estimated 2,180 feet of existing spawning habitat within the study area portion of the lower Provo River). Quality of spawning habitat would also be improved through design of the riverine section of the new channel with a meandering course and by allowing this channel to migrate across a naturally functioning floodplain.

Alternative B

With a more naturally functioning river delta under Alternative B, a more diverse and more naturally functioning native fish community would be expected. Native fishes, and particularly June sucker, would benefit greatly from increases in these types of habitat that are currently lacking. Alternative B is constrained by its design, which focused on limiting the amount of private property acquisition necessary for meeting the project need. The delta width (Assessment Factor 1) with Alternative B would be 3,030 feet, stretching from the natural topographic rise on the northeast side of the study area to the new berm that would be constructed through the middle of the study area. The preliminary design for Alternative B would divide the Provo River into only two main braids. Even so, these and subsequent braids that would occur through the delta area would allow nutrients and sediment to disperse across the floodplain/delta area, in turn decreasing turbidity and increasing primary production for aquatic macroinvertebrates and all juvenile fishes, including June sucker.

Some off-channel oxbow ponds would be constructed, initially, and more off-channel features would be expected to form over time. Assessment Factor 2 estimates that the spring inundation area for Alternative B would be 192.0 acres. This would serve as a staging area for adult fish prior to and following the spawning run. An estimated 287.1 acres would be suitable rearing habitat for larval fish (Assessment Factor 3).

The preliminary design of Alternative B shows 2,360 feet of enhanced spawning habitat (Assessment Factor 4). This occurs in the portion of the new river channel that would be above the typically lake-influenced portion of the delta. This riverine environment would increase the quantity of spawning habitat in the lower Provo River by about 8 percent (compared to the estimated 2,180 feet of existing spawning habitat within the study area portion of the lower Provo River). Quality of spawning habitat would also be improved through design of the riverine section of the new channel with a meandering course, and by allowing this channel to migrate across a naturally functioning floodplain.

Alternative C

With a more naturally functioning river delta under Alternative C, a more diverse and more naturally functioning native fish community would be expected. Native fishes, and particularly June sucker, would benefit greatly from increases in these types of habitat that are currently lacking. Like Alternative B, Alternative C is constrained by its design, which focused on excluding peat wetlands in the north and east portions of the study area from the restoration project. The delta width (Assessment Factor 1) with Alternative C would be 3,285 feet, stretching from a berm that would be constructed through the middle of the study area to another berm constructed along the north side of Boat Harbor Drive. The preliminary design for Alternative C would divide the Provo River into three main braids. These and subsequent braids that would occur through the delta area would allow nutrients and sediment to disperse across the floodplain/delta area, in turn decreasing turbidity and increasing primary production for aquatic macroinvertebrates and all juvenile fishes, including June sucker. Some off-channel oxbow ponds would be constructed initially and more off-channel features would be expected to form over time.

Assessment Factor 2 estimates that the spring inundation area for Alternative C would be 154.0 acres. This area would serve as a staging area for adult fish prior to and following the spawning run. An estimated 276.2 acres would be suitable rearing habitat for larval fish (Assessment Factor 3). A limitation associated with Alternative C is that a large amount of emergent wetlands (about 118 acres) would be isolated from fish access by the constructed berm.

The preliminary design of Alternative C shows 2,600 feet of enhanced spawning habitat (Assessment Factor 4). This riverine portion of Alternative C is the same as Alternative A and would increase the quantity of spawning habitat in the lower Provo River by about 19 percent (compared to the estimated 2,180 feet of existing spawning habitat within the study area portion of the lower Provo River). Quality of spawning habitat would also be improved through design of the riverine section of the new channel with a meandering course, and by allowing this channel to migrate across a naturally functioning floodplain.

Existing Channel Option 1

Similar to some of the nonnative fishes, June sucker presence would be partially driven by habitat. Under Option 1 (without impoundment), the existing channel of the lower Provo River would remain open to Utah Lake as under current conditions. These conditions offer relatively little suitable habitat for reproduction as the current channel is rather incised with uniform substrate composition and little habitat heterogeneity. Connectivity with sections of the Provo River upstream of the project implementation area would be blocked with respect to spawning access; and restricted with respect to downstream movement of larval drift. The limited connectivity would likely adjoin only small amounts of rearing habitat for any larval or juvenile individuals that by chance would drift downstream into the old channel; however, these few individuals would likely encounter a suite of nonnative predators in the less-than-optimal habitat, similar to existing conditions. Improving summer water quality (DO levels) may create more suitable conditions for June sucker that may inhabit the existing channel, although any improvement in habitat would also benefit warmwater fishes (e.g., channel catfish, white bass, bluegill, largemouth bass) and common carp under Option 1.

Conditions likely to be present under Option 1 would not significantly alter June sucker presence or abundance; however, the routing of peak flows to the proposed delta rather than the existing channel during the late spring and early summer would likely change June sucker movements. Routing of these higher flows will result in the environmental cues for spawning occurring in the restored delta area, rather than the current Provo River channel. Thus spawning runs of June suckers would occur in the restored delta area. These changes would also affect annual spawning movements of nonnative game fish (e.g., white bass), which would likely prefer the restored river delta habitat area created with implementation of an action alternative.

Existing Channel Option 2

Under Option 2, conditions would be altered by placing a second impoundment at the lower end of the existing channel to selectively manage the historic lower channel as a semi-separate water body. The placement of an impoundment would normally significantly alter the fish community and natural dynamics of a flowing system. However, due to the restoration of the proposed delta and the amount of water that would subsequently be delivered downstream, the ponding of a roughly 1.5-mile section would have little effect on June sucker. Under Option 2, upstream movement of all fish species occurring in the impounded portion of the lower channel would be excluded; however, as June sucker may spawn in the upstream section of the lower Provo River, any downstream transport of larval or juvenile June sucker in the limited flow provided to the semi-separate water body would effectively trap these individuals. Should the water body be managed for the benefit of nonnative game fishes, any young June sucker individuals produced or entrained would likely be consumed by the game fish. However, as with Option 1, it would be expected under Option 2 that the majority of June sucker larvae would be transported with the main flow of the river into the restored delta area.

3.9.7 June Sucker – Indirect and Cumulative Impacts

Given the life-history strategy of June sucker (long-lived species with sporadic recruitment success during any given year) it is unlikely that every year, or even set of years, would provide strong and/or detectable natural recruitment events due to variability in conditions (flow, lake level, nonnative fish abundance, etc.). Any of the action alternatives would provide a broad range of opportunity and potential increase in niche space. Current management practices and recovery actions, such as the continuation of active common carp removal, stocking/population augmentation efforts, other habitat improvements, supplementation of river flows, etc., would also be necessary to achieve recovery program goals and objectives and eventual downlisting and delisting of the species. Likewise, it would be important for managers to promote the collection of baseline monitoring data in and around the study area both before and after restoration, so as to enable a quantifiable assessment of the effect of restored delta habitat on June sucker within the context of the rest of the fish community.

A potential management issue that may arise with a restored river delta is that the restored habitat would potentially also benefit nonnative minnows (e.g., common carp and fathead minnow) that would negatively affect habitat quality (carp) and may compete with June sucker for resources. White bass (a predatory species) would be attracted to inflow channels for their upstream spawning activities, as they are currently in the Provo River. However, Petersen (1996) demonstrated that young June sucker can cope with white bass predation, if provided with adequate cover.

With appropriate post construction monitoring and fisheries management, any of the action alternatives would have indirect and cumulative benefits for June sucker. While there may be some short-term issues pertaining to project construction, including temporary turbidity increases, water temperature, nutrient loads—best management practices would be used to alleviate and mitigate any such items and are included in project mitigation measures (Chapter 2). In the longer term and for the foreseeable future, the project would benefit June sucker by providing opportunity for the species to overcome the early life-stage recruitment bottleneck. Overall, the proposed action combined with other JSRIP efforts including Hobble Creek restoration efforts and supplemental flows, and carp removal and control efforts would result in cumulative net benefits to June sucker within the context of the other past, present, and reasonably foreseeable projects and actions within the project area.

3.9.8 Ute Ladies'-tresses – Affected Environment (Baseline Conditions)

Species Status

The Ute ladies'-tresses, a white-flowered orchid, occurs in low- to mid-elevation wetlands and riparian zones in the central Rocky Mountains. The Ute ladies'-tresses was listed as threatened under the ESA on January 17, 1992, because of its rarity, low population sizes, and threats of loss or modification of riparian habitats (USFWS 1992).

The USFWS has determined that a 1996 petition to remove the Ute ladies'-tresses from federal protection under the ESA provides substantial biological information to indicate that removal may be warranted (USFWS 2010c). Originally, scientists believed that Ute ladies'-tresses populations only occurred in permanently moist areas not significantly impacted by human disturbance (USFWS 1992). However, surveys since 1992 have found expanded ranges of habitats occupied by Ute ladies'-tresses. By 2005, 26 new populations across its range had been discovered along irrigation canals, berms, levees, irrigated meadows, excavated gravel pits, roadside barrow pits, reservoirs, and other areas modified by human activities. New surveys have also shown the species to occur at an expanded elevation range of 7,000 feet in northern Utah (Fertig et al. 2005).

Section 7 of the ESA, which includes consultation guidelines for Ute ladies'-tresses, identifies Priority Survey Areas for states containing populations, as well as adjacent states known to have potential habitat (USFWS 1995). Specific habitats to be surveyed include all riparian and wetland communities below 7,000 feet.

All populations of this species have been found on wetland sites that remain moist throughout the growing season (USFWS 1992). In Utah the Ute ladies'-tresses is most often found along old stream channels and on recently deposited material within the floodplain of adjacent rivers (UNHP 1994). Both groundwater and river water contribute to the wetland hydrology of such sites. The Ute ladies'-tresses plants have been observed in inundated conditions and in merely moist conditions (Gecy 1994, Riedel et al. 1994). Historical accounts and herbarium records indicate that Ute ladies'-tresses was once more common within its present range (Coyner 1990, 1991; Jennings 1990).

Vegetation associated with Ute ladies'-tresses is variable, but its physiognomy is consistent. Canopy cover above 5 feet is sparse, while canopy cover below this height includes mixed densities of various herbaceous species. Common associated species vary throughout its range. The most common are reed canarygrass, Arctic rush, and other rush species (*Juncus* spp.), sedge species (*Carex* spp.), creeping bentgrass, beaked spikerush (*Eleocharis rostellata*), saltgrass, and seaside arrowgrass (*Triglochin maritima*). The most important environmental parameter, apart from soil moisture, appears to be exposure to sunlight. Ute ladies'-tresses thrive in full sunlight or partial shade (USFWS 1992).

In most instances, soils that support Ute ladies'-tresses populations are alluvial deposits containing a high percentage of gravel and sand (UNHP 1994). However, this may be a coincidental occurrence with open canopy alluvial wetland sites; populations have been found in both clay (Manci and Wheeling 1994) and highly organic soils (UNHP 1994).

Study Area Known Occurrences

As part of this EIS, study area surveys were conducted in August 2010, 2011, 2012, and 2013. Nine Ute ladies'-tresses occurrences (locations with plants that have been documented by a qualified biologist) have been found over 4 years of surveys within the study area. The documented occurrences were observed within three primary wetland types (wet meadow/emergent marsh complex, wet meadow, and raised fen) with a common vegetative understory consisting of herbaceous wetland vegetation at elevation ranges of 4,486.7 to 4,496.0

feet. Of the occurrences, five were documented across consecutive years, with additional surveys needed to further document the presence of Ute ladies'-tresses occurrences in the study area. It is not uncommon for Ute ladies'-tresses plants to remain dormant during growing seasons where conditions are unfavorable or within previously occupied areas experiencing a level of disturbance preventing Ute ladies'-tresses emergence. At least one additional survey for Ute ladies'-tresses will occur prior to construction if the proposed project is implemented.

Cattle and horse grazing as well as mowing activities within the study area alter conditions within areas of potential Ute ladies'-tresses habitat. Light to moderate grazing activity may benefit Ute ladies'-tresses by reducing sun competition from overstory species. Likewise, mowing activity could have a positive effect on Ute ladies'-tresses habitat depending on the timing of mowing. In a study by Arft (1995) it was found that winter grazing and mowing significantly increased the number of flowering Ute ladies'-tresses.

3.9.9 Ute Ladies'-tresses – Impacts of the No-Action Alternative

The No-Action Alternative would not impact Ute ladies'-tresses occurrences known or likely to occur in the study area. Hydrologic alterations and land uses that currently have an effect on Ute ladies'-tresses occurrences within the study area would be expected to continue. Grazing and mowing, which may have positive effects by reducing overstory, would also likely continue.

3.9.10 Ute Ladies'-tresses – Impacts of Action Alternatives

In preliminary designs for all action alternatives, berms, realignments of Boat Harbor Drive, trail connections, and stream channel excavations have been located to avoid all known occurrences of Ute ladies'-tresses. If an action alternative is selected, in final design, known occurrences would be avoided to the extent possible. Ground-disturbing activities associated with construction staging areas, ingress and egress areas, stream channel excavation and enhancement, and the installation of riprap have the potential to negatively impact Ute ladies'-tresses in both the short and long-term. Direct impacts to the species include reduced vigor and reproduction of individual plants, destruction of individual plants or entire occurrences. Hydrologic modification of the study area under all action alternatives may have short-term negative impacts for Ute ladies'-tresses if existing occurrences are inundated, submerged or the hydrology is altered sufficiently to render the habitat less suitable or unsuitable for Ute ladies'-tresses. Individual Ute ladies'-tresses occurrences may decline or be extirpated over time within less suitable or unsuitable habitat. However, the restoration of a more natural hydrologic regime in the project area is considered beneficial to the species in the long-term because natural flood events are important for creating new habitat and for reducing the cover of competing vegetation (Fertig et al. 2005). The study area was completely inundated and eight of the nine occurrences were covered with water for approximately 3 years as a result of the 1983–1984 floods. Some of the study area occurrences were also inundated in 2011 during a 10-year flood event.

Ute ladies'-tresses occurrences that have been documented within the study area were observed within wet meadow/emergent marsh complex, wet meadow, and raised fen primary wetland types. All had a common vegetative understory consisting of herbaceous wetland vegetation at elevation ranges of 4,486.7 to 4,496.0 feet elevation. These wetland habitats would expand under Alternative A or Alternative C and therefore would be expected to potentially benefit Ute ladies'-tresses occurrences in the project implementation area. Alternative B would have less potential benefit, due to a net loss of wet meadow habitat. Any of the three action alternatives would have habitat improvements in the riparian section of the new river channel, including development of wet meadow, potentially providing new or enhanced suitable habitat for Ute ladies'-tresses within the project area.

Restoration or enhancement of existing degraded wetlands and upland peat soils within the project implementation area would likely increase the amount of suitable habitat for Ute ladies'-tresses. Potentially dormant individuals occupying currently unsuitable habitat may reemerge if more appropriate conditions are met (Fertig et al. 2005). This is especially true for degraded mounded peat wetlands identified in the northwestern portion of the study area. The elevation of the existing degraded mounded peat wetlands would likely rise and become larger and more pronounced once the hydrologic conditions are restored as has been observed in the Provo City mitigation site. An effort to identify currently unknown degraded mounded peat wetlands would be made as part of final design; any that are identified would be avoided by direct construction activities to the extent feasible.

3.9.11 Ute Ladies'-tresses – Indirect and Cumulative Impacts

Because no survey data prior to hydrologic modification of the study area (construction of Skipper Bay dike, drainage, and pumping) is available, it is not clear how past actions have affected Ute ladies'-tresses. There is likely more wet meadow habitat currently in the northeastern portion of the study area as a result of these hydrologic modifications, which may have allowed individual plants to occupy lower elevations of the study area. Grazing and mowing have likely helped to reduce species competition; at the same time, weeds and invasive riparian species (Russian olive, tamarisk) have also been introduced to the study area. Mounded and flat peat wetlands have also been degraded by grazing activity. Some of these have been restored in the Provo City wetland mitigation site and occurrences of Ute ladies'-tresses have been observed in small numbers. Over the long term, implementation of an action alternative would return natural hydrology to the study area that would benefit peat wetlands and Ute ladies'-tresses. However, ongoing vegetation management would be necessary to prevent invasive vegetation from having adverse effects. Due to creation of a conservation easement by a private landowner, the majority of the study area is protected from development, thus the majority of the study area is unlikely to be developed in the foreseeable future, with or without the proposed action. The only other foreseeable development in the project vicinity is the proposed Provo Lakeview Parkway and Trail; that project would have to comply with Section 404 of the Clean Water Act and the ESA if the project impacts wetlands and is determined to have potential to affect Ute ladies'-tresses or other listed species.

3.9.12 Yellow-billed Cuckoo – Affected Environment (Baseline Conditions)

The western distinct population segment of yellow-billed cuckoo was listed as a threatened species on November 3, 2014, due to present or threatened destruction, modification, or curtailment of its habitat or range and other natural or manmade factors affecting its continued existence (USFWS 2015). Rationales provided by the USFWS specifically cite actions such as dam construction and operations, water diversions, river flow management, stream channelization and stabilization, land conversion to agricultural uses—such as crops and livestock grazing—urban and transportation infrastructure, and increased incidence of wildfire, particularly where these actions contribute toward habitat fragmentation and promote invasion of nonnative plant species such as tamarisk (*Tamarix* spp.).

Yellow-billed cuckoo is considered a riparian obligate species, typically occupying large tracts of cottonwood and/or willow riparian forest with dense subcanopies below 33 feet. Historically, yellow-billed cuckoos were probably common-to-uncommon summer residents in Utah; the current distribution of yellow-billed cuckoos in Utah is poorly understood, though they appear to be an extremely rare breeder in lowland riparian habitats statewide (UDWR 2015; Parrish, Howe, and Norvell 2002; Howe and Hanberg 2000).

The species may occasionally occur in the lower Provo River area, though the existing riparian forest communities in the study area are not consistent with known nesting habitat characteristics for this species (UDWR 2015); in particular, the existing lower Provo River riparian forest has little or no understory or shrub growth. The USFWS has estimated the number of breeding pairs in the State to be fewer than 10 and not likely more than 20. The most recent nesting was documented at Ouray National Wildlife Refuge on the Green River and at the Matheson Wetland Preserve near Moab, Utah (USFWS 2013).

3.9.13 Yellow-billed Cuckoo – Impacts of the No-Action Alternative

The primary factor influencing the presence of a potential breeding population of yellow-billed cuckoo in the study area under existing and reasonably foreseeable conditions under the No-Action Alternative is the absence of an adequately sized and unfragmented riparian forest community with understory vegetation. Under the No-Action Alternative, the yellow-billed cuckoo would remain an uncommon summer resident and breeding activity would be absent or extremely rare.

3.9.14 Yellow-billed Cuckoo – Impacts of Action Alternatives

Construction of the project would not affect any known population of yellow-billed cuckoo. Habitat disturbance along the existing riparian corridor would be minimal (less than 0.25 acre with either of the two options for the existing channel) and occur in areas with a high level of existing human activity/disturbance. Additionally, the existing study area riparian forest communities are not consistent with known nesting habitat characteristics for yellow-billed cuckoo (UDWR 2015); in particular, the lower Provo River riparian forest has little or no understory or shrub growth.

Over the long term, the project would have positive effects on yellow-billed cuckoo by creating more suitable habitat to support this species than currently exists in the study area. Estimated net gains in riparian forest by project alternative are as follows:

- Alternative A, 36.6 acres;
- Alternative B, 19.4 acres; and
- Alternative C, 27.3 acres.

Additionally, these larger patches of riparian forest would develop understory vegetation that study area riparian communities currently lack.

3.9.15 Yellow-billed Cuckoo – Indirect and Cumulative Impacts

Because yellow-billed cuckoo distribution in Utah is poorly understood and the species is considered an extremely rare breeder in lowland riparian habitats statewide, it is not clear how past actions have affected the species other than noting that urban development and agricultural practices statewide have likely diminished the amount and quality of available habitat. Due to creation of a conservation easement by a private landowner, the majority of the study area is protected from development; thus, the majority of the study area is unlikely to be developed in the foreseeable future, with or without the proposed action. The only foreseeable development in the project area vicinity is the proposed Provo Lakeview Parkway and Trail, which would likely be constructed well before the created riparian forest has matured to provide suitable yellow-billed cuckoo habitat. Additionally, the Provo Lakeview Parkway and Trail project would be located along the eastern edge of the created riparian forest habitat; therefore, habitat would not be fragmented by the road or trail. However, once the riparian forest community has fully matured, any yellow-billed cuckoos present would be exposed to traffic- and recreation-related noise. Despite the presence of the Provo Lakeview Parkway and Trail, the proposed action would benefit yellow-billed cuckoo by creating suitable habitat in areas that would not otherwise be suitable for the species.

3.9.16 Determinations of Effect under the Endangered Species Act

Determinations of Effect

The JLA's determination for the endangered June sucker is, "***may affect, likely to adversely affect***." The proposed project is intended to benefit June sucker; however, a small number of larvae and/or young fish most vulnerable to predation will likely drift into the existing channel and not survive. With respect to this determination, the purpose and need for the proposed project is to meet specified recovery criteria for the June Sucker Recovery Plan (USFWS 1999a) and, as such, the proposed project is expected to benefit the species overall. In terms of cumulative effects, ongoing efforts to improve habitat for June sucker would increase likelihood of survival of this species and may eventually result in delisting.

The JLA's determination for the threatened Ute ladies'-tresses orchid (*Spiranthes diluvialis*) is, "***may affect, likely to adversely affect***." Over the long term, the project is also expected to have net benefits to Ute ladies'-tresses; however, some individual plants may be adversely affected. Given the potential to negatively impact Ute ladies'-tresses individuals, the JLAs have proposed to work with the USFWS to jointly develop a list of Ute Ladies'-Tresses Conservation Measures for the Provo River Delta Restoration Project, which is included in the Mitigation Measures section below.

Because the study area does not provide nesting habitat characteristics for yellow-billed cuckoo and disturbance of existing riparian forest habitat would be minimal, the JLA's determination for the yellow-billed cuckoo is, "***may affect, not likely to adversely affect***." Over the long term the project is expected to positively affect the species by supporting a net gain in riparian forest and improvement in habitat quality.

3.9.17 Mitigation Measures

June Sucker

- Do not conduct construction activities in the existing Provo River channel during the June sucker spawning period from April 1 to July 31 to avoid adverse effects on the species.

- Take care to minimize sedimentation inputs associated with stream-disturbance activities during construction.

Ute Ladies'-tresses

In consultation with the USFWS, the following conservation measures for Ute ladies'-tresses have been developed and will be applied to the proposed project.

Pre-Construction Conservation Measures

1. Perform at least one additional survey for Ute ladies'-tresses prior to construction to meet the USFWS guidance of 3 years of surveys. This survey will determine whether any changes have occurred to known populations since the last survey in 2013. Survey the project area for additional occurrences. Additional surveys may be required, depending on the time between construction implementation and the last survey. The last survey should be performed no later than 3-years from construction initiation.

2. Avoid direct impacts to all identified occurrences during the final design and project implementation, to the extent possible.

3. Fence locations of known occurrences using environmental fencing and the assistance of a qualified biologist prior to construction activities in the project implementation area. Have the qualified biologist establish ingress, egress, and staging areas to avoid known occurrences.

Active-Construction Conservation Measures

1. Document the extent of the impacted area when avoidance of direct impacts to Ute ladies'-tresses occurrences is not possible. Direct impacts include excavation for river channels or other proposed project features and placing fill material on known occurrences. Direct impacts do not include inundation because the species has survived prolonged periods of past inundation. Based on lake elevation levels, all occurrences except #4 would have been inundated with water for an extended period of time during 1983–1985. Many of the existing occurrences were also inundated for several months during a 10-year flood event that occurred during the 2011 growing season. Additionally, occurrence #6 was observed to be underwater in 2013 during the wetland delineation site visit with the Corps during a time when the Despain property was not being aggressively drained.

2. Salvage soil when avoidance of direct impacts is not possible and relocate it to another portion of the project area where the hydrology is sufficient to support Ute ladies'-tresses. The potential transplant areas are mutually agreeable to the USFWS and identified in the Biological Assessment for this project. Relocation methods will attempt to keep the upper 2 feet of the soil profile intact if the salvage area(s) are small (less than 100 square feet); however, this method may not be feasible if larger areas are salvaged. For larger impact areas, the top 12 inches of soil will be relocated to the transplant site. Because salvage efforts have a high failure rate, this activity is considered an impact-minimization strategy, but the salvaged area would still be included in the impact calculation. If Ute ladies'-tresses are found in the transplanted areas during the post-construction surveys, then the salvaged area would be removed from the impact calculation.

3. Minimize soil and vegetation disturbance by operating equipment on top of temporary earth fills above geotextile mats when avoidance of temporary impacts (soil compaction by vehicles and machinery) to an occurrence is not possible.

4. Abstain from construction within 300 feet of known occurrences during the Ute ladies'-tresses flowering period of July 31–September 15. A qualified botanist may perform weekly surveys to document the beginning and ending of the flowering period to narrow this timing requirement based on the specific flowering period at the project area. Implement other best management practices for dust control during the Ute ladies'-tresses flowering period if any known occurrences are being impacted by dust. Follow best management practices for sediment control throughout construction to ensure that bare soil and sediment are not transported to Ute ladies'-tresses areas.

5. Avoid, to the extent feasible, construction impacts to peat wetlands, including degraded springs.

Post-Construction Conservation Measures

1. Report all documented direct impacts to known Ute ladies'-tresses occurrences to the USFWS within 6 months of completion of construction. The report will include map locations, areas of impact, and location(s) of salvaged soils from occurrences that could not be avoided during construction.

2. Use Utah Lake water elevation data to determine inundation periods for known Ute ladies'-tresses occurrences.

3. Perform three consecutive years of post-construction monitoring throughout the project implementation area, paying special attention to known occurrences and salvage and relocation areas. Post-construction begins once the hydrology has been restored to the project implementation area (i.e., removal of Skipper Bay dike and Provo River levee). Provide an annual monitoring report to the USFWS with information consistent with the 2010–2013 survey report for the study area (BIO-WEST 2013), and include an occurrence number, count, location, elevation, wetland type, associated vegetation, and representative photo.

4. Follow USFWS-specific weed-control recommendations for known occurrences. Amend the vegetation management plan (Appendix B), if needed, to include the USFWS measures.

The following best management practices or general conservation measures will be followed to protect Ute ladies'-tresses in the study area:

1. Use boulders, root-wads, and other natural materials from local sources to stabilize streambanks and in the active stream channel rather than using concrete, asphalt, steel, other human-made materials.

2. Use erosion-control environmental commitments where project construction will disturb soil. These areas are expected to be along channel-construction and -modification areas, construction access roads, floodplain grading areas, setback berms, and stockpile areas. The procedures will be designed to stabilize soils, restore vegetation to a desired plant community, and to prevent infestation by noxious plants and to avoid erosion.

3. Remove and stockpile topsoil to a depth of 1 foot (or less if topsoil layer is less than 1 foot deep) for site restoration.

4. Secure additional topsoil of suitable quality for revegetating disturbed sites from areas that will have minimal impacts on important fish and wildlife habitats.

5. Implement the weed-control program in the vegetation management plan(Appendix B) to control noxious weeds resulting from project implementation.

6. Examine and wash equipment and vehicles, if necessary, to reduce the possibility of introducing toxic materials and undesirable plant species from previous work sites into the project area.

7. Fuel machinery off site or in a confined, designated area to prevent spillage into the soils, waterways, and wetlands.

8. Monitor disturbed areas for weeds and undesirable plant species during construction and implement necessary weed-control actions.

9. Control noxious weeds and undesirable plants by chemical, mechanical, and hand removal, as well as biological means, as may be appropriate, giving due consideration to compatibility with wildlife management plans, needs for protecting native plant communities, and avoidance of environmental contamination. Obtain approval for procedures and required permits for the controls that are used. See Appendix B for more details.

10. Burn or properly dispose of weeds removed by mechanical- or hand-control methods to prevent their spread to other areas.

11. Control noxious and undesirable vegetation in the vicinity of Ute ladies'-tresses orchid occurrences by methods provided by the USFWS.

12. Manage stockpiles of top soil that would remain barren for extended periods to control erosion and avoid proliferation and spread of noxious weeds and undesirable plants.

13. Reclaim disturbed areas to desired riparian, agricultural, and upland plant communities as soon as possible after construction. Require the contractor to use specified plant materials and reclamation techniques.

14. Implement erosion-control measures to prevent or reduce wind and water erosion and help establish vegetation in areas subject to erosion.

15. Conduct a site analysis on areas where there is a potential erosion problem to determine appropriate procedures that are needed (i.e., soil stabilizing materials, seeding mixtures, and mulching and fertilizing treatments).

16. Select plant species for rehabilitating disturbed areas and erosion control based on soil type, root-stabilizing characteristics, consistency with composition of contiguous native plant communities, ability to compete with undesirable vegetation, and compatibility with restoration goals.

17. Develop a comprehensive revegetation plan for the project implementation area and monitor the area 3 years following implementation to determine success and make recommendations regarding follow-up seeding, planting, and weed-control efforts that may be necessary.

18. Implement USFWS-provided specific herbicide treatment recommendations within Ute ladies'–tresses occurrence areas as detailed in the updated vegetation management plan (Appendix B).

Yellow-billed Cuckoo

- Comply with the Migratory Bird Treaty Act by completing any vegetation clearing between August 30 and April 1, which is outside of the typical nesting/brood-rearing period for migratory birds.

- Alternatively, have a qualified wildlife biologist perform a nest clearance survey prior to construction activities, paying particular attention to surveying riparian disturbance areas for potential occurrence of yellow-billed cuckoo.

3.9.18 Threatened and Endangered Species Summary

Three federally listed species are known to occur in or near the study area and may be affected by the proposed action. The first, June sucker, is an endangered fish species endemic to Utah Lake and is the focus of the proposed Provo River Delta Restoration Project. The second, Ute ladies'-tresses, is a threatened orchid flower species that is found in the study area and in other sparse populations throughout the west-central United States. The proposed action alternatives would have similar effects for these species. The third, yellow-billed cuckoo, is a new, federally listed threatened bird that uses mature riparian vegetation. The proposed project will avoid removal of existing riparian trees as much as possible along the existing channel and is expected to have a long-term positive effect on the species by supporting a net gain in riparian forest habitats along the new channel.

The most relevant detriments to June sucker are current environmental conditions for the Provo River and Utah Lake and conditions that would be associated with the No-Action Alternative. Any of the action alternatives would have significant direct and cumulative benefits for June sucker as well as all aquatic biota found in the lower Provo River and Utah Lake by restoring a naturally functioning river delta to the Utah Lake-Provo River interface. Spawning habitat would also be improved in a portion of the lower Provo River. These enhancements would contribute toward achieving specific criteria of the June Sucker Recovery Plan and would contribute substantially toward downlisting and eventual delisting of the species.

Hydrologic modification of the study area under all action alternatives may have short-term negative impacts for Ute ladies'-tresses if existing occurrences are inundated, submerged or the hydrology is altered sufficiently to render the habitat less suitable or unsuitable for Ute ladies'-tresses. Individual Ute ladies'-tresses occurrences may decline or be extirpated over time within less suitable or unsuitable habitat. However, the restoration of a more natural hydrologic regime in the project implementation area would be considered beneficial to the species in the long-term because natural flood events are important for creating new habitat and for reducing the cover of competing vegetation. Known occurrences have been avoided in preliminary designs for all action alternatives. Additional surveys would be planned prior to final design or construction activity, and adjustments to avoid or minimize direct impacts would be made as possible. Best management practices would be implemented during construction to avoid or minimize unintentional or indirect impacts.

The yellow-billed cuckoo is a threatened species that historically occurred in the vicinity of the study area and, according to the USFWS, is known to occasionally occur in the lower Provo River area. However, the riparian communities in the study area are not consistent with known nesting habitat characteristics for this species. Conservation measures to avoid potential effects during the nesting/brood-rearing period would be implemented during project construction, in compliance with the Migratory Bird Treaty Act.

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3.10 Land Use

This section describes the current land use, and how that land use would change or be affected by implementation of each alternative. This includes the existing uses of the land in the study area, as well as potential future uses identified by Provo City and Utah County in planning documents. This also considers land use on lands adjacent to or near the study area that would be either directly or indirectly impacted by implementation of the alternatives.

3.10.1 Issues Addressed in this Section

The following issues related to land use were raised during scoping and in consultations with agencies, landowners, and other stakeholders:

- Would the project be compatible with adjacent land use and transportation planning?
- Would the project affect operation of Provo Airport or planned land uses associated with the airport?

Effects on land use were assessed in consultation with Utah County, Provo City, landowners, field investigations of the study area, available data from the U.S. Census and the Utah Automated Geographic Reference Center, and reviews of study area aerial photography. Potential effects to Provo Airport operations and planned land uses were evaluated in consultation with Provo City and Federal Aviation Administration (FAA). Because the airport is outside the vicinity of direct project effects, these issues are evaluated in Section 3.10.7 (Indirect and Cumulative Impacts). As mentioned above, concerns related to aircraft-bird strike risk are evaluated in Section 3.16.

3.10.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to land use were eliminated from further analysis. Potential impacts to agriculture and farmlands are addressed in Section 3.11. Socioeconomic impacts are addressed in Section 3.14. Public recreation impacts are addressed in Section 3.15. Concerns related to aircraft-bird strike risk are evaluated in Section 3.16. Some parcels within the study area have been designated by Utah County as an Agricultural Protection Area (APA); this is discussed and evaluated in Section 3.11.

3.10.3 Area of Influence

The area investigated for land use was the study area and adjoining lands.

3.10.4 Affected Environment (Baseline Conditions)

The majority of the study area is located within an unincorporated portion of Utah County. Developed parcels to the east of the study area are within the municipal boundary of Provo City, as are lands on the south side of the existing Provo River channel.

To better integrate environmental impact statements into state or local planning processes, the Council on Environmental Quality regulations for implementing NEPA 1506 2(d) require environmental impact statements to “discuss any inconsistency of a proposed action with any approved state or local plan and laws (whether or not federally sanctioned). Where an inconsistency exists, the statement should describe the extent to which the agency would reconcile its proposed action with the plan or law."

Land Ownership and Encumbrances

Ownership of lands in the study area is a mix of private, municipal, County, State, and federal,[7] with the majority (538 out of 708 acres) being privately owned lands within an unincorporated portion of Utah County. In order to implement the proposed action, lands needed for the project would be acquired by the federal government if not already in public ownership and available for full use for project purposes. A list of those anticipated required approvals or permits is included in Chapter 1, section 1.6. There are a number of potential legal entanglements affecting several of the land parcels within the study area which, depending on the alternative selected, would need to be resolved in order to implement the proposed project. The map in Figure A-27 (Appendix A) depicts the study area with several of the encumbrances or entanglements identified. The various easements, title disputes, and so on would each be addressed in turn in accordance with relevant statutes. Only general information pertaining to each is provided in this Final EIS in the appropriate sections (e.g., Section 3.10: Land Use, Section 3.11: Agriculture, and Section 3.14: Socioeconomics).

Utah County Land Use and General Plan

In the Utah County General Plan (Utah County 2007), the study area is zoned "Residential Agriculture 5." As stated in the plan, "these areas are zoned for land uses relating to the grazing and pasturing of livestock, mining, production agriculture operations and low density residential development."

Land uses within the study area include Utah County recreational trails, a paved County road (Boat Harbor Drive), Utah Lake State Park, and two privately owned recreation facilities. Recreational trails extend along the north side of the Provo River (Lower Provo River Parkway) and along the existing dike on the west end of the study area (Skipper Bay dike trail). These trails are components of the larger Provo/Jordan River Parkway trail system in Utah County. One paved County road within the study area, Boat Harbor Drive, provides access to agricultural parcels, the Provo River, and secondary access to Utah Lake State Park. Utah Lake State Park is located north of the existing outlet of the Provo River into Utah Lake. Utah Lake State Park averages about 250,000 visitors annually (Utah Division of State Parks and Recreation 2011).

Provo City Land Use and Planning

The study area is mostly within an unincorporated portion of Utah County. Adjacent lands south of the Provo River and along the east side of the study area are within the municipal boundary of Provo City. South of the existing river channel there is a commercial RV park and a commercial

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[7] With respect to federal ownership, the United States and the State of Utah reached a settlement in 2011 regarding ownership of certain lands around Utah Lake (U.S. District Court, District of Utah, Central Division, March 3, 2011 (Civil No. 2:97CV 0927K)). This settlement of a lawsuit filed in 1997 involves several land parcels within the study area. Approximately 86.12 acres of land in the study area previously reflected on Utah County records as private property was in fact withdrawn from the public domain by the United States in 1889. These lands are owned by the United States, having never been patented out of federal ownership. The United States is currently moving forward with appropriate actions to demonstrate title.

recreation business (CLAS Ropes Course) that also provides canoe rentals and boating trips on the Provo River. Lands to the east of these businesses on the south side of the river are within the municipal boundary of Provo and are currently agricultural, but are zoned in the Provo City General Plan for residential development. In 2010 Lakeshore Drive in Provo was extended across the Provo River to connect with an existing intersection at Center Street and 3110 West Street. Lakeshore Drive is a residential collector road for existing residential neighborhoods bordering the study area to the east.

Concurrently with development of this Environmental Impact Statement (EIS), Provo City was conducting an evaluation of alternatives for a new north-south arterial roadway to the west of Lakeshore Drive. This proposed project is known as the Provo Lakeview Parkway and Trail. This transportation facility would connect Geneva Road in Orem with 3110 West Street in Provo and would cross the study area. The JLAs coordinated with Provo City early in the process of developing alternatives to determine compatibility of both projects.

Approximately 68 acres adjacent to the northeast study area boundary are owned by Provo City and/or Provo City School District. Currently farmed, these lands may be used as a future school site. Private agricultural lands to the north of the study area are located in Utah County outside the municipal boundaries of Provo City and Orem.

The approximately 333-acre K. Dale and Sonja Despain Cattle Ranch and Bird Refuge Conservation Easement is within the study area. This easement was purchased in 2001 with financial assistance from Utah's LeRay McAllister Critical Land Conservation Fund (UGOPB 2012) and Provo City. The easement is held by Provo City and was designated for farming and ranching values, management of wildlife habitat, and scientific research or education. Two wetland mitigation sites are also present within the study area. The Provo City wetland mitigation site is approximately 16.7 acres (K.A. Smith Consulting, Inc. 2009) and is co-located within the Despain conservation easement. The BLB Drywall mitigation area is approximately 3.7 acres.

Provo City Vision 2030

Provo City developed a vision document that identifies a plan to implement by 2030. This plan, adopted by the City Council following a public planning process, provides a vision of what Provo City will look like by 2030, to "provide consistent long-term direction to municipal decision-making in areas not typically addressed by a general plan or other tools used in Provo's strategic planning" (Provo City 2013).

This plan sets a series of goals and objectives in areas such as family and neighborhoods, land use and growth, leisure, and natural resources. Goals with specific application to the Provo River Delta Restoration Project include the following:

- *Goal 4.1 Work effectively as a City and with other government agencies and private organizations to protect, preserve and restore its natural resources in the surrounding mountains, canyons, and foothills; in the wetlands, shorelines, and riverbanks, and in all city parks; and develop a city-wide culture of pro-active stewardship to preserve the ecological integrity of these resources.*

- *Goal 4.2 Ensure that Provo River is a year-round stream with protected flows that provide both spawning and rearing habitat for native fish species (e.g., June sucker) and seasonal sport species; support and sustain general fishing use; and develop trail access to the river, which will be free-flowing from Provo Canyon to a re-established delta area that enters Utah Lake.*

- *Goal 4.5 Recognize that Utah Lake is a focal point of local natural resource systems that contribute to the environmental health, economic prosperity, and quality of life of area residents and visitors. Through collaborative restoration, protection, and sustainable-use efforts, the lake and its multiple-use amenities are fully recognized, enjoyed and protected for current and future generations (Provo City 2013).*

Utah Lake Master Plan

The Utah Lake Master Plan (ULMP) was adopted in 2009 by the Utah Lake Commission, a cooperative effort that includes each municipality surrounding Utah Lake, State regulatory agencies, and political officials. The ULMP identifies a vision for Utah Lake as a resource integral to surrounding communities. This includes identifying a vision, and goals for lake management, including management of Utah Lake and associated resources, including recreation and natural resources (Utah Lake Commission 2009).

Land use policies outlined in the ULMP include the following:

- *Land Use Policy 1 – The [Utah Lake] Commission [Commission] encourages the coordination of general plans and land use regulations among governments within the Utah Lake Master Plan Area.*

- *Land Use Policy 2 – The Commission encourages land uses in the Utah Lake Master Plan Area that are designed, located, and operated so as to protect or enhance the ecological function of Utah Lake's natural resources.*

- *Land Use Policy 3 – The Commission promotes compatible land use transitions and appropriate land use development by facilitating communication, cooperation and collaboration among local governments, state, and federal agencies, to effectively implement the Master Plan.*

- *Land Use Policy 4 – The Commission encourages local governments and state and federal agencies to cooperate to provide effective and efficient law enforcement in the Utah Lake Master Plan Area.*

- *Land Use Policy 5 – The Commission encourages that any recreational and commercial development project be consistent with this Master Plan.*

Natural resource management policy outlined in the ULMP includes the following:

- *Natural Resources Policy 1 – The Commission supports and encourages preservation of high value wildlife areas.*
- *Natural Resources Policy 2 – The Commission advocates creation of habitat buffer areas along the shore of Utah Lake in appropriate locations.*
- *Natural Resources Policy 3 – The Commission values and supports efforts to recover federally listed threatened and endangered species and to prevent additional federal listings within the Utah Lake Master Plan Area.*
- *Natural Resources Policy 4 – The Commission will take an active role in expanding and improving interpretive and directional signage to inform the public of the values of Utah Lake.*
- *Natural Resources Policy 5 – The Commission encourages efforts to control invasive or undesirable plant, animal, and insect species.*
- *Natural Resources Policy 6 – The Commission encourages studies to determine the feasibility to reduce lake level fluctuation to accommodate Commission objectives such as recreational use and ecological integrity.*
- *Natural Resources Policy 7 – The Commission will consider engineered solutions to challenges pertaining to Utah Lake as long as they are consistent with other goals and objectives of the Master Plan.*
- *Natural Resources Policy 8 – The Commission encourages and supports opportunities to improve Utah Lake water quality.*
- *Natural Resources Policy 9 – The Commission supports and encourages efforts to better understand the Utah Lake ecosystem through coordinated research and monitoring programs.*
- *Natural Resources Policy 10 – The Commission promotes the efficient use of Utah Lake's water resources and encourages appropriate actions that may reduce evaporation and other losses.*
- *Natural Resources Policy 11 – The Commission encourages the thorough and expedited study of the effects of nutrients on beneficial uses of Utah Lake and supports the pursuit of a site-specific TDS (total dissolved solids) standard for Utah Lake.*
- *Natural Resources Policy 12 – The Commission encourages that planning efforts for the expansion or construction of wastewater treatment facilities consider nutrient removal in the design process.*

Recreation policies outlined in the ULMP include the following:

- *Recreation Policy 1 – The Commission encourages efforts to improve public access facilities and increase opportunities for public access to Utah Lake.*
- *Recreation Policy 2 – The Commission encourages development of recreation facilities that minimize adverse impacts to sensitive lands and resources and are consistent with the goals and objectives of the Master Plan.*
- *Recreation Policy 3 – The Commission encourages the distribution of recreation opportunities around Utah Lake appropriate to population and needs.*
- *Recreation Policy 4 – The Commission promotes the development of a variety of recreational opportunities at Utah Lake.*

The ULMP provides a specific vision statement supporting recovery of the June Sucker: "The fish community is proactively managed to recover June sucker, support a compatible recreational fishery, and control undesirable or incompatible species (e.g., carp)."

3.10.5 Impacts of the No-Action Alternative

Existing agricultural land uses would likely continue in absence of an action alternative. All of the study area lands are zoned agricultural in the Utah County General Plan (Utah County 2007). In the future some lands could be incorporated into a municipal area (Provo City or Orem). However, due to floodplains, wetlands, a conservation easement and wetland mitigation areas, development would not be likely in the majority of the study area in absence of the proposed action. Existing river channel land uses would likely continue as they currently exist.

3.10.6 Impacts of the Action Alternatives

Existing Channel Option 1

With Option 1, land adjacent to the existing channel would be acquired for the location of the diversion structure and for realignment of Boat Harbor Drive, but this option would not otherwise significantly change adjacent land uses or ownership.

Existing Channel Option 2

Option 2 has the same implications for land use as Option 1, except that land and access to the lower dam would also be necessary.

Alternative A

Alternative A is consistent with land use planning for the area and accommodates other planned uses. Provo City has identified a preferred alignment for the proposed Provo Lakeview Parkway and Trail. Alternative A design elements have accommodated Provo City's preferred alignment for this proposed facility. Boat Harbor Drive would be realigned between the existing river channel, and the new river channel. Under Alternative A, the proposed realignment of Boat Harbor Drive would affect existing river access at Alligator Park. Therefore, expansion and improvement of that access is proposed as part of the design for this alternative. The main objective would be to consolidate ingress and egress to and from the parking lot to a single point. Currently Boat Harbor Drive constitutes the west boundary of the parking area, with no discernible ingress/egress designation. Other recreation enhancements associated with Alternative A are described in Section 3.15: Recreational Resources.

Alternative B

Alternative B is also consistent with land use planning for the area and accommodates other planned uses, similar to Alternative A. Alternative B would involve a slightly different realignment of Boat Harbor Drive, compared to Alternative A or C and would not change access and parking at Alligator Park. Other recreation enhancements associated with Alternative B are described in Section 3.15: Recreational Resources.

Alternative C

Alternative C is also consistent with land use planning for the area and accommodates other planned uses. Alternative C includes the same proposed realignment of Boat Harbor Drive as Alternative A, and also includes the same proposed improvements to the Alligator Park river access. Other recreation enhancements associated with Alternative C are described in Section 3.15: Recreational Resources.

3.10.7 Indirect and Cumulative Impacts

None of the action alternatives would affect land uses beyond the study area. Ongoing coordination with Utah County, Provo City, the Utah Lake Commission, and other entities would be necessary as land uses surrounding the project implementation area change over time.

Action alternatives do not conflict with planned land uses associated with the Provo Airport or Provo City's airport-related development area. In Provo City's General Plan, an area of land surrounding the airport is reserved for airport-compatible development (Provo City 2009). This local land use designation is located entirely south of Center Street and does not overlap with the project study area; therefore, the project would not have effects to airport-related development. In consultations with FAA, the JLAs also learned that changes in land cover and structure can necessitate adjustments to the operation of radar systems that guide aircraft. These adjustments are necessitated by typical land use changes, including new development, for example. Land use changes associated with project action alternatives would not affect the operational effectiveness of radar systems, but may necessitate some changes to calibration, both during the construction period and after project completion. Therefore, the JLAs would coordinate with FAA and the Provo Airport prior to project construction so that appropriate personnel can be alerted to pending land use modifications and any necessary adjustments to radar systems can be made.

Another concern expressed by Provo Airport and FAA was whether any construction equipment or project features would be of sufficient height to intrude into protected airspace; however, none of the project features or construction equipment needed for any of the action alternatives would exceed the existing tree line height adjacent to the study area (along the existing Provo River corridor and along Skipper Bay dike). The Provo Airport Master Plan (Provo City 2000) identified conflicts with the airport's air space, and these existing tree canopies were not identified as intruding on the critical airspace; therefore, the project features and construction equipment would not have an impact on the airspace. Concerns related to aircraft-bird strike risk are evaluated in Section 3.16.

In terms of cumulative land use, the proposed action would contribute incrementally to other Utah Lake habitat improvement projects, including other projects implemented by the JLAs such as the Hobble Creek improvements and the Utah Lake Wetland Preserve, a network of wetland and interspersed upland habitats near the southern end of Utah Lake that have also been implemented related to mitigation for federal Reclamation water development projects. The vegetation management plan for the proposed action (Appendix B) would contribute toward lake-wide efforts to manage invasive species, particularly phragmites control efforts, that are being implemented by Utah County, the Utah Division of Forestry, Fire, and State Lands (FFSL), the Utah Lake Commission, and other partners.

3.10.8 Mitigation Measures

Final design of an action alternative may result in some modifications to the proposed designs. Consultation with Provo City, Utah County, landowners, and other stakeholders would be ongoing through final design of the Provo River Delta Restoration Project. The JLAs would coordinate with FAA and Provo Airport prior to project construction activities to alert them of pending land use changes that may require recalibration of radar systems.

3.10.9 Land Use Summary

Compatibility with local and regional land use planning is a relevant issue for EISs. The proposed action is compatible with Utah County and Provo City planning and the Utah Lake Master Plan. Ongoing coordination with Utah County, Provo City, the Utah Lake Commission, FAA, and other entities would be necessary as land uses surrounding the project implementation area change over time.

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3.11 Agriculture and Farmlands

This section addresses potential impacts on agricultural resources and farmlands in the study area.

3.11.1 Issues Addressed in this Section

Issues addressed in this section are as follows:

- How would agricultural activity in the study area change as a result of the project?
- Would the project utilize designated prime farmland, farmland of statewide importance, or areas designated as APAs?

Effects on agriculture were assessed in consultation with the Utah Department of Agriculture and Food, the Natural Resource Conservation Service, local landowners, available data from the Utah Automated Geographic Reference Center, and reviews of study area aerial photography. Impacts to farmland were evaluated in consultation with the Natural Resources Conservation Service (NRCS) using a standardized process required by federal regulations (7 CFR 658) for implementing the Farmland Protection Policy Act of 1981 (FPPA).

3.11.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to agriculture were eliminated from further analysis. Potential socioeconomic effects related to these issues are addressed in Section 3.14, Socioeconomic Impacts. Compatibility with existing and planned land use is addressed in Section 3.10.

3.11.3 Area of Influence

The area investigated for agricultural impacts was the study area and adjoining lands. For the assessment of cumulative effects, conversion of agricultural land on a countywide basis is considered.

3.11.4 Affected Environment (Baseline Conditions)

In the general area, lands in Utah County adjacent to Utah Lake have been used for agriculture. However, urban development continues to expand from Provo City, westward towards Utah Lake. Additionally, lands adjacent to the lake and Provo River are used primarily for recreation, including Utah Lake State Park, and some private recreation facilities, including the CLAS Ropes Course and Lakeside RV Park. South of the Provo River channel and study area is Provo Airport.

Crop production in the study area is primarily for livestock feed, mostly alfalfa hay and occasional field corn. Lands not used for crop production are used for pasturing horses and cattle.

Out of the 708-acre study area, approximately 612.5 acres have an agricultural land use, broken out into the following:

- 516.7 acres primarily used for grazing/pasture,
- 90.6 acres cropped (alfalfa currently, occasionally some field corn is grown), and
- 5.2 acres in agricultural structures (barns, horse corrals, etc.).

Lands immediately east of the study area, within the Provo City limits, have been developed for residential use. Conversion of agricultural lands into residential, commercial, and industrial use has been constant for many years as noted by Provo City and Utah County in their respective general plans (Provo City 2009, Utah County 2007).

Some lands within the study area are designated under the FPPA as prime farmland or farmland of statewide importance, as illustrated in Figure A-28, Appendix A. Prime farmland, as defined by the U.S. Department of Agriculture, is "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses" (NRCS 2011). Farmland of statewide importance is similar, but is designated by appropriate State agencies rather than the federal government. Both designations require evaluation under the FPPA; therefore, the NRCS was consulted in evaluating impacts of project alternatives.

In May 2012 Utah County designated certain parcels within the study area as an APA as provided for in Utah Code (UCA Title 17 Chapter 41). The APA in the study area includes 25 parcels totaling approximately 490 acres and is illustrated in Figure A-28. Designation of an APA prohibits local governments from passing ordinances that would unreasonably restrict farm practices, as well as prohibiting changes to zoning that would promote development (UCA 17-41-402). The APA designation does not prevent property owners from developing their property, however, and a property owner may file a petition to remove the land from the APA as outlined in Chapter 17-41-306 of Utah Code.

While an APA designation does not directly affect or limit actions of the federal government, it does influence assessment of farmland impacts under the FPPA; lands with local or State agricultural protection score higher in the NRCS Farmland Conversion Impact Rating used to assess farmland impacts of federal projects.

3.11.5 Impacts of the No-Action Alternative

Existing agricultural land uses would likely continue in absence of an action alternative. All of the study area lands are zoned agricultural in the Utah County General Plan (Utah County 2007). In the future, some lands could be incorporated into a municipal area (Provo City or Orem). However, due to floodplains, wetlands, and a conservation easement, development would not be likely in the majority of the study area in absence of the proposed action.

3.11.6 Impacts of Action Alternatives

Because the action alternatives differ in acres, they also differ in types of agricultural production that would be affected, as indicated in Table 3-32. Under any of the action alternatives, land acquisitions would affect property owners who use or lease lands for agricultural uses.

Table 3-32. Study area agricultural uses and Agricultural Protection Area, acres.

LAND USES	BASELINE CONDITION	PROJECT ALTERNATIVES, AGRICULTURAL LANDS ACQUIRED		
		A	B	C
Agricultural land uses				
Grazing/pasture	516.7	-413.0	-284.5	-209.5
Crops (alfalfa, field corn)	90.6	-79.4	-18.2	-74.3
Barns, corrals, other structures	5.2	-5.2	-1.4	-3.9
Total Acres	**612.5**	**-497.6**	**-304.1**	**-287.7**
Agricultural Protection Area (APA)	490.0	-462.8	-299.5	-257.7

Alternative A would acquire nearly all of the agricultural lands within the study area that are north of Boat Harbor Drive, including nearly all of the cropped acreage and all of the farm structures. Alternative B would acquire fewer of the cropped acres, avoids most of the lands with agricultural structures, and avoids most of the higher-valued hay production/grazing/pasture lands as well. As discussed in Chapter 2, this alternative was developed in consultation with property owners and is the locally Preferred Alternative as well as the agency Preferred Alternative. Alternative C would acquire the least overall acreage of lands with agricultural uses; however, it would acquire the majority of the higher-value agricultural lands. This is reflected in the farmland conversion impact ratings presented below.

Farmland conversion impacts using the NRCS Farmland Conversion Impact Rating were less than significant for all action alternatives—using the required rating method, a significant impact rating occurs with scores of 160 or higher on the impact rating form. However, there are differences in scores for the three action alternatives, with Alternative C having the highest impact score, and Alternative B the lowest score. Scores for action alternatives were:

- Alternative A – 127.9 points
- Alternative B – 121.9 points
- Alternative C – 130.9 points

Most of the agricultural lands that would be acquired under any alternative are included within the designated APA. The APA increased the above cited farmland conversion scores by 20 points for all action alternatives. While not required by federal law, ideally, the APA could be avoided by one or more action alternatives. However, because of the size of the APA in relation to the alternatives advanced for detailed analysis, avoidance of the APA would not be possible;

smaller-acreage alternatives as well as alternative geographic locations for the project were considered but not carried forward because they would not meet the project need and/or were not feasible to implement, as summarized in Chapter 2, Section 2.8 and detailed in the *Alternatives Development Technical Memorandum* (URMCC 2011).

3.11.7 Indirect and Cumulative Impacts

The proposed action would not have indirect effects to agriculture and farmlands. Cumulatively, Utah County and other counties of the Wasatch Front have experienced major urban expansion resulting in large residential, commercial, and industrial centers along with associated infrastructure such as freeways and surface streets. The 1850 U.S. Census found that Utah County had a population of approximately 2,000 people. The population has increased dramatically since 1850 and this steady increase has led to continuing urban expansion.

Utah County has had approximately 77,000 acres developed out of 1,372,000 acres in Utah County. Some large areas of the County—Utah Lake and the Wasatch Mountains—are not developable because of topographical constraints. Urban development during the past century has reduced the area of farmland, as well as wetlands and wildlife habitat, particularly in Utah Valley where most of this development has occurred. Many of the wetlands north of Utah Lake have been lost or impacted with the introduction of farming in the 1900s. Starting in the 1980s, farmlands in the northern part of Utah Valley, along with additional wetlands were lost or impacted by urban development. Hot spots of development in recent years and in the reasonably foreseeable future will be northwest and west of Utah Lake—such as Saratoga Springs and Eagle Mountain—and southeast and south of Utah Lake—such as Spanish Fork and Payson (MAG 2007, Toth et al. 2004).

The overriding land use trend has been the conversion of land from agricultural uses to commercial and residential uses in response to Utah County's traditionally high rate of population growth. Utah County has been the fastest growing County on the Wasatch Front, averaging 3.7 percent annual population growth, 1990–2009. Statewide annual growth over the same period averaged 2.5 percent annually (UGOPB 2009).

The Utah Governor's Office of Planning and Budget estimates that urban development will decrease the amount of agricultural land in Utah County from 308 square miles in 2005 to 235 square miles by 2030 (UGOPB 2008). In general, there is an ongoing trend of urbanized development in Utah County and in the wider Utah Lake Basin. This trend is expected to continue for the reasonably foreseeable future.

3.11.8 Mitigation Measures

Because land uses in the study area are predominately agricultural under baseline conditions, the JLAs identified a number of possible mitigation measures to reduce the impacts to landowners and agricultural operations caused by acquisition of their private property for the project.

1. Scheduling. A project the magnitude of the proposed delta restoration project would take several years to plan, design, fund, construct and implement if approved. The JLAs would coordinate closely with landowners to identify reliable target dates for ranchers/landowners to count on for planning purposes so they know when they might need to begin adjusting herd size, or whether or not to invest in reseeding an alfalfa crop, for example.

2. Temporary Retained Use. The JLAs would exercise as much flexibility as allowed by law to enable landowners/ranchers to retain use of their property as long as possible, which in some cases may extend even after they have sold it to the government for the project.

3. Temporary Replacement Property. The JLAs have a limited amount of agricultural land in another region of Utah County that has been acquired contiguous to another project. The JLAs would consider the temporary or permanent use of those properties as replacement for properties sold to the government for the delta restoration project, to ease the transition out of agricultural production or from the study area to another location.

3.11.9 Agriculture and Farmlands Summary

Project alternatives were evaluated for effects to agriculture and farmlands. Impacts to agricultural productivity cannot be avoided with any of the action alternatives; therefore, the JLAs have identified possible mitigation measures to reduce the impacts to landowners and agricultural operations. As discussed in Chapter 2 and in Chapter 4, consultations with property owners resulted in modifications to Alternative B, the Preferred Alternative, that would help reduce effects to agriculture and farmlands while still being able to meet the project need.

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3.12 Noxious Species

Potential for noxious species and invasive plant species to affect the success of the proposed action was identified as an important issue. Of particular concern are State-listed noxious weeds and phragmites, which is a Utah County-listed noxious species and a current management concern throughout the Utah Lake environment.

3.12.1 Issues Evaluated in the Impact Assessment

Species on the Utah Noxious Species List within the study area require management consideration. Controlling the spread of these species is mandated by the Utah Noxious Weed Act (Utah Administrative Code, R68-9). Noxious species often out-compete native vegetation and may lower biodiversity and habitat quality.

3.12.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues associated with noxious species were eliminated from further analysis.

3.12.3 Area of Influence

The area of influence for noxious weeds and phragmites is the study area, adjacent lands, and adjacent emergent marsh habitat within the lakebed.

3.12.4 Affected Environment (Baseline Conditions)

Noxious Weeds

Table 3-33 lists State of Utah and Utah County Noxious Weeds. Noxious species found within the study area include Canada thistle, field bindweed (*Convolvulus arvensis*), houndstongue (*Cynoglossum officinale*), quackgrass (*Elymus repens*), saltcedar, phragmites, and musk thistle (*Carduus nutans*). Other nonnative species of management concern that are not on the Utah Noxious Plant List include lambsquarters, annual ragweed, Russian thistle (*Salsola kali*), curly dock (*Rumex crispus*), spiny cocklebur (*Xanthium spinosum*), stinging nettle (*Urtica dioica*), Siberian elm, Russian olive, and five horn smotherweed.

Anthropogenic activities that have the potential to spread and introduce noxious species into a site include agricultural, fishing access, livestock activity, vehicle travel, domestic pet presence, and other recreational activities. These activities not only bring in outside seeds but they also cause disturbance. Areas with recent disturbance are more likely to provide habitat for noxious species establishment. Along the Provo River and canals in the study area, annual high water deposits seeds of Russian olive, Siberian elm, tamarisk, and phragmites. This makes riparian area and canals especially vulnerable to nonnative species invasion and control of these areas a high priority.

Table 3-33. State of Utah and Utah County noxious weed list.

COMMON NAME	SCIENTIFIC NAME
Black henbane	*Hyoscyamus niger*
Diffuse knapweed	*Centaurea diffusa*
Johnsongrass	*Sorghum halepense*
Leafy spurge	*Euphorbia esula*
Medusahead	*Taeniatherum caput-medusae*
Oxeye daisy	*Leucantheum vulgare*
Purple loosestrife	*Lythrum salicaria*
St. John's wort	*Hypericum perforatum*
Spotted knapweed	*Centaurea stoebe*
Sulfur cinquefoil	*Potentilla recta*
Yellow starthistle	*Centaurea solstitialis*
Yellow toadflax	*Linaria vulgaris*
Bermudagrass	*Cynodon dactylon*
Dalmatian toadflax	*Linaria dalmatica*
Dyer's woad	*Isatis tinctoria*
Hoary cress	*Cardaria draba*
Musk thistle	*Carduus nutans*
Perennial pepperweed	*Lepidium latifolium*
Poison hemlock	*Conium maculatum*
Russian knapweed	*Centaurea repens*
Squarrose knapweed	*Centaurea virgata*
Scotch thistle	*Onopordum acanthium*
Canada thistle	*Cirsium arvense*
Field bindweed	*Convolvulus arvensis*
Houndstongue	*Cynoglossum officinale*
Quackgrass	*Elymus repens*
Saltcedar (tamarisk)	*Tamarix spp.*
Common reed [a]	*Phragmites australis*

[a] Utah County-listed noxious weed.

Phragmites (Common Reed)

Phragmites is an invasive perennial reed species that was introduced from Europe. It is also called "common reed" but conventionally referred to as "phragmites," particularly when referring to control efforts, although a native form of the *Phragmites* genus exists in Utah. Salt Lake and Utah Counties in particular have been fighting the invasive form of this plant since the 1980s. Dense monoculture stands of the invasive phragmites will out-compete native wetland vegetation and are considered to have low habitat value for wildlife. Phragmites spreads through both seed and rhizomes, with seed being the dominant means in Utah. A single stem can produce over 10,000 seeds and new plants can sprout from a single vegetative node. Phragmites is extremely efficient at utilizing anthropogenic nutrients from eutrophic waters and agricultural runoff. Shifts from a natural nutrient regime (e.g., due to water quality) allow phragmites to rapidly out-compete native vegetation and favor large, dense phragmites monocultures (Kettenring et al. 2012, Kettenring and Mock 2012).

Large monocultures of phragmites exist immediately adjacent to the study area to the north and west. Indeed, the majority of Utah Lake fringe wetlands are dominated by phragmites. At the present time, Utah County and partner entities, particularly the FFSL and the Utah Lake Commission are implementing an aggressive, multi-phased, multi-year phragmites control program on various parts of Utah Lake (Utah Lake Commission 2013).

3.12.5 Impacts of the No-Action Alternative

Under the No-Action Alternative, noxious weeds would continue to establish in the study area due to anthropogenic activities. Utah County would continue its existing management of these weeds as required by law.

Under the No-Action Alternative, Utah County and partner agencies would likely continue their phragmites abatement efforts in waters and wetlands surrounding Utah Lake. The study area currently contains some smaller stands of phragmites that are likely spreading through rhizomes. These existing phragmites stands would likely continue to expand within the study area wetlands and would likely form larger monoculture stands in the future unless treatment efforts were undertaken by private landowners and/or local governments.

3.12.6 Impacts of Action Alternatives

Potential effects of the action alternatives A, B, or C would be similar with respect to the need for noxious weed control and phragmites abatement.

Noxious Weeds

It is well known that ground disturbance and construction equipment create opportunities for invasive species to establish and spread. Best management practices for reducing this potential are also commonly implemented with construction projects and have been included in the current project as part of the mitigation commitments that would be implemented with any of the three action alternatives (Chapter 2, Section 2.10.1). However, weed control in the project implementation area would be an ongoing land management need if the proposed action is implemented. Therefore the JLAs have developed a vegetation management plan for the project (Appendix B). This plan incorporates an aggressive topsoil handling and revegetation component to the vegetation management plan, in addition to traditional forms of weed control included in the broader Integrated Pest Management Plan (URMCC 2012b).

Phragmites

Under any of the action alternatives, Phragmites is expected to be intensely managed in perpetuity within the study area and nearby areas of Utah Lake where stands are present and create a significant seed source for the project implementation area; therefore, management directives specific to control of phragmites on and near the project implementation area are included in the vegetation management plan (Appendix B).

3.12.7 Indirect and Cumulative Impacts

If not properly managed, lands acquired for the project could have indirect effects on spread of noxious weeds and phragmites to other lands through seed dispersal. For phragmites, the established stands in other areas surrounding Utah Lake are currently having the negative effect of increasing introductions and expansion of stands to other locations. Utah County, the Utah Lake Commission, and other partner agencies are currently implementing a lake-wide control effort; if successful, monoculture stands of this invasive species may become smaller in scale and influence, improving habitat quality at Utah Lake. Ongoing efforts in this regard will be necessary with or without the proposed action. The JLAs and other JSRIP partner agencies are currently involved with the phragmites control effort related to other projects in the Utah Lake area—in particular the Hobble Creek area and the Utah Lake Wetland Preserve on the south end of the lake. With selection of an action alternative, the JLAs and JSRIP would increase their existing level of involvement and assistance with phragmites control to include the lands associated with the proposed action.

3.12.8 Mitigation Measures

Under any action alternative, the vegetation management plan (Appendix B) would be implemented as required mitigation. During the construction phase, best management practices would be implemented to reduce the potential of construction activity to introduce and spread noxious weeds.

3.12.9 Noxious Species Summary

Species on the Utah Noxious Species List within the study area require management consideration. In particular, stands of phragmites will out-compete native wetland vegetation. Under any action alternative, the vegetation management plan (Appendix B) would be implemented as required mitigation.

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3.13 Utilities

Existing public utilities within or nearby the study area are Provo City power lines, a natural gas pipeline that is owned and maintained by the Questar Gas Company of Salt Lake City (Questar), stormwater channels, culverts, and outfalls, and water pump stations. These facilities are illustrated in Figure A-29, Appendix A.

3.13.1 Issues Addressed in the Impact Analysis

The following issues are addressed related to potential effects of the project on public utilities:

- How much of the natural gas pipeline would be inundated in each action alternative?
- Would the project affect the service life of the natural gas pipeline by increasing corrosion or scour as a result of changes to surface and groundwater hydrology?
- How would access to the natural gas pipeline change with each alternative?
- Would service and emergency repair access to the natural gas pipeline be affected?
- How would the natural gas pipeline be impacted by construction activities?
- Does the natural gas pipeline place any limitations on meeting the purpose and need of the project?

3.13.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to utilities were eliminated from analysis. Stormwater facilities and pump stations are addressed in surface and groundwater hydrology, Section 3.2. Water rights are addressed in Section 3.3.

3.13.3 Area of Influence

The area investigated for public utilities was the study area and adjoining lands.

3.13.4 Affected Environment (Baseline Conditions)

Through consultation with Questar employees (M. Gill and B. Peterson 2013, pers. comm.), the JLAs learned that the pipeline is a 20-inch diameter high-pressure main line. Pressure on this line is 354 pounds per square inch (psi). Regulating stations in various locations reduce the pressure to 45 psi for providing flow of gas into distribution lines and service connections. However, there are no distribution lines or service connections within the study area.

The main line through the study area (Figure A-29) was installed in the mid-1970s. At the south end of the study area, the pipeline crosses the existing Provo River channel with an aboveground crossing. Existing groundwater conditions in the study area range from at or very near the surface during the spring months, to 6 feet below the ground surface during the fall months, varying seasonally and spatially along the pipeline alignment. The pipe then continues south through Provo Airport and under the Provo Bay portion of Utah Lake.

When the natural gas pipeline was constructed, the northern half of the study area was not drained as much as it is currently, and therefore did not dry out as much during the summer and fall months. Aerial photography and USGS topographic mapping shows the area as wetland and open water when the pipeline was first installed. Questar did not have "as-built" drawings, but believes the pipeline would not have been installed very deep through the study area because of the high groundwater level at the time of construction. Through most of the year, the soils along the pipeline alignment are saturated due to the high groundwater. Under existing conditions, should an emergency event occur, access to repair the line could be done with tracked vehicles, though drainage of the impacted area would be required in most cases, in order to extricate, repair or replace the line, and rebury it.

3.13.5 Impacts of the No-Action Alternative

The No-Action Alternative would not create change to public utilities in the study area.

3.13.6 Impacts of Action Alternatives

In the preliminary design of action alternatives, a 50-foot buffer around the pipeline was used to avoid excavation over the pipeline corridor except for three or four distributary channels that would be constructed less than 2 feet deep. Potential impacts of action alternatives are summarized in Table 3-34.

3.13.7 Indirect and Cumulative Impacts

Effects from the action alternatives to the natural gas pipeline crossing the study area are localized. As noted in Table 3-34, the primary difference among alternatives is the amount of pipeline that would be inundated by water as it varies across alternatives. In the event of a pipeline break or future scheduled maintenance, Questar would be working in different conditions, with more of the pipeline inundated, similar to the conditions that prevailed when the pipeline was first installed or to portions of the pipeline that cross Provo Bay but on a lesser scale.

3.13.8 Mitigation Measures

Prior to construction, it would be necessary to complete test holes to determine depth to the pipeline throughout the property acquisition boundary. The pipeline would be clearly marked and avoided during construction. Coordination with Questar would be necessary throughout these efforts.

3.13.9 Utilities Summary

The only public utility infrastructure in the study area that would require careful avoidance and mitigation is a high-pressure natural gas line owned and maintained by Questar. Questar did not have "as built" drawings, but believes the pipeline would not have been installed very deep through the study area because of the high groundwater level at the time of construction. Prior to construction, it would be necessary to complete test holes to determine depth to the pipeline throughout the property acquisition boundary. The pipeline would be clearly marked and avoided during construction. Coordination with Questar would be necessary throughout these efforts.

Table 3-34. Assessment of potential impacts of project alternatives on the existing natural gas pipeline in the study area.

ISSUES	NO ACTION	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
Length of pipeline that would be seasonally inundated.	No change.	Approximately 4,800 feet.	Approximately 2,700 feet.	Approximately 3,900 feet.
Would the project affect the service life of the pipeline?	There would be no change to the service life of the pipeline.	As noted above, the pipeline is buried in soils that are primarily saturated most of the time due to high groundwater. Even when inundated with water, there would be no change to the conditions of the pipeline that is currently saturated soils.	Same as Alternative A	Same as Alternative A
Would service and emergency repair access be affected?	Access to the pipeline would remain the same. Should an emergency event occur, the area could be accessed using trucks and other heavy equipment Depending on seasonal fluctuations, drainage of the area may be necessary during repairs and replacement.	Approximately 4,800 feet of the pipeline would be inundated, similar to where the pipeline crosses Provo Bay. This could change access in an emergency event. Water depths would be 2–3 feet through this area, with some areas slightly deeper than 3 feet.	Same as Alternative A, except approximately 2,700 feet of the pipeline would be inundated.	Same as Alternative A except approximately 3,900 feet of the pipeline would be inundated.
Construction activity crossing the pipeline.	None	A berm would be constructed over the pipeline on the southern extent of the property acquisition boundary.	Same as Alternative A	Same as Alternative A
Limitations on ability to meet purpose and need.	None.	None.	None.	None.

3.14 Socioeconomic Impacts and Environmental Justice

Projects can have both beneficial and adverse impacts to social and economic characteristics of the surrounding communities. Additionally, project effects may not be equally distributed for all segments of the population. Executive Order 12898 requires each federal agency to make achieving environmental justice a part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority race/ethnic populations and low-income populations. In addition to avoiding disproportionate negative effects, the Executive Order also requires federal agencies to ensure that no persons are excluded from participation in or denied benefits of programs, policies, and activities because of their race, color, or national origin.

3.14.1 Issues Addressed in the Socioeconomic Impact Analysis

Possible socioeconomic effects evaluated in this impact assessment are potential for action alternatives to affect the following:

- private property uses and property values,
- private business and public sector revenue, and
- environmental justice.

Existing conditions were determined through an assessment of existing property values and tax revenues reported by Utah County, Provo City planning documents, and data from the U.S. Census. Potential effects to nearby residential communities outside the study area are evaluated as indirect effects (Section 3.14.7).

3.14.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No socioeconomic issues were eliminated from further analysis. The specific issues and concerns raised by the public that are addressed in other sections of this chapter include the following:

- land use planning and zoning, which is addressed in Section 3.10;
- potential effects to agriculture, which are addressed in Section 3.11;
- recreation facilities, which are addressed in Section 3.15; and
- mosquito abatement, which is addressed in Section 3.16.

3.14.3 Area of Influence

The area of influence for socioeconomic effects was the study area and nearby neighborhoods and businesses.

3.14.4 Affected Environment (Baseline Conditions)

Study Area Land Ownership and Economic Activity

Ownership of lands in the study area is a mix of private, municipal, County, State, and federal, with the majority (538 out of 708 acres) being privately owned lands within an unincorporated portion of Utah County. Private lands are used for agricultural production and private recreation activities (horseback riding, upland bird hunting). As discussed elsewhere in this document, a significant portion of the study area is within the K. Dale and Sonja Despain Cattle Ranch and Bird Refuge, a State-designated conservation easement which precludes development. Study area parcels are located within Utah County Tax District 30. These parcels collectively paid $10,802.03 of property taxes in 2012 (Utah County 2013).

Outside the study area, adjacent land uses include agriculture, residential neighborhoods, and Utah Lake State Park. Along the south boundary of the existing channel there are two private recreational businesses—Lakeside RV Campground and CLAS Ropes Course.

Adjacent Residential Neighborhoods and Demographic Characteristics

The adjacent residential neighborhoods are all within Provo City. For community planning purposes, Provo has 34 neighborhoods within 5 area neighborhood councils. The neighborhoods adjacent to the study area are Lakeview North, Lakeview South, and Fort Utah. These neighborhoods are within the Southwest Area Neighborhood Council. Neighborhoods throughout the Southwest Area are predominantly single family residential.

Table 3-35 provides a summary of demographic characteristics for census block groups that roughly correspond to the neighborhoods adjacent to or near the study area. These characteristics are compared to the overall Provo-Orem urban area (Provo-Orem CCP) and to the State of Utah.

Census block groups within 1.25 miles of the study area had a 2010 U.S. Census population of 5,642 persons. The population adjacent to the study area is somewhat more ethnically diverse than the larger geographic areas reported in Table 3-35, though the majority of the population in these block groups are white alone—69.4 percent (i.e., reporting one race and not indicating Hispanic or Latino ethnicity). Comparatively, 77.9 percent of all Provo-Orem residents and 80.7 percent of all Utah residents were white alone.

The neighborhoods near the study area have a higher proportion of residents under 18 years of age (38.4 percent) compared to the general Provo-Orem area (25.8 percent) and the State as a whole (31.1 percent). This is likely a reflection of the development of the area as single-family residential neighborhoods, which is also reflected by other demographic indicators reported in Table 3-35; specifically, there is a high proportion of owner-occupied residences, per capita and income comparable to the overall urbanized area, and a relatively low poverty rate compared to the larger geographies.

Table 3-35. Population and household characteristics.

POPULATION AND HOUSEHOLD CHARACTERISTICS	NEIGHBORHOODS NEAR THE STUDY AREA[a]	PROVO-OREM URBAN AREA	UTAH STATEWIDE
Population total	5,642	200,281	2,715,379
Percent of Total Population by Ethnicity/Race			
Hispanic or Latino	23.5	15.3	12.7
White alone	69.4	77.9	80.7
Black alone	0.5	0.7	1.0
American Indian alone	0.7	0.6	1.0
Asian alone	1.5	2.2	2.0
Pacific Islander alone	1.6	1.0	0.9
Other race alone	0.2	0.2	0.1
Two or more races alone	2.5	2.1	1.6
Gender and Age			
Percent female out of total population	49.9	50.4	49.8
Age under 18, percent	38.4	25.8	31.1
Age 65 and over, percent	5.1	6.9	9.5
Income			
Per capita income	$18,180	$18,534	$23,650
Percent below poverty level	4.8	11.4	23.1
Households			
Number of households	1,484	60,246	871,358
Owner occupied residences, percent	81.3	48.7	70.7

[a] Census block groups within 1.25 miles of the Study Area.

Sources: See the following references in Chapter 5 US Census Bureau 2013, EPA 2013, Headwaters Economics 2013.

3.14.5 Impacts of the No-Action Alternative

The No-Action Alternative would not acquire private lands in the study area and would not have significant impacts to community-wide socioeconomic characteristics such as regional population, employment, community business patterns, community facilities, housing, or social interaction patterns.

3.14.6 Impacts of Action Alternatives

Project Alternative A, B, or C

Because the study area is not developed, there would be no residential or business relocations with Alternative A, B, or C; therefore, selection of any of these alternatives would not result in significant impacts to community-wide socioeconomic characteristics such as regional population, employment, community business patterns, community facilities, housing, or social interaction patterns. Construction of any of these alternatives would have a temporary positive economic effect by providing construction employment.

In terms of adverse socioeconomic impacts, lands acquired for an action alternative would no longer provide private income from agricultural use and would not continue to provide Utah County tax revenue. Based on geospatial analysis comparing property acquisition boundaries to Utah County parcel data, Alternatives A, B, and C differ in terms of private property acquisition:

- Alternative A – 417.8 private property acres in 40 parcels with 18 distinct owners.
- Alternative B – 221.4 private property acres in 28 parcels with 11 distinct owners.
- Alternative C – 248.6 private property acres in 30 parcels with 12 distinct owners.

As evaluated in the agricultural impact assessment (Section 3.11), Alternative B avoids many of the agricultural lands that are primarily used for horse pasture, hay, and recreational horseback riding.

Existing Channel Option 1

Option 1 would retain the existing river channel as a recreation amenity for the local area. With minimum flows and aeration water quality in the channel would be improved during summer compared to existing conditions. Businesses associated with the channel should not be adversely affected by this condition as they would under the No-Action Alternative.

Existing Channel Option 2

Option 2 would retain the existing river channel as a recreation amenity for the local area and would offer opportunity to manage the water elevation year-round, positively affecting aesthetic qualities of the area as a recreational resource. With minimum flows and aeration water quality in the channel would be improved during summer compared to existing conditions. Businesses associated with the existing channel should not be adversely affected.

Environmental Justice

None of the project alternatives or existing channel options would directly affect any populated areas. Benefits associated with project would be to provide enhanced recreation opportunities. These enhancements would be equally available to all citizens. Residents in local neighborhoods would likely have the opportunity to use the recreational amenities afforded by the project more often relative to other Utah County residents because of the closer proximity. Therefore, the project alternatives would not have a disproportionate effect on any populations but could potentially have a slightly greater beneficial effect on minority populations that are slightly higher represented in the local neighborhoods than the rest of Utah County.

3.14.7 Indirect and Cumulative Impacts

Because the study area is located within a floodplain, has many existing wetlands, and a large portion of the area is in a conservation easement or set aside as wetland mitigation area, residential or commercial development of study area lands is not reasonably foreseeable. Therefore, existing land uses would likely continue for the foreseeable future if the proposed action were not implemented. Lands to the south of the existing channel within the Provo City municipal boundary have been zoned for residential development and may be developed, with or without implementation of the project. These developments would add to property tax revenues collected by Utah County.

Because lands outside of the study area are expected to become developed, agricultural operations that rely on lands both within and outside the study area are likely to become less viable in the future regardless of whether or not the proposed action is implemented.

Recreation facilities and enhancements associated with the proposed action (described and evaluated in Section 3.15) may help to increase property values for existing and future residential areas in the vicinity. For example, in the south end of the Salt Lake Valley, master planned developments such as Rosecrest in Herriman and Daybreak in South Jordan, have successfully integrated lakes, trails, wetlands, and natural features to create extremely desirable residential areas. On the northwest corner of Utah Lake, several developments in Saratoga Springs are finding success with recreational connection to Utah Lake, with neighborhood boat ramps and marinas.

3.14.8 Mitigation Measures

As discussed in Chapter 2 (Section 2.10.1), property acquisition would follow a standard process required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 USC 61). Fair market value for acquisition of these lands would be determined during this process. Every reasonable effort would be made to complete land acquisitions on a willing-seller basis. Actual property acquisition may vary based on minor adjustments during final design, possible acquisition of additional property on a willing-seller basis, and determination of whether some parcels may be acquired in part or in whole as negotiated with individual landowners.

3.14.9 Socioeconomic Summary

Projects can have both beneficial and adverse impacts to social and economic characteristics of the surrounding communities. None of the action alternatives would result in significant impacts to community-wide socioeconomic characteristics such as regional population, employment, community business patterns, community facilities, housing, or social interaction patterns. Lands acquired for an action alternative would no longer provide private income from agricultural use and would not continue to provide Utah County tax revenue. Property acquisition would follow a standard process for determining fair market value; every reasonable effort would be made to complete land acquisitions on a willing-seller basis.

None of the project alternatives or existing channel options would directly affect any populated areas. Benefits associated with the project would be to provide enhanced recreation opportunities. These enhancements would be equally available to all citizens. Therefore, the project alternatives would not have a disproportionate effect on any populations but could potentially have a slightly greater beneficial effect on minority populations that are slightly higher represented in the local neighborhoods than the rest of Utah County.

3.15 Recreational Resources

Creating enhanced recreation opportunities is one of the purposes of the proposed project. A concern for the proposed project identified during scoping was how the project may affect existing recreation opportunities associated with the lower Provo River and Utah Lake State Park.

Existing recreational opportunities and potential recreation enhancements were determined in consultation with State agencies (Utah State Parks, UDWR, and FFSL), local governments (Utah County and Provo City), and private citizens. The Technical Assistance Team, formed to assist with development of project alternatives, also assisted with identifying recreational resources and opportunities in the project area and vicinity.

3.15.1 Issues Addressed in the Impact Analysis

Issues addressed related to public recreation are:

- How would public recreation facilities and supported activities change with implementation of the project?
- Would the proposed project affect the existing Provo River Trail?
- Would the project affect Utah Lake State Park?
- How would open space between the urban fringe and Utah Lake that provides a visual relief important to the visual character and recreational separation of Provo River be impacted?
- How would public use of the delta restoration area be coordinated with needs of wildlife management control for airport safety?

3.15.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

This section addresses public recreational resources. In terms of privately owned recreation facilities, there is an RV park (Lakeside RV Campground) and a ropes course (CLAS Ropes Course) located along the existing channel. The ropes course business also provides canoe rentals and boating trips on the Provo River. Potential effects to these businesses are evaluated in Section 3.14, Socioeconomics.

3.15.3 Area of Influence

The potential area of influence for public recreational resources is the study area and surrounding lands, including the existing Provo River channel, shoreline trails, and Utah Lake State Park.

3.15.4 Affected Environment (Baseline Conditions)

The existing Provo River channel corridor is a valuable recreational resource for activities such as boating, fishing, walking, and bicycle riding (Figure 3-24).

Figure 3-24. The existing Provo River Parkway Trail on the north levee of the existing channel is popular for a variety of recreational activities.

Existing public recreational opportunities are associated with Provo City and Utah County trails in the vicinity, Utah Lake State Park, and the existing Provo River channel. Existing recreation trails extend along the north levee of the Provo River (Provo River Parkway) and along the existing dike on the west end of the study area (Skipper Bay dike trail). These trails are components of the larger Provo/Jordan River Parkway Trail system in Utah County (see www.mountainland.org/trails). The County plans to extend and improve the regional connectivity of this trail system as Utah County grows (Utah County 2007). The typical paved trail design used by Utah County is shown in Figure 3-25.

Utah Lake State Park averages about 250,000 visitors annually (Utah Division of State Parks and Recreation 2011). Facilities and activities at Utah Lake State Park include a marina, boat launch ramps, campsites, visitor center, fishing areas, picnicking, day use pavilions, and swimming. The existing river channel outside the park draws additional recreation visits (fishing and boating).

The existing river channel adjacent to Utah Lake State Park and upstream throughout the study area provides a variety of boating and fishing opportunities. The nature of the existing river in terms of water width, depth, and water velocities is very different upstream of the UDWR fish weir than it is downstream. The deep, low-velocity reach downstream of the UDWR fish weir

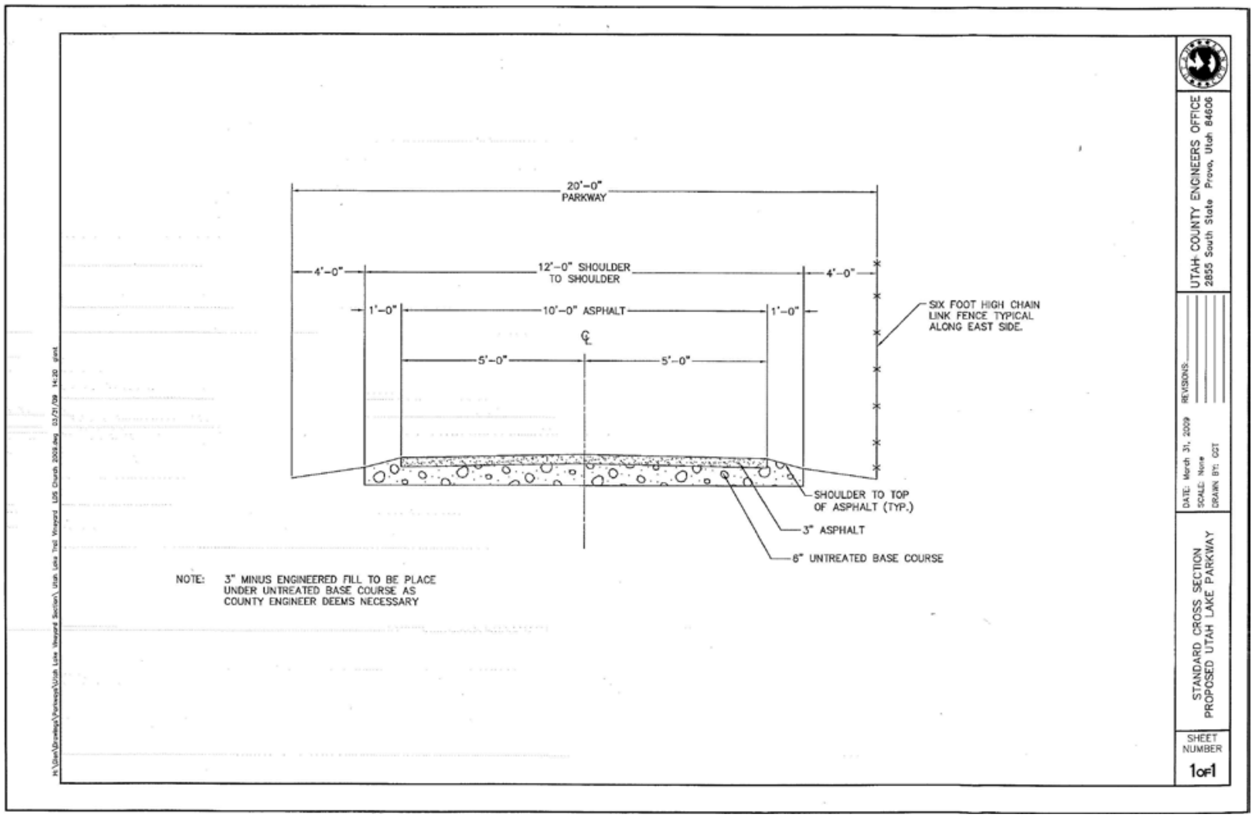

Figure 3-25. Standard cross section for existing trails within the study area.

lends itself to flat water activities, whereas the upstream reaches are more of a white water experience during high flows, and then becomes too shallow to float during the summer low-flow months. There is a boat launch located on the north side of the Center Street Bridge, just east of Utah Lake State Park entrance. This boat launch is utilized by motorized and nonmotorized boaters. Boaters can also launch from a parking area (locally referred to as Alligator Park) along the existing channel that is accessed from Boat Harbor Drive. The entire channel length is accessed on foot by existing trails.

3.15.5 Impacts of the No-Action Alternative

Under the No-Action Alternative, existing Provo River channel recreation opportunities would likely continue. There would not be the additional public recreation features and opportunities associated with the action alternatives.

3.15.6 Impacts of Action Alternatives

Existing recreational activities in the study area would be maintained under all three action alternatives and options associated with the existing channel. Some existing facilities such as the northern portions of Skipper Bay dike trail would be impacted, but new trails would be constructed with an overall greater trail length and greater connectivity with the existing trail system in terms of providing a loop back to the Provo River Parkway Trail, instead of a dead-end as currently exists. The degree to which existing and new recreational opportunities would be enhanced is alternative and option dependent. Figures A-1 through A-6 (Appendix A) provide an overview of recreational features associated with each alternative and option. Two viewing towers would be constructed under all action alternatives, one at the end of the remaining portion of the Skipper Bay dike trail and the other at the northwest corner of the property acquisition area. The second viewing tower in the northwest corner would only be built if/when the Provo Lakeview Parkway and Trail is constructed, because access to this location would depend on that facility (except under Alternative C, because the berm proposed with Alternative C would create access).

Public access to the delta restoration area would be subject to periodic closure to accommodate wildlife-control measures if they are needed to accomplish airport safety objectives. Closures could occur on short notice and may also be scheduled in advance in some circumstances. Wildlife control measures would include scare tactics, hazing, and possibly lethal control (see Section 3.16.11).

New Parking Areas/Trailheads

Under either Alternative A or C, the parking lot on the north side of the existing channel known as Alligator Park would be improved. New parking and river access would be built to the north of Boat Harbor Drive at a location west of Alligator Park. The main objective (also described in Section 3.10: Land Use) would be to improve safety by consolidating ingress to and egress from the parking lot to a single point. Currently, Boat Harbor Drive constitutes the west boundary of the parking area, with no discernible ingress/egress designation. Under Alternative B, no property acquisition would occur in the vicinity of Alligator Park, so this existing facility would not be improved as a component of the proposed project.

Under any of the three alternatives, a new parking area and trailhead would be constructed on the south side of the existing river channel, near where the realigned Boat Harbor Drive would intersect with Lakeshore Drive. Additionally, a new parking area providing access to the new river delta area would be constructed to the north of Boat Harbor Drive at a location to the west of the existing Alligator Park as illustrated in Appendix A, Figure A-1 (Alternative A), Figure A-3 (Alternative B), and Figure A-5 (Alternative C).

Trails

New trails on the berms associated with any of the action alternatives would be paved with a 10-foot-wide asphalt surface with a design similar to the existing trails in the study area. Additionally, the berm trail segments would incorporate a separate unpaved pathway intended for equestrian use. Width of the pathway would vary depending on location. It would generally be 4-feet wide but may be as narrow as 2 feet in some locations. At least one of the proposed parking areas would include space to accommodate several horse trailers and essential equestrian features such as a hitching rail.

The berm height for all new trails would be 4,495 feet throughout the western portion of the project area (Figure 3-26), and would taper or slope near the interfaces to match the existing trail elevations of 4,498 feet near Boat Harbor Drive and the Provo River on the east and 4,493 feet at Skipper Bay Dike on the west. Currently, the elevation of the Skipper Bay dike trail ranges between 4,491–4,493 feet, making the trail unusable when the Utah Lake water surface exceeds 4,491 feet. The lower northern portion of Skipper Bay dike trail was overtopped in 2011, as was

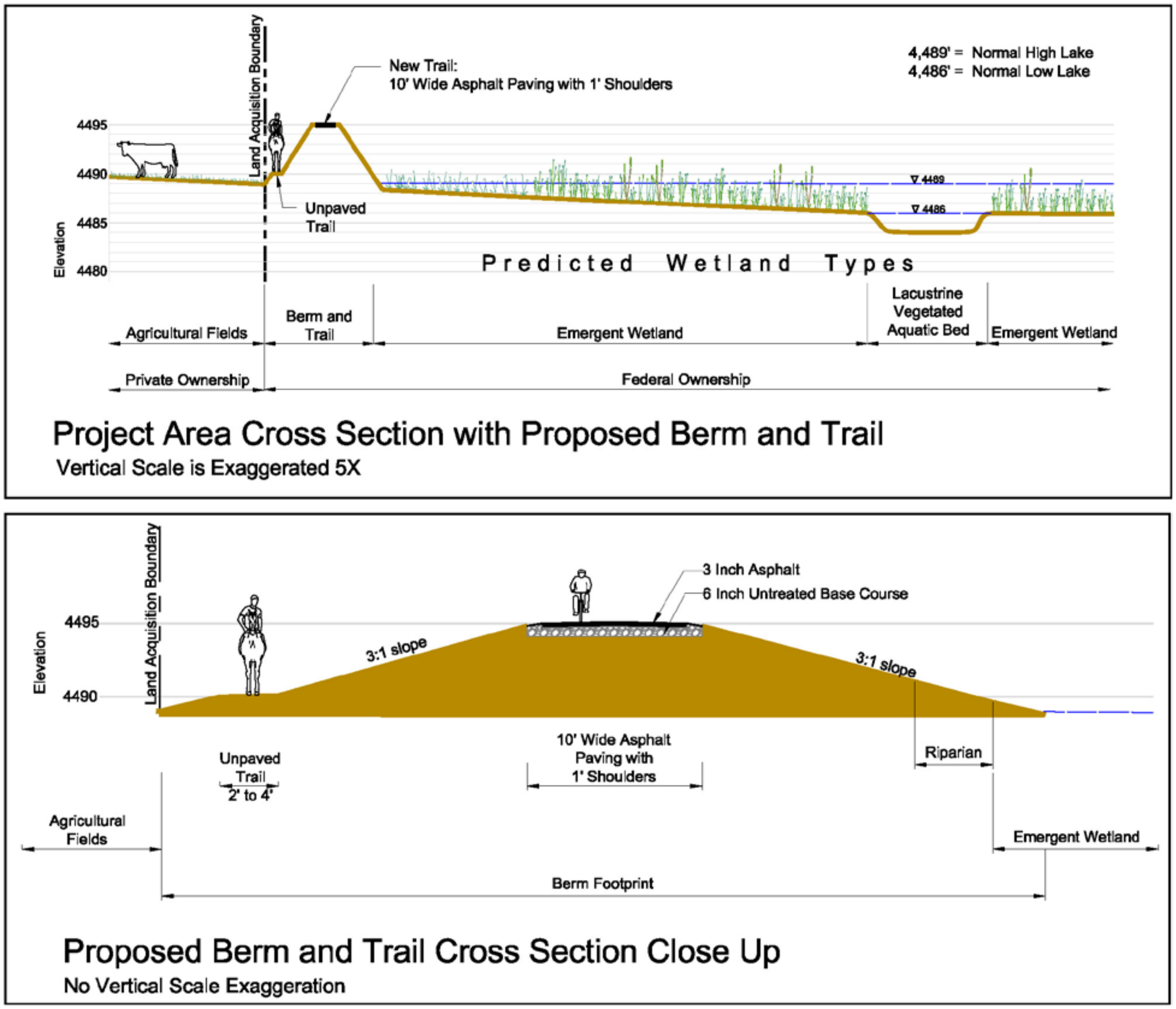

Figure 3-26. Two cross-section views of the proposed berm and trails.

the western portions of Provo River Parkway Trail, the western portions of Boat Harbor Drive and northern portions of Center Street, and a large section of Utah Lake State Park. Sandbags were used to protect the trail with limited success. The design elevation of 4,495 feet was selected for the new berm and trail because it exceeds the FEMA-designated 100-year flood elevation of Utah Lake, and is not likely to be overtopped except during very rare events. Anything higher on the western portion of the study area would require a substantial increase in fill, would visually stick out of place with a very large footprint, and would impact existing and predicted wetlands.

With Alternative A or B, a right-of-way would be designated for construction of a short east-west trail segment on the north end of the study area (Appendix A, Figures A-1 and A-3). This segment (approximately 1,660 feet in length) would be developed in concert with Provo City's planned Provo River Parkway and Trail. It would likely be developed as an unpaved trail to the Utah Lake shoreline at the northwest corner of the proposed project's property acquisition boundary. Wetland impact avoidance would be necessary for developing the trail segment, including a possible bridge or boardwalk structure for an undetermined portion of the trail length. A viewing tower would be constructed at the west end of the trail. This trail segment would not be built unless the Provo Lakeview Parkway and Trail are constructed. Under Alternative C, property would not be acquired by the federal government in this area, so this trail segment is not proposed as a component of Alternative C; however, the berm associated with Alternative C would provide a different access route to the same Utah Lake shoreline area (Appendix A, Figure A-5); therefore, under Alternative C, the viewing tower is proposed at this location even if the Provo Lakeview Parkway and Trail are not constructed.

Long-term Management and Regulation of Trails, Trailheads, and Parking Areas

In developing the above-described recreation features, the JLA's objective would be to provide recreation opportunities in the project area with connectivity to other existing recreation features and opportunities in the general vicinity. Equestrian facilities and the parking area along Lakeshore Drive/Boat Harbor Drive were added in the Final EIS, based on comments received following release of the Draft EIS. Following construction of the proposed recreation facilities, the JLAs anticipate transferring long-term ownership and management of trails and parking areas to Utah County and/or Provo City, depending on jurisdiction of areas where the respective facilities would be located. Allowed uses of trails, trailheads, and parking areas would, therefore, be determined by the County or City according to its respective rules and ordinances. It would also continue to be incumbent upon the County and City to determine allowed uses and management of other existing and planned trails within the respective jurisdictions of facilities connecting to the proposed project's recreation trails, trailheads, and parking facilities (e.g., Provo River Parkway Trail, Airport Dike Trail, Provo Lakeview Parkway and Trail).

Existing Channel Options

There are two options associated with the existing channel capable of being implemented under any action alternative. With minimum flows and aeration water quality in the channel would be improved during the hot low flow summer months compared to existing conditions. Changes in water quality are described in Section 3.4 and would however affect fisheries, aesthetics, and the recreational uses of the lower river.

Option 1 was developed and carried forward for further analysis because it maintains the riparian forest and trails associated with the existing channel in a similar condition as currently occurs as it maintains direct connectivity with Utah Lake at the current mouth of the river. It is important to note that the primary recreational resources and activities that take place both on the Provo River, and within the river corridor, are within the reach of the river downstream of the UDWR fish weir that functions as an extension of Utah Lake. That is, the water elevation of the Provo River channel downstream of the UDWR fish weir is primarily controlled by Utah Lake. Even with 10 cfs minimum flows, the water elevations in the existing river channel below the UDWR fish weir would not change relative to the No-Action Alternative, even in low-water years, such as 2013, when lake levels were recorded as low as 4,485 (water levels and flows are discussed in greater detail in Section 3.2). The water elevations in the lower Provo River would continue to fluctuate under Option 1 (similar to the No-Action Alternative), exposing the muddy bed and banks annually during the months of July through September. The peak flows that typically bring the majority of trash and organic debris into the lower channel would be diverted into the delta, reducing the overall accumulation of trash and debris in the existing channel. The result of Option 1, which could be paired with any of the action alternatives, would not significantly change the types of recreational opportunities currently associated with the existing channel (fishing, nonmotorized boating, swimming).

Option 2 was developed and carried forward for further analysis because it too maintains the riparian forest and trails associated with the existing channel in a similar condition as currently occurs but also provides opportunities to enhance recreation associated with the existing channel. When Utah Lake recedes, water levels in the existing channel drop on average, three feet during the dry and warm summer months (July–September). The muddy substrate on the bed and banks becomes exposed and the water becomes less accessible from the stream banks and of lower water quality when the lake is low. In addition, the water surface becomes, on average, 20 feet narrower in the existing channel during low lake elevations, reducing the area available for canoeing by a total of 3.6 acres.

Option 2 differs from Option 1 in that it provides a controlled water surface elevation that would not only benefit recreational opportunities associated with the existing channel, it would enhance the existing riparian forest that shades the trail. If the aeration measures implemented as part of the proposed action were inadequate to achieve State water quality standards for DO, removal of a portion of the high-SOD substrate could be a mitigation measure to help improve DO levels during the hot low flow summer months. The small dam at the mouth of the river associated with Option 2 would provide opportunities to temporarily dewater the existing channel and dredge the muck that has built up over the past several decades. See Section 3.4.8 Water Quality Mitigation Measures for a full description of the measures proposed by the JLAs to improve water quality.

Currently the banks of the river are very steep in areas, with lots of concrete, riprap, and debris (Figure 3-27). With the dewatering abilities associated with Option 2, the existing channel would be accessible to heavy equipment that could be used to improve the condition of the existing bed and banks for recreation, including safer access to the water in designated locations. Additional details for improving the condition of the existing channel would be incorporated during final design and would involve ongoing coordination and cooperation with Utah County, Provo City, landowners, and interest groups.

Action Alternatives

The impacts to recreational resources are summarized in Table 3-36.

Additionally, recreational resources expanding trail opportunities for hiking and biking, as well as interpretation opportunities would happen with each action alternative. The differences between alternatives are the size and location of the project area available for public access, and the location and amount of trails, parking and public access to be added.

Figure 3-27. Steep banks covered in concrete and trash accumulations are common along the existing river channel. The top left photo shows the existing steep concrete covered south bank just downstream of the Utah Division of Wildlife Resources fish weir. The top right photo shows trash and organic debris accumulations in the existing channel. The bottom photos show the trail and steep concrete covered northern bank downstream of Alligator Park.

Table 3-36. Recreational resource impact assessment by alternative.

RECREATIONAL RESOURCE	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
Paved trail additions	+5,306 feet	+6,365 feet	+11,780 feet
Paved trail removal (Skipper Bay dike trail partially removed)	-3,454 feet	-2,872 feet	-3,315 feet
Net change in paved trail	+1,852 feet	+3,493 feet	+8,465 feet
Unpaved equestrian trail on all new berm trail segments parallel to paved trail	Included	Included	Included
Unpaved trail segment from planned Provo Lakeview Parkway and Trail to Utah Lake shoreline (approximate length: 1,660 feet)	Included	Included	Not included

Table 3-36. Continued.

RECREATIONAL RESOURCE	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
Changes to existing trails	The trails along the existing river channel would remain unchanged except that a new pedestrian bridge would be installed over the Provo River near the new delta diversion, and the trails would go under a bridge where the new section of Boat Harbor Drive crosses the existing channel. The Skipper Bay dike trail would terminate farther south than it currently does, and would include a viewing tower at the trail's end. The connection between the Provo River Parkway Trail and the Skipper Bay dike trail currently crosses Center Street and Boat Harbor Drive. The joint lead agencies would coordinate with Utah County to improve the trail connection at this location, possibly using pedestrian crossing signs, expanding the shoulder of the road for pedestrians use, and/or painting a designated pathway for pedestrians.		
Utah Lake State Park	Utah Lake State Park is outside of the acquisition boundary. Facilities at the State Park would not be changed as a result of the project. Access to the State Park from Center Street and Boat Harbor Drive would be maintained. Under Option 2, a small dam would be constructed adjacent to the State Park, and boat access to the river upstream from the State Park, and downstream from outside of the State Park would be changed.		
Private recreational resources	Private recreational resources including the RV park, CLAS Ropes Course, boat rentals, and boat tours that take place on the existing river channel would not be impacted. Conditions in the existing channel conducive to recreation would be enhanced under Option 2, except that boat access to Utah Lake proper would require portage at the new small dam near Utah Lake State Park.		
Open space and visual relief	Lands between the western edge of residential development and Utah Lake would change from agricultural lands to a combination of riparian woodlands, grassed uplands, emergent wetlands, and open water, providing a natural setting as the delta vegetation becomes re-established. The project area would not be developed for commercial, industrial, or residential purposes, maintaining open space and natural settings.		
Riparian corridor along river channel	Riparian vegetation along the river channel corridor provides a canopy over the Provo River and Provo River Trail. The project would not involve any significant changes to the riparian vegetation along the existing river channel. Option 2 provides for a more stable water table for riparian vegetation.		

Table 3-36. Continued.

RECREATIONAL RESOURCE	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
Additional parking, viewing towers, and primitive trails	Two new trailhead parking areas would be created and the existing Alligator Park parking area would be improved. Two viewing towers would be constructed. A network of primitive trails would be allowed to develop within the restored river delta area.	Two new trailhead parking areas would be created. Alligator Park would not be improved as part of the proposed project. Two viewing towers would be constructed. A network of primitive trails would be allowed to develop within the restored river delta area.	Two new trailhead parking areas would be created and the existing Alligator Park parking area would be improved. Two viewing towers would be constructed. A network of primitive trails would be allowed to develop within the restored river delta area.
Signage	Signage would be provided at the new parking and other trail access points to inform the public of the new trail system, including the use of primitive trails that are expected to develop throughout the project area. Important habitats to be protected would be identified and protected through signage and other means. Temporary closures of important habitats within the project area might be appropriate during sensitive times of the year for certain species.		
Fishing opportunities	The delta is designed to provide prime habitats for the various stages of fish development for the June sucker. These habitats would also benefit sport fishes found in Utah Lake, including various bass species and catfish. The stable water surface elevation in the existing channel under Option 2 would provide better access to the water than existing conditions and Option 1, and provides more opportunities to modify the bed and banks in a way to improve angler access to the existing channel.		
Scenery and visual resources	The existing Provo River Parkway and Skipper Bay dike trails afford opportunities for the public to enjoy open space, including foreground and middle-ground views of Utah Lake, fringe wetlands, and agricultural settings. The study area open space also provides background views of the mountain ranges to the north and east beyond the developed portions of the Utah Valley. The additional trails and viewing towers that would be constructed under any of the action alternatives would increase public opportunities to enjoy open space in the study area. There may be instances when public spaces are temporarily closed to manage wildlife to minimize the bird-aircraft strike risk associated with the adjacent Provo Airport.		

3.15.7 Indirect and Cumulative Impacts

Cumulative impacts include further expansion of the overall trails network in the lower Provo River/Utah Lake interface. The Provo River Trail extends from Utah Lake, to Deer Creek Reservoir, and continues upstream from Deer Creek, through the Heber Valley to Jordanelle, with eventual connection to the Union Pacific Rail Trail. These trails are part of an interconnected trail network connecting the Wasatch Front, and the Wasatch Back, connecting to Heber, Midway, Park City, and Salt Lake. Additionally, plans have been identified to develop a trail network around Utah Lake, with connections to the cities around the lake, and connection to the Jordan River Trail, which follows that river to Great Salt Lake. All action alternatives have been developed to connect existing and proposed new trails with the proposed Provo City Lakeview Parkway and Trail. Trails are generally viewed positively, connecting residential areas with natural resources, as well as providing safe recreational opportunities for walking and biking. Trails constructed in the Provo River Delta area would provide additional sections and connectivity to the very large trails networks of Utah Valley.

3.15.8 Mitigation Measures

Enhanced recreation features are a component of the proposed project and impacts to existing recreation facilities have been avoided, minimized, and replaced or would be upgraded with proposed project alternatives. Many detailed comments and suggestions have been received during scoping and during the Technical Assistance Team meetings regarding ideas to promote and enhance the existing channel for recreational fishing opportunities. Many of the ideas expressed would be implemented in concert with a selected alternative and option, as appropriate. The JLAs feel that many of those elements are best determined at the next level of design, once an alternative and option has been identified. The incorporation of aeration as a project component of the minimum flows to be released into the existing river channel together with the water quality mitigation measures (if needed) described in Section 3.4.8 to improve water quality, including the option of removing some of the riprap and improving stream bank access to the channel, would also provide a benefit to the existing recreational uses of the existing channel. The guaranteed minimum flow of 10 cfs to 50 cfs associated with all action alternatives would also provide a benefit to the aesthetics of the existing channel during the summer irrigation season in dry years when otherwise the existing channel experiences zero flow at times under existing conditions such as occurred for a prolonged period in 2013.

3.15.9 Recreational Resources Summary

Creating enhanced recreation opportunities is one of the purposes of the proposed project. The existing Provo River channel corridor is a valuable recreational resource for activities such as boating, fishing, walking, and bicycle riding. The existing recreational activities in the study area would be maintained under any of the action alternatives and options associated with the existing channel. The northern portion of Skipper Bay dike trail would be removed under all action alternatives, and a new viewing tower would be constructed at the new trail's end. All action alternatives include new trails, including equestrian trails, and new fishing, boating, and wildlife viewing opportunities and facilities. Providing guaranteed minimum flows of 10–50 cfs and aeration of the water to achieve State water quality standards for DO will enhance the water quality and the recreational opportunities and experience compared to existing conditions especially during summer. Option 2 for the existing channel would provide slightly better water quality (slightly lower temperatures) and better access to the water than existing conditions and

Option 1, and would provide more opportunities to modify the bed and banks in a way to improve and provide safer access for anglers and other recreation users to the existing channel. Additional details for improving the condition of the existing channel would be incorporated during final design and would involve ongoing coordination and cooperation with Utah County, Provo City, landowners, and interest groups.

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3.16 Public Health and Safety

3.16.1 Issues Evaluated in the Impact Analysis

During the scoping process, concern was expressed about higher mosquito production becoming a nuisance and health risk for area residents and recreation users. Another issue raised during scoping was whether changes in bird presence in the study area would result in an increased risk of bird-aircraft collisions, given proximity of the study area to Provo Airport. These public health and safety issues and potential project effects were addressed by coordinating with appropriate agencies and experts. Information on mosquito breeding, habitats, and treatments in Utah County was obtained from the Utah County Health Department and available literature.

Concurrent to preparation of this Draft EIS, Provo Airport was completing its own wildlife hazard assessment (Airport Wildlife Consultants 2014). Provo City and the JLAs agreed to share information from their respective wildlife observations and hazard assessments. The JLAs also invited the FAA to become a cooperating agency. Several meetings were held with Provo City, FAA, and the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA Wildlife Services). Input was requested on analysis methods, and a detailed technical report describing the assessment methods and findings was prepared. The technical report (URMCC 2015b) is available from the project website, www.provoriverdelta.us, or may be obtained by contacting the Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission).

3.16.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

No issues related to public health and safety were eliminated from further analysis. Section 3.2 (Surface and Groundwater Hydrology) provides context for assessing baseline and probable future mosquito production in the study area. Section 3.5 (Wetland Resources) includes an assessment of existing and predicted wetlands and aquatic habitats that informed the assessment of habitat changes in the proposed project area. Section 3.8 (Wildlife Resources) includes an assessment of existing and predicted wildlife habitat, and reports bird species known or likely to occur in the study area that informed the assessment of bird-aircraft strike risk.

3.16.3 Area of Influence

For the evaluation of mosquito habitat effects, the area of influence was the study area because potential changes in mosquito-producing habitat would be limited to that area. For broader context, mosquito-control districts and treatment strategies employed by Utah County in the general environment of Utah Lake are also discussed.

Areas where bird surveys have been completed are illustrated in Figure A-30, Appendix A. For the evaluation of bird strike risk, monthly observations of bird species composition and abundance were made for the study area and also for Provo Bay south of Provo Airport (URMCC 2015b).

3.16.4 Mosquito Abatement – Affected Environment (Baseline Conditions)

Mosquitoes need water to reproduce. There are two generalized groups of mosquito species in Utah, one group that reproduces in floodwater areas and another that reproduces in areas of permanent water (Utah County 2012a). The floodwater group of mosquitoes can complete rapid life cycles in small amounts of temporary water such as rain pools or excess irrigation water. The permanent-water species persists throughout the season. Several of the permanent water species are disease vectors (Utah County 2012a). Existing study area mosquito abatement is conducted through the Utah County Health Department. Utah County monitors mosquito populations throughout Utah Valley and determines treatment strategies (Utah County 2012b).

Standing areas of shallow water that remain wet for a period of 5–7 days in the summer are the most conducive to mosquito production. Organically rich, stagnant waters with low DO levels, such as those occurring in pastures, are particularly productive of mosquitoes (Utah County 2012b). *Culex tarsalis* is a mosquito species associated with irrigated agriculture and stream drainages that is a particular concern because it is a known vector of western equine encephalitis (Nielsen et al. 2002, Utah County 2012a). This and other *Culex* species are also vectors of West Nile Virus (R. Mower 2012, pers. comm.). Larval control is the most effective method because it prevents mosquitoes from emerging as biting adults (Utah County 2012b). However, dense stands of phragmites surrounding Utah Lake create an almost impenetrable barrier to effectively treat mosquito larvae (Utah County 2012b). These areas are extensive along the Utah Lake shoreline. Of particular concern are the vicinities of Provo Bay, Provo Airport, and Utah Lake State Park because these areas have extensive stands of phragmites and are near population centers. Utah County conducts aerial spraying in these areas when mosquito production is particularly high. The existing Provo River channel does not provide mosquito-breeding habitat. Provo River seepage or floodwaters under wet conditions may provide this type of habitat, but mosquito control is generally not needed along the Provo River east of Boat Harbor Drive (R. Mower 2012, pers. comm.).

Within the study area, current practices of pumping water out of the study area, combined with cattle and horse grazing, increase conditions conducive to mosquito production (shallow pools and canals of stagnant, organic-rich water with low DO levels). Therefore, the study area already has significant production of mosquitoes. The Utah County Health Department monitors adult mosquito populations in various locations in Utah County. In 2013 two additional trap sites were added within the project study area to assess existing mosquito production and species composition. A summary of the data is included in Appendix C. The two most common species captured were *Culex tarsalis* and *Culex pipiens*.

3.16.5 Mosquito Abatement – Impacts of the No-Action Alternative

Mosquito-producing habitats would continue to exist in the study area in absence of the proposed project. It is expected that Utah County would continue its existing abatement efforts under the No-Action Alternative.

3.16.6 Mosquito Abatement – Impacts of Action Alternatives

Lands in the study area are already capable of producing significant numbers of mosquitoes, and abatement efforts are currently implemented in the study area. However, any of the three action alternatives would increase the size and duration of shallow water areas capable of producing mosquitos.

The project itself would provide some benefits to mosquito abatement by the following:

- creating flowing water areas that would not produce mosquitoes and shallow water areas that would have better water quality than existing stands of stagnant shallow water in agricultural fields,
- managing the area to support small fish of various species that would consume mosquito larvae, and
- implementing intensified control of existing dense phragmites stands that reduce access and effectiveness of existing mosquito abatement efforts.

Even so, increased mosquito monitoring efforts and active abatement would be necessary with implementation of any of the action alternatives. Consequently, the JLAs, in coordination with the Utah County Health Department, have developed a mosquito management plan specific to the proposed project (Appendix C). This plan would be implemented on selection of any of the three action alternatives.

3.16.7 Mosquito Abatement – Indirect and Cumulative Impacts

For mosquito abatement, an action alternative would only affect the potential mosquito production originating from the lands that would be acquired; thus, the project would not have indirect effects on mosquito production. Cumulatively, the project would have potential to improve mosquito abatement efforts in the surrounding area by implementing a mosquito abatement plan specific to the lands acquired for the project and by controlling phragmites on and near the study area, which would increase access for implementing mosquito monitoring and abatement efforts in the local area.

3.16.8 Bird Strike Risk – Affected Environment (Baseline Conditions)

As previously stated, during scoping and through subsequent interagency consultations, concern was expressed about the potential for increased risk of bird strikes in association with air traffic at Provo Airport. Several approaches were taken to evaluate bird strike risk under baseline conditions. A concise summary of these efforts is provided here; more details are provided in the previously mentioned technical report (URMCC 2015b), available on the project website, www.provoriverdelta.us, or it may be obtained by contacting the Mitigation Commission.

Bird Strike Literature and Incidence

According to a recent report (FAA 2012), from 1990 to 2011, 462 species of birds and 38 species of terrestrial mammals were identified as struck by aircraft nationwide; deer and coyotes are the terrestrial mammals that were most frequently involved with damaging strikes.

On the global scale, while bird strike incidents occur frequently—one estimate is three "significant hits" per week (Millward 2013)—it can also be said that they are quite rare; for airliners, regional jets, and business jets, globally there had been only 1 fatality per 1 billion flying hours from the beginning of public aviation (1912) through 1995 (Thorpe 2003). However, incidents have increased in frequency in more recent years, in the United States at least, because both numbers of birds and numbers of flights have shown increasing trends (FAA 2012). The largest number of fatalities that has ever occurred in a single incident (62 fatalities) occurred in Boston in 1960 when a Lockheed L188 Electra collided with a flock of starlings a few seconds after takeoff (Thorpe 2003). Since that time advancements have been made in aircraft design as well as in wildlife hazard assessment methods and mitigation measures.

The seriousness of incidents varies by type of aircraft. The analysis by Thorpe (2003) for the International Bird Strike Committee summarized trends associated with fatal bird strike incidents, identifying differences between incidents involving jets, general aviation aircraft (civil aviation operations not including scheduled air services), and helicopters. Birds involved in 10 fatal jet crashes up to 1995 ranged from collisions with single, large-bodied raptors to collisions with large flocks of small-bodied perching birds. General aviation aircraft had more total incidents involving fatalities, likely because these aircraft fly at lower elevations and are more vulnerable, particularly to windshield penetration. The birds most commonly struck by general aviation aircraft resulting in fatalities were raptors, accounting for half of the global incidents. Helicopters were also found to be vulnerable to windshield penetration but had few incidents globally; a greater proportion of helicopter incidents occurred in the United States, likely because helicopters are used more frequently in the United States, according to Thorpe's analysis.

Incidents that occur during takeoff are often the most serious, partly because of the speeds at which aircraft fly; however, serious incidents do not necessarily occur within the immediate vicinity of the airport. For commercial and general aviation aircraft, 72–75 percent of strikes have occurred below 500 feet above ground level, but strikes occurring above 500 feet were more likely to cause serious damage to the aircraft (FAA 2012). A recent and well-known incident is the successful ditching of U.S. Airways flight 1549 (Airbus A320-214) in the Hudson River on January 15, 2009, following a collision with a flock of Canada geese. The collision occurred at an altitude of 2,818 feet above ground level at a distance of about 4.5 miles from the approach end of the runway at LaGuardia Airport (NTSB 2010). On March 4, 2008, an executive jet (Cessna 500) collided with one or more pelicans after takeoff from Wiley Post Airport in Oklahoma City, resulting in a fatal crash killing all five persons on board (NTSB 2009). Based on analysis contained in the incident report, the collision was estimated to have occurred at an elevation of 3,050 feet at a distance of approximately 3 miles from the runway. In 2011 another incident involving pelicans occurred 20 miles from an Arkansas airport at 5,000 feet above ground level; fortunately, this aircraft, a regional jet (CRJ 200), was able to land safely (FAA 2012).

The U.S. Air Force Bird Avoidance Model (BAM)

In an initial effort to provide an assessment of existing risk near Provo Airport and associated with the study area for the current project, the U.S. Air Force Bird Avoidance Model (BAM) was initially proposed. The BAM is a tool used to predict the risk of bird-aircraft collisions based on annual Breeding Bird Survey and Christmas Bird Count data (USAF 2012). The BAM system ranks the risk of bird strike as either low, moderate, or severe at dawn, dusk, evening, and daytime based on total bird mass present per unit area. Although some researchers have suggested that the risk of bird strike is five times greater during migration than at any other time of year (Blockpoel 1976, Jerome 1976, Neubauer 1990), results using the standard BAM assessment predicted that the current risk is at a moderate level throughout the year and at all times of the day for the air space controlled by Provo Airport (results of this assessment are provided in the technical report [URMCC 2015b]).

A modified BAM assessment was also prepared using bird survey data collected as part of the current project instead of Christmas Bird Count data. Data were collected during the 2012 spring and fall migration periods in four distinct survey areas (Figure A-30, Appendix A), which represent major habitats in the study area. Field survey locations were as follows: (1) North Wetlands–this area is dominated by emergent and wet meadow wetlands bounded by Skipper Bay dike and Utah Lake on the west, a water drain and marshlands to the north and northeast, uplands and wet meadow/emergent marsh complex on the east, and by an east-west oriented fence line and upland agricultural fields on the south; (2) the South Agricultural Fields–bounded by Skipper Bay dike and Utah Lake on the west, the North Wetlands on the north, wet meadow/emergent marsh complex on the east, and North Boat Harbor Drive and the existing channel and riparian corridor on the south; (3) along the riparian corridor of the existing channel (Provo River Parkway) –between Lake Shore Drive on the east and the Utah Lake State Park on the west; and (4) Provo Bay and dike–along the southern edge of Provo Airport, including the emergent marsh and open water in Provo Bay south of the airport dike.

Provo Bay is outside of the study area for the current project, but it was surveyed to allow assessment of the current bird-aircraft strike risk at Provo Airport and to describe an existing bird community associated with habitat that is likely similar to habitat that would become present in the study area following project implementation. Because this existing bird community is expected to be similar to the bird community that would occur to some degree following project implementation, it assists with evaluation and assessment of both the current bird-aircraft strike risk at Provo Airport and an assessment of the potential bird-aircraft strike risk following project implementation.

Bird surveys were conducted with the objective of providing a complete inventory of bird communities occurring within each of the designated survey areas. By treating the surveys as complete inventories and recording not only species but also the number of individuals of each species present, an assessment of the potential risk of bird-aircraft strikes based on species abundance and/or total mass was possible.

The modified BAM assessment using just the 2012 survey data (data for subsequent seasons were collected through 2013 following completion of the modified BAM assessment) indicated that the Provo River Parkway survey area had the highest bird mass per unit area during both spring and fall migration seasons than any of the other survey areas. The North Wetlands had the second highest bird mass per unit area during the spring, whereas Provo Bay had the second highest bird mass per unit area during the fall. The South Agricultural Fields had the lowest bird mass per unit area during both spring and fall.

Concerns about the direct application of BAM for this project were expressed through consultations with Provo City Airport staff and USDA Wildlife Services because BAM does not determine the risk by hazardous species as outlined in the FAA Advisory Circular 150/5200-33B. Therefore, monthly data collections were continued for another year and a more species-specific approach was developed for the assessment of predicted risk for the study area based on methods outlined in FAA Advisory Circular 150/5200-33B. While the impact assessment does not categorize risk levels using BAM criteria, bird mass was calculated as an additional means of describing existing and predicted conditions.

Study Area Bird Species, Abundance, and Bird Mass

In the survey areas (Figure A-30, Appendix A), bird surveys were completed from April 2012 through October 2013. Methods generally were similar to those described by Cleary and Dolbeer (2005) for conducting wildlife hazard assessments for airports as required by the FAA. An important difference is that for conducting a wildlife hazard assessment, Cleary and Dolbeer recommended sampling between 10 and 20 sites for 5 minutes each, at least twice monthly, for 1 year. For this EIS, fewer sites (four) were sampled for a longer period (2 hours) monthly, for 1 year and quarterly (every 3 months) for 1 year. The greater length of time spent at a site allowed the observer to gain a better understanding of how birds used a site and insight into fly-over pattern and direction. Total bird observations are provided in the technical report (URMCC 2015b), which is available from the project website (www.provoriverdelta.us).

The FAA Advisory Circular 150/5200-33B provides a list of 28 wildlife species classes that are known to be hazardous to aircraft.[8] Table 3-37 presents bird species that are on the FAA list and present in the study area. Table 3-37 also includes species classes that are not on the FAA list but are abundant and present in the study area under baseline conditions. In total, 30,327 individuals across 28 species were detected across all seasons. When considering FAA-listed species specifically, 89 percent of the species identified as hazardous were observed in the study area during at least one season. The number of FAA-listed species observed was greatest during the spring (21 species or 75 percent of the FAA-listed species) and the lowest during the winter (19 species or 68 percent of FAA-listed species). However, the abundance of FAA-listed species was highest during the winter (10,348 individuals) and lowest during the spring (2,380 individuals). During the spring, two FAA-listed species (ducks and blackbirds) accounted for 58 percent of all FAA-listed species observed in the study area. Starlings and blackbirds accounted for the majority of observations made of FAA-listed species during the summer, fall, and winter (55 percent, 76 percent, and 54 percent, respectively).

Abundance is variable across species and seasons. The most abundant species currently are geese, ducks, gulls, shorebirds, starlings, blackbirds, swallows, sparrows, coot, and robin. Geese abundance varies seasonally; they are most abundant during the spring and least abundant during the fall. Ducks are most abundant in the spring and winter. Shorebirds are abundant in the spring, starlings and blackbirds are abundant year-round, American coots (*Fulica americana*) are abundant in the spring, and American robin (*Turdus migratorius*) is abundant year-round.

[8] The FAA list is not a scientific list of species names but rather a list of classes of species that are most frequently involved in bird-aircraft collisions. For simplicity of discussion, types of birds included in the FAA list are referred to in this EIS as the "FAA-listed species" or simply "species."

Table 3-37. Study area seasonal total observations and relative abundance of avian species identified as hazardous to aircraft, April 2012 through October 2013.

FEDERAL AVIATION ADMINISTRATION CLASS	STUDY AREA SEASONAL TOTAL OBSERVATIONS					RELATIVE ABUNDANCE (PERCENTAGES)				
	Spring	Summer	Fall	Winter	Total Abundance	Spring	Summer	Fall	Winter	Total Relative Abundance
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft										
Vulture	1	3	2	0	6	<1	<1	<1	<1	<1
Geese	547	24	0	26	597	6	1	<1	<1	2
Pelican	1	1	0	0	2	<1	<1	<1	<1	<1
Cormorant	0	0	0	0	0	<1	<1	<1	<1	<1
Crane	18	13	9	2	42	<1	1	<1	<1	<1
Eagle	0	0	0	2	2	<1	<1	<1	<1	<1
Duck	4,234	200	349	4,472	9,255	48	8	4	43	31
Osprey	14	6	1	1	22	<1	<1	<1	<1	<1
Pheasant	22	18	18	18	76	<1	<1	<1	<1	<1
Turkey	0	0	0	0	0	<1	<1	<1	<1	<1
Heron	3	2	1	1	7	<1	<1	<1	<1	<1
Hawk (*Buteos*)	17	9	23	14	63	<1	<1	<1	<1	<1
Gull	23	12	183	27	245	<1	<1	2	<1	1
Rock pigeon	13	7	8	25	53	<1	<1	<1	<1	<1
Owl	0	0	1	1	2	<1	<1	<1	<1	<1
Snow bunting	0	0	0	0	0	<1	<1	<1	<1	<1
Horned lark	0	0	0	2	2	<1	<1	<1	<1	<1
Raven	2	0	0	0	2	<1	<1	<1	<1	<1
Crow	0	0	1	0	1	<1	<1	<1	<1	<1
Mourning dove	10	50	60	22	142	<1	2	1	<1	<1
Shorebird	329	60	73	3	465	4	2	1	<1	2
Starling	403	898	4,033	3,934	9,268	5	35	47	38	31
Blackbird	859	497	2,449	1,699	5,504	10	20	29	16	18
American kestrel	5	8	18	17	48	<1	<1	<1	<1	<1
Meadowlark	15	25	11	0	51	<1	1	<1	<1	<1
Swallow	288	438	412	0	1,138	3	17	5	<1	4
Sparrow	189	109	319	82	699	2	4	4	1	2
Nighthawk	0	0	0	0	0	<1	<1	<1	<1	<1
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds										
American coot	1,444	0	63	55	1,562	16	<1	1	1	5
American robin	316	134	441	65	956	4	5	5	1	3
Waterbird species	22	26	42	0	90	<1	1	<1	<1	<1
White-faced ibis	27	0	0	0	27	<1	<1	<1	<1	<1
Total	**8,802**	**2,540**	**8,517**	**10,468**	**30,327**	**100**	**100**	**100**	**100**	**100**

As expected, the mass of birds detected during the project-specific surveys conducted in 2012 and 2013 within the study area was variable across species and seasons (Table 3-38). The species that accounted for the greatest mass in the study area include geese, ducks, starlings, blackbirds, and American coots. Geese, which are most abundant during the spring, accounted for the greatest bird mass during the spring and the least amount during the fall when they are largely absent from the study area under existing conditions. Duck mass was highest during the spring and winter, while starling and blackbird seasonal mass was highest during the summer and fall. Although the total abundance of birds was highest during the winter, many of the birds were small-bodied and, therefore, the total mass of birds detected was highest during the spring. This difference might be best explained by the fact that geese, which accounted for 6 percent of the birds detected during the spring, were nearly absent from the study area during the winter months surveyed. Other species such as shorebirds, swallows, and sparrows were also more abundant during the spring than during the winter and, therefore, contributed more to the total bird mass calculated for spring than winter.

Provo Bay Bird Species, Abundance, and Mass

Provo Bay was surveyed to determine differences in bird use with open water adjacent to emergent marsh wetlands in terms of species composition and abundance, as well as for modeling purposes described in the impact assessment (Section 3.16.9). In total, Provo Bay (Table 3-39) had fewer observed species than the study area but larger numbers of birds of a few species that primarily use open water and emergent marsh habitats (e.g., pelicans, cormorants, herons, and shorebirds). When considering the FAA-listed species presented in Table 3-39, Provo Bay accounted for 10,302 individuals across 32 species including the four species that are not FAA listed but whose abundances exceeded daily counts of 100 birds. Of FAA-listed species specifically, blackbirds and swallows were most abundant across all seasons (13 percent and 10 percent, respectively). American white pelicans, which were not as abundant in the study area, accounted for 6 percent of observations across all seasons and 24 percent of observations made during the winter in Provo Bay. Ducks, which were most commonly observed during the spring and summer, accounted for 15 percent and 9 percent, respectively, of all FAA-listed species observations in Provo Bay.

It should be noted that the portion of Provo Bay surveyed is only the portion of the bay that can be observed from the dike located along the south boundary of Provo Airport; approximately 400 acres. For context, it is important to understand that the entire bay is approximately 6,400 acres of open water and emergent marsh habitat. Provo Bay has been designated by BirdLife International and the National Audubon Society as a globally significant Important Bird Area. Utah County birders, who helped to attain the designation, have documented more than 35,000 waterfowl, 1,500 California gulls (*Larus californicus*), 600 American white pelicans, 6,200 white-faced ibis, 120 snowy egrets (*Egretta thula*), 4,000 American avocets (*Recurvirostra americana*), 1,000 black-necked stilts (*Himantopus mexicanus*), and 600 Wilson's phalaropes (*Phalaropus tricolor*) using Provo Bay during the 2008 breeding season (Evans and Martinson 2008).

Table 3-38. Study area seasonal and total bird mass (grams) of avian species identified as hazardous to aircraft, April 2012 through October 2013.

FEDERAL AVIATION ADMINISTRATION CLASS	MEAN MASS (g)[a]	BIRD MASS (g)[b]				
		Spring	Summer	Fall	Winter	Total Mass
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft						
Vulture	1,918	1,918	5,754	3,836	0	11,508
Geese	4,280	2,341,160	102,720	0	111,280	2,555,160
Pelican	9,000	9,000	9,000	0	0	18,000
Cormorant	2,453	0	0	0	0	0
Crane	3,460	62,280	44,980	31,140	6,920	145,320
Eagle	4,913	0	0	0	9,826	9,826
Duck	1,301	5,508,434	260,200	454,049	5,818,072	12,040,755
Osprey	2,000	28,000	12,000	2,000	2,000	44,000
Pheasant	1,263	27,786	22,734	22,734	22,734	95,988
Turkey	8,500	0	0	0	0	0
Heron	2,500	7,500	5,000	2,500	2,500	17,500
Hawk (*Buteos*)	1,224	20,808	11,016	28,152	17,136	77,112
Gull	657	15,111	7,884	120,231	17,739	160,965
Rock pigeon	350	4,550	2,450	2,800	8,750	18,550
Owl	1,706	0	0	1,706	1,706	3,412
Snow bunting	35	0	0	0	0	0
Horned lark	38	0	0	0	76	76
Raven	811	1,622	0	0	0	1,622
Crow	538	0	0	538	0	538
Mourning dove	123	1,230	6,150	7,380	2,706	17,466
Shorebird	336	110,511	20,154	24,521	1,008	156,194
Starling	88	35,303	78,665	353,291	344,618	811,877
Blackbird	71	60,560	35,039	172,655	119,780	388,032
American kestrel	120	600	960	2,160	2,040	5,760
Meadowlark	106	1,590	2,650	1,166	0	5,406
Swallow	19	5,530	8,410	7,910	0	21,850
Sparrow	28	5,198	2,998	8,773	2,255	19,223
Nighthawk	79	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds						
American coot	692	999,248	0	43,596	38,060	1,080,904
American robin	84.8	26,796.8	11,363.2	37,396.8	5,512	8,1068.8
Waterbird species	692	15,224	17,992	29,064	0	62,280
White-faced ibis	679	18,333	0	0	0	18,333
Total		**9,308,291**	**668,118**	**1,357,598**	**6,534,718**	**17,868,724**

[a] Mean mass (g) is the mean mass of a single bird as reported in species accounts available from Birds of North America Online (available at: http://bna.birds.cornell.edu/bna/).
[b] Bird mass (g) represents the total bird mass, which was calculated by multiplying the mean mass for a single individual by the seasonal and total abundance of each species.

Table 3-39. Provo Bay seasonal total observations and relative abundance of avian species identified as hazardous to aircraft, April 2012 through October 2013.

FEDERAL AVIATION ADMINISTRATION CLASS	SEASONAL TOTAL OBSERVATIONS, PROVO BAY OBSERVATION AREA					RELATIVE ABUNDANCE (PERCENTAGE)				
	Spring	Summer	Fall	Winter	Total Abundance	Spring	Summer	Fall	Winter	Total Relative Abundance
Species Listed by the Federal Aviation Administration (FAA) as Hazardous to Aircraft										
Vulture	0	0	0	0	0	<1	<1	<1	<1	<1
Geese	116	8	0	49	173	10	1	<1	3	2
Cormorant	6	9	5	0	20	1	1	<1	<1	<1
Pelican	39	42	149	401	631	3	3	2	24	6
Crane	10	0	1	1	12	1	<1	<1	<1	<1
Eagle	0	0	0	0	0	<1	<1	<1	<1	<1
Duck	171	118	170	75	534	15	9	3	5	5
Osprey	1	1	0	0	2	<1	<1	<1	<1	<1
Turkey	0	0	0	0	0	<1	<1	<1	<1	<1
Pheasant	2	4	0	2	8	<1	<1	<1	<1	<1
Heron	5	7	9	3	24	<1	1	<1	<1	<1
Hawk (*Buteos*)	3	0	9	7	19	<1	<1	<1	<1	<1
Gull	2	12	96	31	141	<1	1	2	2	1
Rock pigeon	0	0	0	0	0	<1	<1	<1	<1	<1
Owl	0	0	0	0	0	<1	<1	<1	<1	<1
Horned lark	0	0	0	0	0	<1	<1	<1	<1	<1
Snow bunting	0	0	0	0	0	<1	<1	<1	<1	<1
Crow	0	0	0	0	0	<1	<1	<1	<1	<1
Raven	0	0	1	0	1	<1	<1	<1	<1	<1
Mourning dove	1	15	18	1	35	<1	1	<1	<1	<1
Shorebird	6	192	141	0	339	1	14	2	<1	3
Blackbird	169	107	882	198	1,356	14	8	14	12	13
Starling	12	43	6	202	263	1	3	<1	12	3
American kestrel	1	0	4	5	10	<1	<1	<1	<1	<1
Meadowlark	2	0	12	0	14	<1	<1	<1	<1	<1
Swallow	220	604	215	0	1,039	19	45	4	<1	10
Sparrow	34	6	73	26	139	3	<1	1	2	1
Nighthawk	0	0	0	0	0	<1	<1	<1	<1	<1
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds										
American coot	312	18	2,128	12	2,470	27	1	35	1	24
American robin	9	5	11	401	426	1	<1	<1	24	4
Waterbird species	51	148	2,198	1	2,398	4	11	36	<1	23
White-faced ibis	0	0	8	240	248	<1	<1	<1	15	2
Totals	**1,172**	**1,339**	**6,136**	**1,655**	**10,302**	**100**	**100**	**100**	**100**	**100**

Observations of Provo Bay near Provo Airport support bird use of the bay, especially during fall migration (59.6 percent of annual observations at Provo Bay occurred during fall) and parallel the types of species that have been observed by Utah County birders in the broader Provo Bay environment. Cormorants, pelicans, ducks, gulls, and shorebirds were observed using the open water and emergent marsh habitats near Provo Airport. The most numerous birds were blackbirds, which are gregarious and utilize areas with large patches of phragmites, which significantly reduce habitat value for other water birds and waterfowl.

Generally, birds were more abundant per unit area within the study area (three survey sites combined) than in the Provo Bay and Airport Dike site. However Provo Bay accounted for higher total bird mass during the fall than the study area (Table 3-40) because the birds using Provo Bay during the fall tended to be larger bodied than those observed in the study area. Pelicans, which were largely absent from the study area during the fall, were quite abundant in Provo Bay. The presence of large-bodied pelicans in Provo Bay during the fall was enough to compensate for the higher abundances of smaller-bodied species at the other survey locations. As described for the study area, the total mass of ducks in Provo Bay was high across all seasons; however, the seasonal mass of ducks documented within the study area was considerably higher than the seasonal duck masses documented for Provo Bay. Furthermore, in Provo Bay, total duck mass was lowest during the winter while duck mass in the study area was lowest during the summer. This difference may be explained by the fact that open water habitat in the study area was greatly reduced during the summer, whereas open water habitat was always present in the observed portion of Provo Bay. Other birds with high seasonal mass in Provo Bay included geese, cormorants, and shorebirds.

eBird Data

To provide context for data collected on bird surveys, data were also obtained from eBird, a citizen-science, peer-reviewed database (eBird 2012) over a 5-year period (2007–2011) for 16 sites within 6.0 miles of Provo Airport (measured from the center of locations as plotted in the eBird database). Sites were selected based on their broad habitat similarities to existing and predicted study area habitats. Describing these bird communities provides spatial and temporal context for assessment of existing and post-implementation bird communities for the study area.

For the period January 2007–December 2011, 248 species and 518,787 individuals were recorded at the 16 eBird locations that were selected to describe existing bird communities on the eastern shore of Utah Lake (eBird 2012). Eighteen species (red-winged blackbird, European starling, Canada goose, white-faced ibis, tree swallow [*Tachycineta bicolor*], American coot, mallard [*Anas platyrhynchos*], northern rough-winged swallow [*Stelgidopteryx serripennis*], yellow-headed blackbird, ring-billed gull [*Larus delawarensis*], bank swallow [*Riparia riparia*], northern pintail, barn swallow [*Hirundo rustica*], American robin, green-winged teal [*Anas crecca*], American wigeon [*Anas americana*], white-crowned sparrow (*Zonotrichia leucophrys*), and yellow-rumped warbler [*Setophaga coronata*]) composed 63.4 percent of the total birds detected. When species were considered within broader taxonomic groups, more than 75 percent of all birds recorded were those classified within 13 groups (swallows, blackbirds, waterfowl, ibises, gulls, coots and rails, shorebirds, grebes, pelicans, terns, herons and egrets, cormorants, and cranes), which are broadly associated with wetlands, lakes, and other aquatic habitats. Over

Table 3-40. Provo Bay seasonal and total bird mass (g) of avian species identified as hazardous to aircraft, April 2012 through October 2013.

FEDERAL AVIATION ADMINISTRATION CLASS	MEAN MASS (grams)[a]	BIRD MASS (grams)[b]				
		Spring	Summer	Fall	Winter	Total Mass
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft						
Vulture	1,918	0	0	0	0	0
Geese	4,280	496,480	34,240	0	209,720	740,440
Cormorant	9,000	54,000	81,000	45,000	0	180,000
Pelican	2,453	95,667	103,026	365,497	983,653	1,547,843
Crane	3,460	34,600	0	3,460	3,460	41,520
Eagle	4,913	0	0	0	0	0
Duck	1,301	222,471	153,518	221,170	97,575	694,734
Osprey	2,000	2,000	2,000	0	0	4,000
Turkey	1,263	0	0	0	0	0
Pheasant	8,500	17,000	34,000	0	17,000	68,000
Heron	2,500	12,500	17,500	22,500	7,500	60,000
Hawk (*Buteos*)	1,224	3,672	0	11,016	8,568	23,256
Gull	657	1,314	7,884	63,072	20,367	92,637
Rock pigeon	350	0	0	0	0	0
Owl	1,706	0	0	0	0	0
Horned lark	35	0	0	0	0	0
Snow bunting	38	0	0	0	0	0
Crow	811	0	0	0	0	0
Raven	538	0	0	538	0	538
Mourning dove	123	123	1,845	2,214	123	4,305
Shorebird	336	2,015	64,493	47,362	0	113,870
Blackbird	88	14,804	9,373	77,263	17,345	118,786
Starling	71	846	3,032	423	14,241	18,542
American kestrel	120	120	0	480	600	1,200
Meadowlark	106	212	0	1,272	0	1,484
Swallow	19	4,224	11,597	4,128	0	19,949
Sparrow	28	935	165	2,008	715	3,823
Nighthawk	79	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds						
American coot	692	215,904	12,456	1,472,576	8,304	1,709,240
American robin	84.8	763	424	933	34,005	36,125
Waterbird species	692	35,292	102,416	1,521,016	692	1,659,416
White-faced ibis	679	0	0	5,432	162,960	168,392
Totals		**1,214,943**	**638,968**	**3,867,359**	**1,586,828**	**7,308,098**

[a] Mean mass (g) is the mean mass of a single bird as reported in species accounts available from Birds of North America On-line (available at: http://bna.birds.cornell.edu/bna/).
[b] Bird Mass (g) represents the total bird mass, which was calculated by multiplying the mean mass for a single individual by the seasonal and total abundance for each species.

the 5-year period, 3,174 pelicans (0.6 percent of all bird observations) were reported along the eastern shore of Utah Lake.

One of the 16 eBird locations presented above—Provo Bay/Provo Airport dike—was examined separately. At this location during the same time period (2007-2011), 227 species totaling 221,879 individuals were detected (eBird 2012). Based on total abundance data extracted from eBird, the bird community at the Provo Bay/ Provo Airport dike site was dominated by species associated with emergent marshes, such as red-winged blackbird, American coot, yellow-headed blackbird, Canada goose, white-faced ibis, northern pintail, mallard, marsh wren, and green-winged teal. These nine species composed nearly 34 percent of the total birds detected. Over the 5-year period, 1,928 pelicans (0.9 percent of all bird species) were observed at Provo Bay/ Provo Airport dike. This constituted 60.7 percent of all the pelican observations documented at the 16 eBird sites along the eastern shore of Utah Lake during this period.

Bird communities described by eBird data for the 16 sites along the eastern shore of Utah Lake were similar to bird communities described in the project-specific bird survey data that were collected within the study area. Fifteen species observed during spring surveys, 8 species observed during summer surveys, 8 species observed during fall surveys, and 10 species observed during winter surveys were among the 20 most abundant species for bird communities along the eastern shore of Utah Lake based on eBird data, and they were also among the top 20 most abundant species observed within the study area. Therefore, all species present in the study area were present along the eastern shore of Utah Lake surrounding Provo Airport.

Data were also obtained from six eBird sites surrounding the Salt Lake City International Airport for the period from 2007 to 2011 to determine similarities and differences in bird use surrounding an airport with a more robust bird-aircraft strike dataset. The eBird sites around the Salt Lake City International Airport revealed that European starlings accounted for over 23 percent of the 28,017 birds detected across all six sites. Along the eastern shore of Utah Lake, starlings accounted for over 11 percent of all eBird detections and over 26 percent of all detections made during BIO-WEST surveys (URMCC 2015b). Gulls, which also accounted for a large number of observations near the Salt Lake City International Airport (greater than 9 percent of total observations) only accounted for 4.2 percent of all observations made at eBird spots along the eastern shore of Utah Lake and only 1.3 percent of all observations made during BIO-WEST surveys (URMCC 2015b). Pelicans are much more common around the Salt Lake City International Airport, accounting for 2.3 percent of all eBird counts compared to 0.9 percent around Provo Airport and 0.6 per cent for the eastern shore of Utah Lake.

Provo Airport's Wildlife Hazard Assessment (WHA)

Under federal regulations (14 CFR 139), the FAA required Provo Airport to complete a Wildlife Hazard Assessment WHA, which is a study of factors contributing to wildlife hazards at and within a 5-mile radius of an airport. The WHA final report (Airport Wildlife Consultants 2014) became available following release of the Draft EIS for the current proposed action; therefore, the following discussion regarding the airport's WHA has been added to the Final EIS.

The need to complete a WHA was based on the presence of wildlife attractants within 5 miles of the airport, the presence of wildlife species known to be hazardous to aviation, and the occurrence of an FAA-defined “triggering event.” The National Wildlife Strike Database maintained by FAA includes reports of nine wildlife strikes at the Provo Airport between 1990 and 2012 (Airport Wildlife Consultants 2014). Five of these strikes involved mule deer, the other four involved unknown bird species. Two of the incidents involved multiple wildlife strikes, and one of the mule deer strikes resulted in $8,400 in aircraft repair costs. These incidents met the requirements of a triggering event under the federal regulations (Airport Wildlife Consultants 2014).

As part of a WHA, the FAA Advisory Circular 150/5200-33B defines habitat types that are considered wildlife attractants. The WHA for Provo Airport (Airport Wildlife Consultants 2014) identified four wildlife attractant habitat types within a 5-mile radius of Provo Airport. These were a landfill, a wastewater treatment facility, wetlands in various locations, and agricultural areas. The study area for the proposed action in this EIS was evaluated as agricultural (although 304 acres of the 708-acre study area are classified wetlands under existing baseline conditions [Section 3.5]). The WHA for Provo Airport involved surveying for bird species abundance at representative locations for each of the identified wildlife attractant habitat types as well as on the airport property (aircraft operations area) and on lands adjacent to the airport property. In the study design developed by Airport Wildlife Consultants (2014), 43 survey points were surveyed twice per month for 12 consecutive months, January–December 2013.

According to the WHA, the most abundant bird species on the airport, adjacent to the airport, and in the study area (Airport Wildlife Consultants 2014)were small birds, either various species of “ground birds” or various species of “blackbirds.” In the WHA, the ground birds category included meadowlarks, horned larks, sparrows, robins, and swallows, among other species of song birds/perching birds. The blackbird category included grackles, red-winged blackbirds, Brewer’s blackbirds, European starlings, and brown-headed cowbirds. The WHA (Airport Wildlife Consultants 2014) and the URMCC (2015b) technical memorandum were consistent in finding that species within these categories were most abundant in the late summer and fall.

Recommendations provided in the WHA (Airport Wildlife Consultants 2014) distinguish primary hazards and secondary hazards. The report states the following:

> AWC’s hazard analysis is separated into primary and secondary hazards. The separation is based on limitations in fiscal resources and environmental regulations. Primary hazards are located on airport property thereby providing personnel with immediate and unrestricted access for wildlife control and monitoring. Mitigation of primary hazards can be accomplished with existing financial resources and within existing regulatory frameworks. Secondary hazards require long term financial commitments, exorbitant mitigation fees, and involve compliance with extensive environmental regulations. This separation of hazards facilitates a common sense approach that airport managers can use to prioritize limited funds and man power for accomplishment of the recommendations and mitigations.

Thus the distinction appears to be based on feasibility of successfully implementing proposed mitigation measures rather than the level of risk created by a given hazard.

Primary Hazards

On-airport hazards are specified as primary hazards. The WHA (Airport Wildlife Consultants 2014) recommends that the moat be filled to eliminate hazards created by this available habitat within the airport property, and that the airport continue its existing wildlife management program, which is a combination of lethal- and nonlethal-control techniques to reduce hazards created by wildlife found on the airport property.

Though not an existing condition, the Provo River Delta Restoration Project is specifically discussed in Provo Airport's WHA. The project is categorized as a "primary hazard" because it has potential "to create a new wildlife hazard and increase the numbers of hazardous wildlife species adjacent to the airport, and the potential for these birds to cause damage after collisions with airplanes." Recommended mitigation provided in the WHA is for the Provo Airport and FAA to participate in the planning process for the Provo River Delta Restoration Project and negotiate design changes to reduce or eliminate the wildlife hazard (Airport Wildlife Consultants 2014). Through consultation with the parties, the JLAs have included this recommendation in the Draft and Final EISs by inviting USDA Wildlife Services, the FAA, and Provo Airport to participate in the final design if an action alternative is selected.

Secondary Hazards

The WHA also reports and acknowledges extensive use of Utah Lake adjacent to airport property by waterfowl, shorebirds, and fish-eating birds (pelicans, cormorants, and herons) (Airport Wildlife Consultants 2014). However, Utah Lake is categorized as a "secondary hazard" in the WHA because there is limited ability to address this hazard (e.g., based on the large size of the lake and logistical problems associated with wildlife management). Recommended mitigation is to haze hazardous species further away from the airport.

Overall Mitigation Measures in Provo Airport's Wildlife Hazard Assessment

The overall recommendations of the WHA (Airport Wildlife Consultants 2014) are for Provo Airport to:

1. Develop a wildlife hazard management plan (WHMP). The plan would provide overall guidance for the airport's hazard management program by: identifying key personnel; providing background information on known hazards; identifying management techniques; prioritizing management measures; recommending necessary permits, equipment, and supplies; and specifying training requirements for personnel.

2. Continue annual monitoring and management. Once the airport has a WHMP, the airport is required to update the plan every 12 months, which is to include reviewing the effectiveness of the WHMP following any triggering events, identifying any changes in wildlife attractants (habitat), and determining if the species composition has changed over time.

3. Develop a wildlife hazard training program to familiarize involved personnel with wildlife identification and dispersal techniques.

Utah Valley University's Bird Strike Data

Findings from Provo's WHA (Airport Wildlife Consultants 2014) and the analysis presented in this EIS are also consistent with strike data reported by Utah Valley University (Table 3-41). Utah Valley University's Aviation Sciences program provided bird strike data for 2012–2013 (R. Hopkinson, pers. comm. 2014) following release of the Draft EIS. Eight bird strikes were reported during those 2 years. Five of the eight strikes involved swallows and two involved unknown small birds that were struck on the airport ground. Only one of the swallow strikes occurred during takeoff, the rest during landing or on the ground. Most strikes involved a single bird; only one involved hitting a flock of swallows (at runway level within 10 feet of landing). All of the swallow strikes occurred in the August–October time period, which is consistent with the time of year these species were observed to be most abundant in the WHA report (Airport Wildlife Consultants 2014) and in the proposed project avian surveys (URMCC 2015b). Finally, only one of the eight reported strikes occurred away from the airport; this strike occurred on July 2013 at 11:00 PM, 1,000 feet above ground on approach. The species of bird struck was not known.

Table 3-41. Bird strikes at Provo Airport reported by Utah Valley University's Aviation Sciences Program, 2012–2013.

DATE	TIME	SPECIES	PHASE OF FLIGHT	HEIGHT ABOVE GROUND LEVEL
8/6/2012	N/A[a]	Bank swallow	N/A	N/A
8/14/2012	8:00 AM	Bank swallow	N/A	N/A
10/29/2012	2:00 PM	Unknown, small, single bird	Approach	5 feet
3/14/2013	9:00 AM	Unknown, small, single bird	Parked	N/A
7/8/2013	11:00 PM	Unknown, single bird	Approach	1,000 feet
8/5/2013	11:30 AM	Bank swallow	Approach	50 feet
9/25/2013	8:30 AM	Tree swallow (flock)	Touchdown	10 feet
10/14/2013	4:00 PM	Barn swallow	Climb	400 feet

Source: R. Hopkinson, pers. comm. 2014.
[a] N/A = information not available or not recorded.

National Wildlife Strike Database

The FAA strongly recommends that wildlife strikes be reported and maintains a national database. Reports of strike incidents at Provo Airport since 1993 indicate one strike resulting in substantial damage involving a deer. In total, there have been 14 incidents reported at Provo Airport, 5 involving deer, all of which occurred prior to 2007, and 9 involving small- to medium-sized birds, all of which occurred since 2007 and none indicating damage to the aircraft (FAA 2015). [9]

[9] These numbers were updated between the Draft EIS and the Final EIS, and it was determined that the national database included five of the eight bird strikes reported by Utah Valley University.

Salt Lake City International Airport, which is surrounded by habitat similar to that found in the Provo Airport vicinity, has experienced a total of 1,793 reported wildlife strikes between 1990 and 2013.[10] Of that total, 1,029 strikes or 57.3 percent of all strikes resulted in no damage to aircraft while only 55 strikes (3 percent) of all strikes resulted in substantial damage to aircraft. Damage was not reported in 30 percent of all strikes (537 strikes). Birds of small and medium size and unspecified species were responsible for the greatest number of strikes (35 percent). Of the known species, horned larks were responsible for 218 bird-aircraft strikes (12 percent). Other species frequently struck by aircraft include American kestrel (*Falco sparverius*) (79 strikes or 4.4 percent), cliff swallows (82 strikes or 4.6 percent), gulls (54 strikes or 3 percent), mallards (36 strikes or 2 percent), and western meadowlarks (*Sturnella neglecta*) (40 strikes or 2.2 percent). Given similarities of habitat, it would be expected that bird-aircraft strikes at Provo Airport might be caused by the same or similar species.

When considering the 5-year eBird data set for six sites surrounding the Salt Lake City International Airport and results of FAA Wildlife Strike Database queries, it is apparent that the presence of birds of various species does not determine that a bird-aircraft strike is imminent. Furthermore, birds identified by Provo City and USDA Wildlife Services as being of greatest concern (e.g., pelicans, gulls, and waterfowl) accounted for fewer strikes than small- to medium-sized birds of unknown species, which accounted for the greatest number of strikes reported to the FAA by Salt Lake City International Airport.

Project-specific surveys and eBird data in the Provo Airport vicinity suggest that large numbers of small- to medium-sized birds are present under existing conditions. Small- to medium-sized birds observed during project-specific surveys include but are not limited to red-winged and yellow-headed blackbirds, European starlings, certain gull species, swallows, and sparrows. As indicated by the abundances of birds in the surveys and eBird data, the abundance of hazardous bird species under existing conditions is noteworthy within the study area and along the eastern shore of Utah Lake. The low number of reported bird-aircraft strike incidents to date at Provo Airport could be attributed in part to incidents with private planes going unreported because no damage occurred.

3.16.9 Bird Strike Risk – Impacts of the No-Action Alternative

Under the No-Action Alternative, the condition of avian habitat within the study area would remain as described for existing conditions. Bird strike risk within the study area would also remain unchanged from existing conditions if the same land use practices and airport operations are continued.

3.16.10 Bird Strike Risk – Impacts Due to Predicted Changes in Bird Abundance and Bird Mass

To assess likely changes resulting from action alternatives, post-project implementation bird abundance estimates were made by species based on predicted habitat responses. The 2012 and

[10] The national database was queried after completion of the Draft EIS. The number of reported wildlife strikes at Salt Lake City International Airport had increased to 2,057, with reported dates through August 30, 2014 (FAA 2015).

2013 avian surveys that were conducted throughout the study area and Provo Bay determined existing bird use within the following six habitat types:

1. riparian forest
2. wet meadow including raised peat mounds
3. emergent marsh
4. open water
5. upland grassland
6. agricultural

The existing riparian forest habitat type is primarily limited to a narrow corridor of riparian vegetation adjacent to the existing Provo River channel. The Provo River Parkway survey area was used to determine bird use for the riparian forest habitat type. The existing wet meadow and raised peat mound habitat type currently occur throughout the North Wetlands survey area (on the higher ground surrounding emergent marsh habitats) and on the eastern portion of the South Agricultural Fields survey area. The North Wetlands and South Agricultural Fields survey areas were used to determine bird use for the wet meadow habitat type. Existing emergent marsh habitat type currently occurs in the low elevation portions of the North Wetland survey area (surrounded by wet meadow and upland grasses) and along the shoreline of Provo Bay (adjacent to open water). The North Wetlands and Provo Bay survey areas were used to determine bird use for emergent marsh habitat type. Open water is currently limited to the existing channel and Provo Bay, with some open water seasonally occurring in the North Wetlands. The Provo Bay and Provo River Parkway survey areas were used to determine bird use in open water. Upland grassland habitat type is found in the highest elevations of the North Wetlands survey area and within the wet meadow/emergent marsh complex on the eastern side of the South Agricultural Fields survey area. The North Wetlands and South Agricultural Fields survey areas were used to determine existing bird use in upland grassland habitat type. The existing agricultural habitat type is limited to the South Agricultural Fields survey area and, therefore, it was used to determine bird use in the agricultural habitat type.

Although all habitat types and associated bird use currently occur in the study area, implementation of the various action alternatives would increase the quantity and quality of certain habitat types (riparian forest, wet meadow, emergent marsh, and open water) and decrease the quantity of other habitat types (upland, grassland, and agricultural). There is a seasonal component that would affect the amount of open water and emergent marsh habitats on lands lower than 4,489 feet. In the spring, water levels are at their annual highs (as previously described in the hydrology section, Section 3.2) and the emergent vegetation such as bulrush, cattails, and reeds are either lying down from the effects of snow cover or have been sheared off by ice. Therefore, open water is predicted to occur in the spring and become more like Provo Bay in the portion of the project area lower than 4,489 feet. Water elevations would recede in the project area from 4,489 feet in the spring to 4,487 feet in late summer (the proposed height of the channel bottom on the west side of Skipper Bay). The emergent marsh vegetation would grow to a mature height (greater than 3 feet) in the late spring/early summer. Therefore, the amount of open water and area like Provo Bay would decrease rapidly through late spring with vegetation growth and continue to decrease throughout the summer until fall as the lake draws down. Emergent wetland vegetation is at its highest and water levels are at their lowest during the fall.

Open water during the late summer and fall would be limited in the project area to excavated channels, oxbows, and the low-elevation lands mapped in the wetlands section as lacustrine vegetated aquatic bed. Water levels increase in early winter and continue to increase throughout winter and early spring. Ice forms during the winter. It is expected that the project area would freeze over during the winter, much like Provo Bay, but ribbons of open water would likely persist throughout most of the winter along the main channels.

Predicted bird habitat was determined based on the quantity of predicted wetlands from the wetlands impact assessment (Section 3.5) and the seasonal fluctuation of open water as evaluated in the hydrology impact assessment (Section 3.2) under each alternative. Comparisons of existing relative to predicted wetlands (Figures A-19 to A-24, Appendix A) were particularly helpful for summer, fall, and winter habitat predictions, while the water inundation depths during spring at 4,489 feet shown in alternatives overview maps (Figures A-1 through A-5) were helpful for the spring predictions. Table 3-42 provides the estimated proportions of predicted habitat by season that would become more like existing survey areas under each action alternative.

Table 3-42. Estimated proportions of predicted habitat that would become more like comparable surrounding areas under each action alternative.

ALTERNATIVE	PROPORTIONS OF PREDICTED HABITAT (WEIGHTING PERCENTAGES USED TO MODEL PREDICTED BIRD ABUNDANCES)		
	Provo River Parkway	**Southern Agricultural Lands**	**North Wetlands**
Alternative A Spring	No change	25% Provo River Parkway 75% Provo Bay	25% No Change 75% Provo Bay
Alternative A Summer	No change	25% Provo River Parkway 60% North Wetlands 15% Provo Bay	75% No Change 25% Provo Bay
Alternative A Fall	No change	25% Provo River Parkway 65% North Wetlands 10% Provo Bay	85% No Change 15% Provo Bay
Alternative A Winter	No change	25% Provo River Parkway 60% North Wetlands 15% Provo Bay	75% No Change 25% Provo Bay
Alternative B Spring	No change	80% No Change 20% Provo River Parkway	25% No Change 75% Provo Bay
Alternative B Summer	No change	80% No Change 20% Provo River Parkway	75% No Change 25% Provo Bay
Alternative B Fall	No change	80% No Change 20% Provo River Parkway	80% No Change 20% Provo Bay
Alternative B Winter	No change	80% No Change 20% Provo River Parkway	75% No Change 25% Provo Bay
Alternative C Spring	No change	25% Provo River Parkway 75% Provo Bay	67% No Change 33% Provo Bay
Alternative C Summer	No change	25% Provo River Parkway 65% North Wetlands 10% Provo Bay	95% No Change 5% Provo Bay
Alternative C Fall	No change	25% Provo River Parkway 65% North Wetlands 10% Provo Bay	95% No Change 5% Provo Bay
Alternative C Winter	No change	25% Provo River Parkway 65% North Wetlands 10% Provo Bay	95% No Change 5% Provo Bay

The predicted proportions were then applied to existing bird abundance estimates[11] by survey area to determine predicted bird abundances for each alternative, assuming that there is a linear relationship between amount of bird habitat and bird abundance. The resulting predicted abundances were then subtracted from those calculated for existing conditions, which resulted in a predicted change in abundance for each species.

In performing and reporting this analysis, a first-level assumption was made that an increase in abundance would equate to an increase in potential strike risk and, conversely, that a decrease in abundance would equate to a decrease in potential strike risk (i.e., a direct correlation). Therefore, this first-level analysis presents a worst-case conclusion; that is, by assuming a direct and positive relationship between increasing bird abundance and increasing potential risk, the analysis attributes maximum adverse effect (increased potential strike risk) to an increase in bird abundance. In fact, the increased abundance would create increased risk only if those birds were to occur within the flight path of aircraft using the Provo Airport, especially during landing and takeoff when the planes are at low altitude and low speed. In addition, no adjustments were made for geographic scale; in particular, portions of the study area that would become more like Provo Bay would be smaller in geographic size compared to the surveyed portion of Provo Bay. This linear method likely results in conservative predictions, meaning predictions are likely representative of the maximum numbers that would be observed given the relatively small size of the study area (approximately 700 acres) compared to Provo Bay (approximately 7,000 acres). Also it is important to remember that reported bird numbers, both for the existing conditions tables and predicted change tables, are seasonal survey totals rather than numbers of birds that would be observed or predicted at a single point in time.

It is important to note that the acreage estimates of predicted wetlands and associated bird habitats, and estimated bird abundances associated with the various project alternatives are best estimates based on a hard look at all available information. Actual habitat changes could be influenced by unknown factors such as unanticipated seasonal and annual variability in lake levels and/or flow rates as a result of unforeseen droughts and/or floods. There are many factors on a regional scale that could influence future bird abundance and species composition in this migratory flyway. Furthermore, anticipated proportions of predicted habitat within the study area that would become more like comparable surrounding habitats where bird surveys were performed (Table 3-42) are not intended to indicate highly precise proportions. The proportions described in Table 3-42 are simply estimated seasonal averages over highly variable climatic conditions with temperatures ranging from less than 0 to greater than 100 degrees Fahrenheit annually. The predictions made in this analysis are based on best professional estimates by a team of biologists, hydrologists, environmental analysts, and a GIS specialist using GIS tools, knowledge of the study area, and mapping products specifically developed for the proposed project. It is acknowledged that this analysis is cumulative (i.e., the predicted wetlands and bird habitats are based on anticipated lake elevations and incoming streamflows over time). The proportions of predicted habitat that would become more like surrounding areas are dependent on the amount and depth of open water and the quality and quantity of wetlands. Ultimately,

[11] The analysis used bird survey results (count data) to estimate abundance for each bird species in each habitat type. For several reasons (sampling limitations, study design bias, imperfect detection), using count data from limited observations introduces a range of estimation error that could not be quantified for this analysis.

predicted bird abundances reported here are dependent not only on the quality of existing bird data but also on the "best professional judgment" proportion estimates of predicted habitats (Table 3-42). Therefore, predicted bird abundances described in this document should be considered more as estimates of relative differences to be expected from project alternatives rather than predictions of exact numbers.

It must also be considered that in many cases, relatively large predicted changes in abundance do not represent actual population level changes of the same magnitude at a regional level for that species. Most often, the change in abundance is due to a change in distribution of the animals throughout the local or regional area. For example, in interagency discussions leading up to this analysis, there was concern expressed regarding pelicans and their potential use of the project implementation area. Pelicans breed in very select, discrete locations. Currently, there is only one known colony of breeding American white pelicans in Utah. It can be found on Gunnison Island in the North Arm of the Great Salt Lake and represents one of the largest breeding populations in North America (Aldrich and Paul 2002). Gunnison Island American white pelican population numbers can be highly variable from one year to the next. According to the UDWR Great Salt Lake Ecosystem Project, an average of 6,119 pelicans have been documented on Gunnison Island from 1980 to 2006 (UDWR unpublished data). Gunnison Island pelicans are known to disperse over an extremely large area to feed and have been documented as far north as American Falls Reservoir in Idaho and as far south as Utah Lake (Aldrich and Paul 2002). Recent increases in Gunnison Island pelican abundances may be attributed to an abundance of carp in Wasatch Front fisheries; studies at pelican foraging areas confirm the pelican's reliance on carp as an important component of their diets (Flannery 1988). Given the small size of the proposed project area relative to the amount of available pelican habitat regionally, the pelicans' tendency to disperse across an extremely large geographic area to feed, and current carp-control projects across Utah Lake, it is highly unlikely that a small change through addition of a relatively few acres of usable foraging habitats in the Utah Lake ecosystem would have a measurable effect on breeding success of pelicans at Gunnison Island. Therefore, any increase in abundance of pelican in the project area would likely be accompanied by a similar decrease in abundance somewhere else in the nearby Utah Lake ecosystem (R. Norvell 2014, pers. comm.). This similar effect would occur for some other species such as waterfowl (B. Stringham 2014, pers. comm.), whereas there are other species that could be directly affected locally in abundance by changes brought about by the proposed project. Results of this modeling exercise are presented for each alternative in separate tables with accompanying text in the subsections below, followed by a summary discussion.

Obviously there are numerous factors that create or influence the risk of a bird-aircraft strike. In simple terms, the aircraft and the bird occupy the same space at the same time. So the presence of a bird or even a flock of birds in the study area within 1.5 miles of Provo Airport does not constitute a hazard to aircraft. Bird(s) only become a *potential* hazard (risk) if/when flying over/across/through the airspace used by an aircraft as it approaches or departs Provo Airport.

Integrating the potential movement patterns of birds into an assessment of a potential future project is difficult and much more speculative than the quantitative bird abundance exercise described above. It typically involves definition of some three-dimensional airspace model around the airport being analyzed (Figure 3-28). The specifics of the 3-D airspace are determined

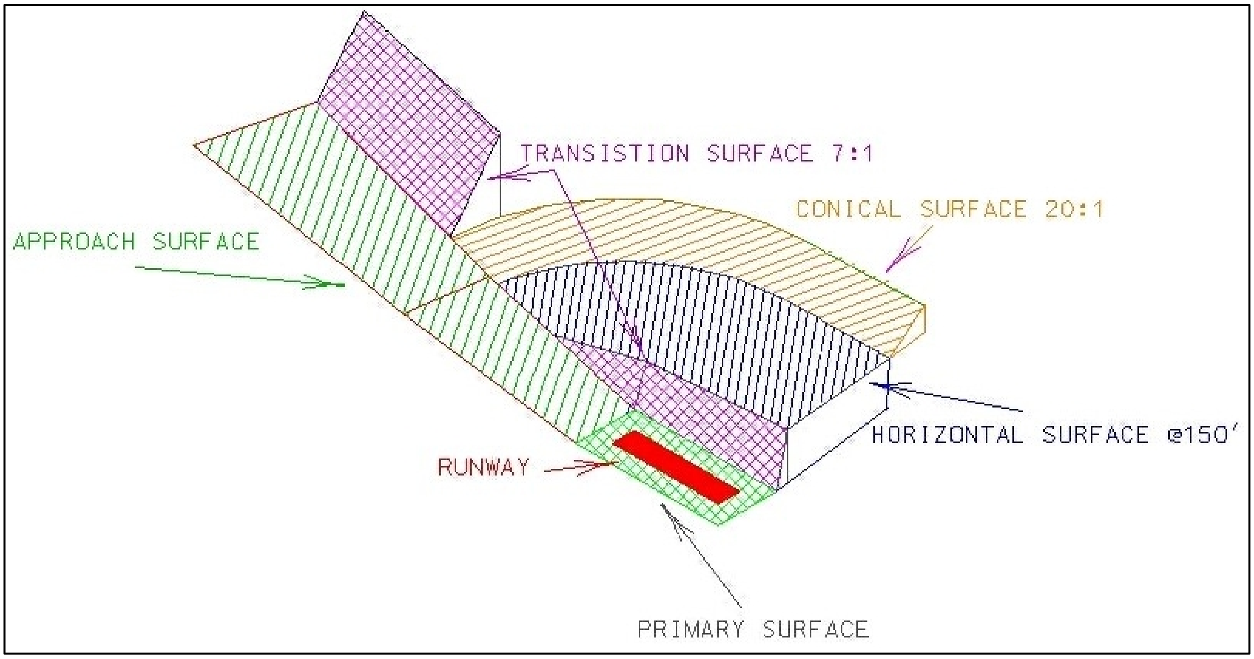

Figure 3-28. Airspace surfaces surrounding an airport (typically used to identify existing or planned ground-based obstructions to navigation near airports under federal regulation 49 CFR Part 77).

by a number of factors specific to the location and orientation of the airport, types of aircraft using the airport, type of air traffic control system in use, etc. The assessment requires predicting whether a bird (individual or flock) is likely to fly through the airspace defined by that model and how frequently or under what conditions, etc. This may require, as in this case, only general discussion of species' tendencies because it has not been possible to observe either the species/numbers of birds predicted under proposed action alternatives and/or their movement patterns under proposed future conditions. Finally, the timing, type, and schedule of aircraft using the airport can affect strike risk.

Resulting strike risk also depends on response to and effectiveness of mitigation measures. Several mitigation measures are presented later in this discussion (Section 3.16.13).

Alternative A

The existing bird habitat and bird-aircraft strike risk surrounding Provo Airport outside of the study area would remain the same as described under the No-Action Alternative. Within the study area under Alternative A, abundances of 8 of the FAA-listed hazardous species are predicted to increase (based on annual totals), 14 species are predicted to decrease, and 6 are predicted to not change (Table 3-43). All four of the non-FAA-listed species included in Table 3-40 are predicted to increase.

Table 3-43. Predicted increase or decrease in seasonal abundance, Alternative A.

FEDERAL AVIATION ADMINISTRATION CLASS	PREDICTED CHANGE IN ABUNDANCE OF BIRDS				TOTAL PREDICTED NET CHANGE
	Spring	Summer	Fall	Winter	
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft					
Vultures	-1	0	+1	0	0
Geese	-254	+10	0	+29	-215
Pelicans	+58	+16	+37	0	+111
Cormorants	+9	+4	+1	0	+14
Cranes	+1	+5	+2	+1	+9
Eagles	0	0	0	+1	+1
Ducks	-2,949	+91	+187	+691	-1,980
Osprey	-9	+3	+1	0	-5
Pheasants	-12	-3	-11	+3	-23
Turkey	0	0	0	0	0
Herons	+5	+4	+3	+2	+14
Hawks (Buteos)	-13	-3	+4	-2	-14
Gulls	-14	-7	-68	+22	-67
Rock pigeon	-10	+2	+3	+9	+4
Owls	0	0	0	0	0
Snow bunting	0	0	0	0	0
Horned lark	0	0	0	-2	-2
Ravens	-2	0	0	0	-2
Crows	0	0	-1	0	-1
Mourning dove	-2	+9	+2	+8	+17
Shorebirds	-232	+89	+68	+1	-74
Starlings	-295	-449	-1,404	+1,449	-699
Blackbirds	-245	+108	-102	+130	-109
American kestrel	-1	0	+1	0	0
Meadowlarks	-11	-20	+5	0	-26
Swallows	+273	+329	+134	0	+736
Sparrows	-61	+8	-15	-16	-84
Nighthawks	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds					
American coot	-579	+7	+560	+19	+7
American robin	-128	+10	+84	+175	+141
Waterbird species	+15	+34	+503	0	+552
White-faced ibis	-20	0	+2	+96	+78
Net Change **Percent Change**	**-4,475** **-50.8%**	**245** **+9.6%**	**-3** **-0.04%**	**2,616** **+25.0%**	**-1,617** **-5.3%**

Based on the annual summaries, implementation of Alternative A is predicted to decrease overall abundance throughout the study area by a relative total of 1,617 birds (a 5.3 percent decrease). Although Alternative A would create habitat conditions during the spring that are very attractive to certain open water species, it would replace habitat that has higher bird usage under baseline conditions. Therefore, this alternative results in a predicted decrease in overall abundance of birds that appear on the FAA list of hazardous species primarily because of the predicted reductions during the spring. Summer and winter abundances are predicted to increase but by a lesser amount than the spring decreases. Because Alternative A is predicted to result in a net decrease in overall abundance, it is expected that the overall potential risk of bird strikes within the study area would also decrease.

Under Alternative A, there would be many species that would decrease in abundance during spring. Exceptions are swallows, which are predicted to increase by about 95 percent, and pelicans and cormorants, which are expected to increase in abundance due to the presence of suitable foraging habitat (lacustrine wetland/open water habitat). However, numbers of those two species are predicted to be relatively low compared with abundances in nearby Provo Bay (Table 3-39). Pelicans are predicted to be intermediate in abundance in fall and lower in summer, while none are predicted to be present during winter under Alternative A. Due to their large size, pelicans are a significant concern as an aircraft hazard. Gulls would decrease in abundance overall annually, with a minor increase in abundance only during winter. Starlings, which are a concern because of their habit of forming dense flocks, would similarly decrease in abundance overall and in every season except winter, during which their abundance is predicted to increase by about 37 percent.

In terms of bird mass, under Alternative A the total mass of birds in the study area across all species and seasons would decrease substantially from existing conditions (Table 3-44). This would be largely due to declines in goose and duck abundances during the spring. Among species that would see increases in mass, the predicted changes in pelican abundance under Alternative A would produce the greatest increase in bird mass despite larger predicted increases in abundance for other species, including swallows and other waterbird species. Understandably, this is due to extremely large differences in body mass. Pelican mass averages approximately 9,000 grams while swallows average only 19 grams.

Compared with all other species combined, the mass of waterfowl (ducks and geese) in the study area would be predicted to decrease the most under Alternative A. Both ducks and geese would be predicted to experience declines in total mass during the spring. The proposed project would flood prime nesting habitat during the spring. Because these species are currently most abundant in the spring, this would result in overall decreases in duck and goose abundance and, consequently, also mass, even though their numbers and mass in other seasons would be predicted to increase slightly over existing conditions.

Table 3-44. Predicted increase or decrease in seasonal bird mass under Alternative A.

FEDERAL AVIATION ADMINISTRATION CLASS	MEAN MASS (grams)[a]	PREDICTED CHANGE IN BIRD MASS (grams)[b]				
		Spring	Summer	Fall	Winter	Total Predicted Change
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft						
Vulture	1,918	-1,918	0	1,918	0	0
Geese	4,280	-1,087,120	42,800	0	124,120	-920,200
Pelican	9,000	522,000	144,000	333,000	0	999,000
Cormorant	2,453	22,077	9,812	2,453	0	34,342
Crane	3,460	3,460	17,300	6,920	3,460	31,140
Eagle	4,913	0	0	0	4,913	4,913
Duck	1,301	-3,836,649	118,391	243,287	898,991	-2,575,980
Osprey	2,000	-18,000	6,000	2,000	0	-10,000
Pheasant	1,263	-15,156	-3,789	-13,893	3,789	-29,049
Turkey	8,500	0	0	0	0	0
Herons	2,500	12,500	10,000	7,500	5,000	35,000
Hawk (Buteos)	1,224	-15,912	-3,672	4,896	-2,448	-17,136
Gull	657	-9,198	-4,599	-44,676	14,454	-44,019
Rock pigeon	350	-3,500	700	1,050	3,150	1,400
Owl	1,706	0	0	0	0	0
Snow bunting	35	0	0	0	0	0
Horned lark	38	0	0	0	-76	-76
Raven	811	-1,622	0	0	0	-1,622
Crow	538	0	0	-538	0	-538
Mourning dove	123	-246	1,107	246	984	2,091
Shorebird	336	-77,929	29,895	22,841	336	-24,857
Starling	88	-25,842	-39,332	-122,990	126,932	-61,232
Blackbird	71	-17,273	7,614	-7,191	9,165	-7,685
American kestrel	120	-120	0	120	0	0
Meadowlark	106	-1,166	-2,120	530	0	-2,756
Swallow	19	5,242	6,317	2,573	0	14,131
Sparrow	28	-1,678	220	-413	-440	-2,310
Nighthawk	79	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds						
American coot	692	-400,668	4,844	387,520	13,148	4,844
American robin	84.8	-10,854	848	7,123	14,840	11,957
Waterbird species	692	10,380	23,528	348,076	0	381,984
White-faced ibis	679	-13,580	0	1,358	65,184	52,962
Net Change		-4,962,772	369,864	1,183,710	1,285,502	-2,123,696 (-11.9%)

[a] Mean mass (g) is the mean mass of a single bird as reported in species accounts available from Birds of North America Online (available at: http://bna.birds.cornell.edu/bna/).
[b] Predicted change in bird mass (g) represents the total change in bird mass, which was calculated by multiplying the mean mass of a single individual by the seasonal and total change in abundance for each species.

Alternative B

The existing bird habitat and bird-aircraft strike risk surrounding Provo Airport outside of the study area would remain the same as described under the No-Action Alternative. Within the study area under Alternative B, abundances of 4 of the FAA-listed hazardous species are predicted to increase (based on annual totals), 18 species are predicted to decrease, and 6 are predicted to not change (Table 3-45). Three of the four non-FAA-listed species included in Table 3-41 are predicted to increase. Based on the annual summaries, Alternative B is predicted to decrease overall avian abundance throughout the study area by a relative change of just over 6,000 birds (a 20.7 percent overall decrease).

The largest declines under Alternative B are for ducks, which are predicted to decrease substantially during the spring and winter. Ducks, which breed in upland communities close to water—such as those found in the study area under existing conditions—would experience a decline in overall abundance during the spring and winter. Many species (e.g., starling, pheasant, and mourning doves) that utilize agricultural habitat types under existing conditions would experience no change in relative abundance under this alternative.

Under Alternative B, the overall abundance of birds is predicted to decrease during the spring, summer, and winter. During the fall, the overall abundance of birds is predicted to increase by nearly 300 birds. As such, it is expected that the project would have seasonal effects to the risk of bird-aircraft strikes. Although potential risk would increase during the fall, Alternative B is predicted to result in a net decrease in overall abundance and, therefore it is expected that the overall potential risk of bird strikes within the study area would also decrease.

Under Alternative B, the total predicted mass of birds across all species and seasons would decrease substantially (-31.6 percent) from existing conditions (Table 3-46). Individual species such as pelicans would be predicted to experience an increase in total mass despite relatively small changes in predicted abundance when compared with other species such as swallows and waterbirds. Swallow abundances would be predicted to change by 160 individuals while pelicans would be predicted to change by 61 individuals. However, differences in body size more than compensate for differences in predicted abundance. A small increase in predicted abundance of pelicans yields a higher change in total mass than the change in mass of many smaller species (swallows) with higher predicted changes in total abundance. Ducks would be predicted to experience the greatest decreases in mass with the highest declines experienced during the spring and summer. Similarly, geese would be predicted to experience high declines in total mass; however, goose mass would be predicted to decrease in the spring and increase throughout the remainder of the year. The proposed project would flood prime nesting habitat during the spring. Because these species are currently most abundant in the spring, this results in overall decreases in duck and goose abundance and, consequently, also mass, even though their numbers and mass in other seasons would be predicted to increase slightly over existing conditions.

Table 3-45. Predicted increase or decrease in seasonal abundance under Alternative B.

FEDERAL AVIATION ADMINISTRATION CLASS	PREDICTED CHANGE IN ABUNDANCE OF BIRDS				TOTAL PREDICTED NET CHANGE
	Spring	Summer	Fall	Winter	
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft					
Vulture	-1	-1	0	0	-2
Geese	-285	+5	0	+6	-274
Pelican	+29	+10	+22	0	+61
Cormorant	+5	+2	+1	0	+8
Crane	-5	-3	-1	-1	-10
Eagle	0	0	0	-1	-1
Duck	-2,663	+42	+61	-1,008	-3,568
Osprey	-9	-1	0	0	-10
Pheasant	-6	-3	-3	-4	-16
Turkey	0	0	0	0	0
Heron	+2	+1	+1	+1	+5
Hawk (*Buteos*)	-6	-1	-1	-1	-9
Gull	-16	+1	-19	+1	-33
Rock pigeon	-10	-2	+1	-6	-17
Owl	0	0	0	0	0
Snow bunting	0	0	0	0	0
Horned lark	0	0	0	0	0
Raven	-2	0	0	0	-2
Crow	0	0	0	0	0
Mourning dove	-1	-4	-7	-3	-15
Shorebird	-230	+32	+10	-1	-189
Starling	-165	-159	-86	-924	-1,334
Blackbird	-223	-86	-282	-340	-931
American kestrel	-1	-1	-1	-2	-5
Meadowlark	-3	-5	+1	0	-7
Swallow	+124	+68	-32	0	+160
Sparrow	-58	-13	-27	-3	-101
Nighthawk	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds					
American coot	-781	+5	+314	+14	-448
American robin	-52	+13	+12	+108	+81
Waterbird species	-1	+32	+318	0	+349
White-faced ibis	-20	0	+1	+60	+41
Net Change **Percent Change**	**-4,378** **-49.7%**	**-68** **-2.7%**	**283** **+3.3%**	**-2,104** **-20.1%**	**-6,267** **-20.7%**

Table 3-46. Predicted increase or decrease in seasonal bird mass under Alternative B.

FEDERAL AVIATION ADMINISTRATION CLASS	MEAN MASS (grams)[a]	PREDICTED CHANGE IN BIRD MASS (grams)[b]				
		Spring	Summer	Fall	Winter	Total Predicted Change
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft						
Vulture	1,918	-1,918	-1,918	0	0	-3,836
Geese	4,280	-1,219,800	21,400	0	25,680	-1,172,720
Pelican	9,000	261,000	90,000	198,000	0	549,000
Cormorant	2,453	12,265	4,906	2,453	0	19,624
Crane	3,460	-17,300	-10,380	-3,460	-3,460	-34,600
Eagle	4,913	0	0	0	-4,913	-4,913
Duck	1,301	-3,464,563	54,642	79,361	-1,311,408	-4,641,968
Osprey	2,000	-18,000	-2,000	0	0	-20,000
Pheasant	1,263	-7,578	-3,789	-3,789	-5,052	-20,208
Turkey	8,500	0	0	0	0	0
Heron	2,500	5,000	2,500	2,500	2,500	12,500
Hawk (*Buteos*)	1,224	-7,344	-1,224	-1,224	-1,224	-11,016
Gull	657	-10,512	657	-12,483	657	-21,681
Rock pigeon	350	-3,500	-700	350	-2,100	-5,950
Owl	1,706	0	0	0	0	0
Snow bunting	35	0	0	0	0	0
Horned lark	38	0	0	0	0	0
Raven	811	-1,622	0	0	0	-1,622
Crows	538	0	0	0	0	0
Mourning dove	123	-123	-492	-861	-369	-1,845
Shorebird	336	-77,257	10,749	3,359	-336	-63,485
Starling	88	-14,454	-13,928	-7,534	-80,942	-116,858
Blackbird	71	-15,722	-6,063	-19,881	-23,970	-65,636
American kestrel	120	-120	-120	-120	-240	-600
Meadowlark	106	-318	-530	106	0	-742
Swallow	19	2,381	1,306	-614	0	3,072
Sparrow	28	-1,595	-358	-743	-83	-2,778
Nighthawk	79	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds						
American coot	692	-540,452	3,460	217,288	9,688	-310,016
American robin	84.8	-4,410	1,102	1,018	9,158	6,869
Waterbird species	692	-692	22,144	220,056	0	241,508
White-faced ibis	679	-13,580	0	679	40,740	27,839
Net Change		-5,140,213	171,364	674,461	-1,345,673	-5,640,062 (-31.6%)

[a] Mean mass (g) is the mean mass of a single bird as reported in species accounts available from Birds of North America Online (available at: http://bna.birds.cornell.edu/bna/).
[b] Predicted change in bird mass (g) represents the total change in bird mass, which was calculated by multiplying the mean mass of a single individual by the seasonal and total change in abundance for each species.

Alternative C

The existing bird habitat and bird-aircraft strike risk surrounding Provo Airport outside of the study area would remain the same as described under the No-Action Alternative. Within the study area under Alternative C, abundances of 17 of the FAA-listed hazardous species are predicted to increase (based on annual totals), 8 species are predicted to decrease, and 3 are predicted to not change (Table 3-42). All four of the non-FAA-listed species included in Table 3-47 are predicted to increase. Based on the annual summaries, implementation of Alternative C is predicted to increase overall abundance throughout the study area by nearly 4,000 birds (a 12.9 percent increase).

Under Alternative C, most species listed in Table 3-47 would experience increases in overall abundance across all seasons except for spring, when breeding habitat (emergent marsh) would be under water. Species predicted to increase the most in total abundance are ducks (winter) and starlings (winter). The largest decreases are for ducks during the spring and starlings during the fall. Yellow-headed and red-winged blackbirds would experience increases in overall abundance during the summer, fall, and winter because of the creation of wetland habitat while European starlings would likely decrease in overall abundance during the spring, summer, and fall because of the conversion of agricultural lands to other habitat types.

Under Alternative C, net change in the predicted abundance of birds is variable across seasons and would decrease in the spring, while increases are predicted during the summer, fall, and winter. Under Alternative C, the total abundance of birds is predicted to increase. As a consequence, the potential risk of bird-aircraft strikes would increase as well.

Under Alternative C, the total mass of birds across all species and seasons would increase (8.3percent) from existing conditions (Table 3-48). Pelicans would account for the greatest amount of change in total mass. In total, pelicans would account for nearly 42 percent of the predicted change in mass across all seasons and species despite a small increase in total abundance relative to other species. Pelicans would be predicted to increase by 69 individuals under Alternative C, while ducks would be predicted to increase by 367 individuals. In total, ducks would only account for 32 percent of the predicted change in total mass. Total bird mass would be predicted to increase during the summer, fall, and winter, while predicted changes in mass would decrease substantially from existing conditions during the spring.

3.16.11 Airport Hazard Impact Evaluation

As indicated in the six preceding tables, changes to avian community abundance and mass within the study area as a result of implementing an action alternative would either increase, decrease, or remain unchanged for certain species/groups, depending on season. Generally, ducks and starlings would experience the greatest changes in overall abundance with blackbirds and swallows also showing pronounced changes, depending on the selected alternative. Other FAA-listed hazardous species would also experience changes in relative abundance but in much smaller amounts. Changes for many of the species would likely result from the conversion of agricultural lands to other habitat types.

Table 3-47. Predicted increase or decrease in seasonal abundance under Alternative C.

FEDERAL AVIATION ADMINISTRATION CLASS	PREDICTED CHANGE IN ABUNDANCE OF BIRDS				TOTAL PREDICTED NET CHANGE
	Spring	Summer	Fall	Winter	
Species Listed by the Federal Aviation Administration as Hazardous to Aircraft					
Vulture	0	0	+2	0	+2
Geese	-102	+9	0	+23	-70
Pelican	+42	+5	+22	0	+69
Cormorant	+6	+1	+1	0	+8
Crane	+4	+8	+5	+1	+18
Eagle	0	0	0	+1	+1
Duck	-1,511	+75	+210	+1,593	+367
Osprey	-4	+4	+1	+1	+2
Pheasant	-9	-1	-6	+6	-10
Turkey	0	0	0	0	0
Heron	+4	+2	+2	+1	+9
Hawk (Buteos)	-10	-3	+8	-2	-7
Gull	-5	-10	-26	+21	-20
Rock pigeon	-4	+4	+3	+15	+18
Owl	0	0	0	+1	+1
Snow bunting	0	0	0	0	0
Horned lark	0	0	0	-2	-2
Raven	-1	0	0	0	-1
Crow	0	0	-1	0	-1
Mourning dove	-1	+13	+19	+12	+43
Shorebird	-103	+56	+79	+2	+34
Starling	-219	-393	-809	+2,376	+955
Blackbird	-121	+182	+560	+397	+1,018
American kestrel	0	+1	+5	+1	+7
Meadowlark	-11	-19	+7	0	-23
Swallow	+224	+263	+247	0	+734
Sparrow	-28	+22	+61	-16	+39
Nighthawk	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds					
American coot	-140	+3	+365	+16	+244
American robin	-98	+12	+152	+78	+144
Waterbird species	+15	-3	+295	0	+307
White-faced ibis	-9	0	+1	+36	+28
Net Change **Percent Change**	**-2,081** **-23.6%**	**+231** **+9.1%**	**+1,203** **+14.1%**	**+4,561** **+43.6%**	**+3,914** **+12.9%**

Table 3-48. Predicted increase or decrease in seasonal bird mass under Alternative C.

FEDERAL AVIATION ADMINISTRATION CLASS	MEAN MASS (grams)[a]	PREDICTED CHANGE IN BIRD MASS (grams)[b]				
		Spring	Summer	Fall	Winter	Total Predicted Change
Species Listed by the Federal Aviation Administration (FAA) as Hazardous to Aircraft						
Vulture	1,918	0	0	3,836	0	3,836
Geese	4,280	-436,560	38,520	0	98,440	-299,600
Pelican	9,000	378,000	45,000	198,000	0	621,000
Cormorant	2,453	14,718	2,453	2,453	0	19,624
Crane	3,460	13,840	27,680	17,300	3,460	62,280
Eagle	4,913	0	0	0	4,913	4,913
Duck	1,301	-1,965,811	97,575	273,210	2,072,493	477,467
Osprey	2,000	-8,000	8,000	2,000	2,000	4,000
Pheasant	1,263	-11,367	-1,263	-7,578	7,578	-12,630
Turkey	8,500	0	0	0	0	0
Heron	2,500	10,000	5,000	5,000	2,500	22,500
Hawk (Buteos)	1,224	-12,240	-3,672	9,792	-2,448	-8,568
Gull	657	-3,285	-6,570	-17,082	13,797	-13,140
Rock pigeon	350	-1,400	1,400	1,050	5,250	6,300
Owl	1,706	0	0	0	1,706	1,706
Snow bunting	35	0	0	0	0	0
Horned lark	38	0	0	0	-76	-76
Raven	811	-811	0	0	0	-811
Crow	538	0	0	-538	0	-538
Mourning dove	123	-123	1,599	2,337	1,476	5,289
Shorebird	336	-34,598	18,810	26,536	672	11,421
Starling	88	-19,184	-34,427	-70,868	208,138	83,658
Blackbird	71	-8,531	12,831	39,480	27,989	71,769
American kestrel	120	0	120	600	120	840
Meadowlark	106	-1,166	-2,014	742	0	-2,438
Swallow	19	4,301	5,050	4,742	0	14,093
Sparrow	28	-770	605	1,678	-440	1,073
Nighthawk	79	0	0	0	0	0
Species Not Listed by the Federal Aviation Administration but with Daily High Counts Exceeding 100 Birds						
American coot	692	-96,880	2,076	252,580	11,072	168,848
American robin	84.8	-8,310	1,018	12,890	6,614	12,211
Waterbird species	692	10,380	-2,076	204,140	0	212,444
White-faced ibis	679	-6,111	0	679	24,444	19,012
Net Change		-2,183,908	217,715	962,978	2,489,697	1,486,482 (+8.3)

[a] Mean mass (g) is the mean mass of a single bird as reported in species accounts available from Birds of North America Online (available at: http://bna.birds.cornell.edu/bna/).
[b] Predicted change in bird mass (g) represents the total change in bird mass, which was calculated by multiplying the mean mass of a single individual by the seasonal and total change in abundance for each species.

Habitat, as defined by Anderson and Gutzwiller (1994), is comprised of a variety of variables including but not limited to size of area, and availability of food cover, and vertical and horizontal structures. If one or more of these factors is absent or altered, the abundance and diversity of birds may be affected. The analysis of changes to bird strike risk assumes that habitat resulting from the implementation of any of the action alternatives is of optimum condition and that all variables required to define optimum habitat condition are present. The assessment of bird strike risk is generally dependent on factors including bird abundance and flight patterns. Predicted changes in avian abundance are the result of changes in the types and amounts of habitat available under each of the action alternatives. The greatest changes in abundance of birds would be due to the conversion of agricultural lands to other habitat types including open water, emergent marsh, and wet meadow.

Across all species, bird abundances are predicted to decrease during the spring regardless of alternative. During the summer, bird abundance is expected to increase under Alternatives A and C while summer abundances under Alternative B would generally decrease. Abundances would increase under Alternatives B and C in the fall while abundances would decrease under Alternative A. Winter abundances would increase under Alternatives A and C, and decrease under Alternative B.

Overall, based solely on predicted changes in bird abundance and mass, without considering behavior or flight patterns, potential bird-aircraft strike risk would be reduced significantly under Alternative B (-20.7 percent and -31.6 percent, respectively), slightly reduced under Alternative A (-5.3 percent and -11.9 percent, respectively), and moderately increase under Alternative C (+12.9 percent and +8.3 percent, respectively).

It was already mentioned that, in most cases, predicted changes in abundance represent a change in distribution of the animals throughout the local or regional area. A predicted increase in abundance in the proposed project area would likely result in a similar magnitude of decrease in abundance nearby, particularly during spring and fall migration periods, and vice versa (R. Norvell 2014, pers. comm.; B. Stringham 2014, pers. comm.). The myriad factors affecting abundance of migrating populations of ducks, geese, and other waterbirds are so diverse and often very remote from the local area that the relatively small changes in habitat abundance caused by the project would have no or very little effect on true population levels. However, there are some species that could be directly affected locally in abundance, so it is important to consider the results on a species-by-species basis if possible.

Impacts Due to Predicted Changes in Bird Movement Patterns

In either situation, a key aspect of the hazard assessment is attempting to determine whether the predicted change in abundance of birds in the proposed project area, regardless of whether it represents a local change in abundance due to distributional shifts or actual population changes, causes a change in the frequency of occurrence of birds flying over/across/through the 3-D airspace defined for the Provo Airport.

There are numerous factors that influence the risk of a bird-aircraft strike. In simple terms, the aircraft and the bird must come to occupy the same space at the same time. Birds only become a *potential* hazard (risk) if/when in flight over, across, or through the airspace utilized by aircraft as they approach or depart the Provo Airport. Bird-movement patterns have not been possible to observe under proposed future conditions and, therefore, predicting whether a bird (individual or flock) is likely to fly through that airspace under proposed action alternatives is not possible. However, discussion of specifics of the Provo Airport 3-D airspace and general discussion of species tendencies allows some analysis of likely future conditions.

Provo Airport Airspace and Local Bird Movements

The traffic pattern (Figure 3-29) and airport airspace plan (Figure A-31, Appendix A) for the Provo Airport encompass a fairly sizable portion of the eastern Utah Lake shoreline. The Provo Airport has two runways and plans for a possible third runway. Runway 13-31 (oriented northwest to southeast) handles the majority of the air traffic, including commercial jet traffic. The 3-D airspace is determined by a number of factors specific to the location and orientation of the airport, types of aircraft utilizing the airport, type of air traffic control system in use, etc. There are several direct paths that a bird could take to or from the proposed project area that would generally cross over or around the Provo Airport airspace that might, because of the 3-D aspect of the airspace, not create a hazard to aviation safety (Figure 3-30). This hypothetical figure shows potential flight paths which, depending on height of the bird as it crosses the 3-D airspace zone, would either create a hazard if it is within the strike zone (red arrow) or would not be a hazard (green arrow) if it is not within the strike zone (i.e., above or below strike elevation).

Performing a thorough bird movement assessment of this type is only possible if/when the proposed project is in place. Not having that option available, we examined the flyover data collected at each of the survey sites during the seasonal (2012) and monthly (2013) bird surveys (URMCC 2015b). During the survey site visits, 3,662 birds were observed flying over the study area but not actively using the habitat. The majority of the birds observed were traveling in a north-to-south direction. The greatest number and proportion of the flyover observations (2,689; about 73 percent) were made during winter. By far the most commonly observed bird species engaged in flyover behavior was red-winged blackbird (2,178) followed by Franklin's gull (*Leucophaeus pipixcan*) (201), and white-faced ibis (137). More than 2,200 of the observed flyovers occurred at the Provo River Parkway monitoring site, closest to the north end of the Provo Airport, and almost all of them were red-winged blackbirds. Red-winged blackbirds are most often associated with wetlands, so the shift to flying over habitats of the riparian forest along the Provo River Parkway is likely the result of wetland habitat not being available during the winter. Because of predominately diurnal movement patterns, strike risk from blackbirds is likely minimal. Regarding American white pelican, another species of particular potential concern, they were observed as flyover species at each of the three survey sites in the study area, most commonly in spring, indicating that, although they do not use the proposed project area habitat currently under baseline, they do use the airspace over the study area.

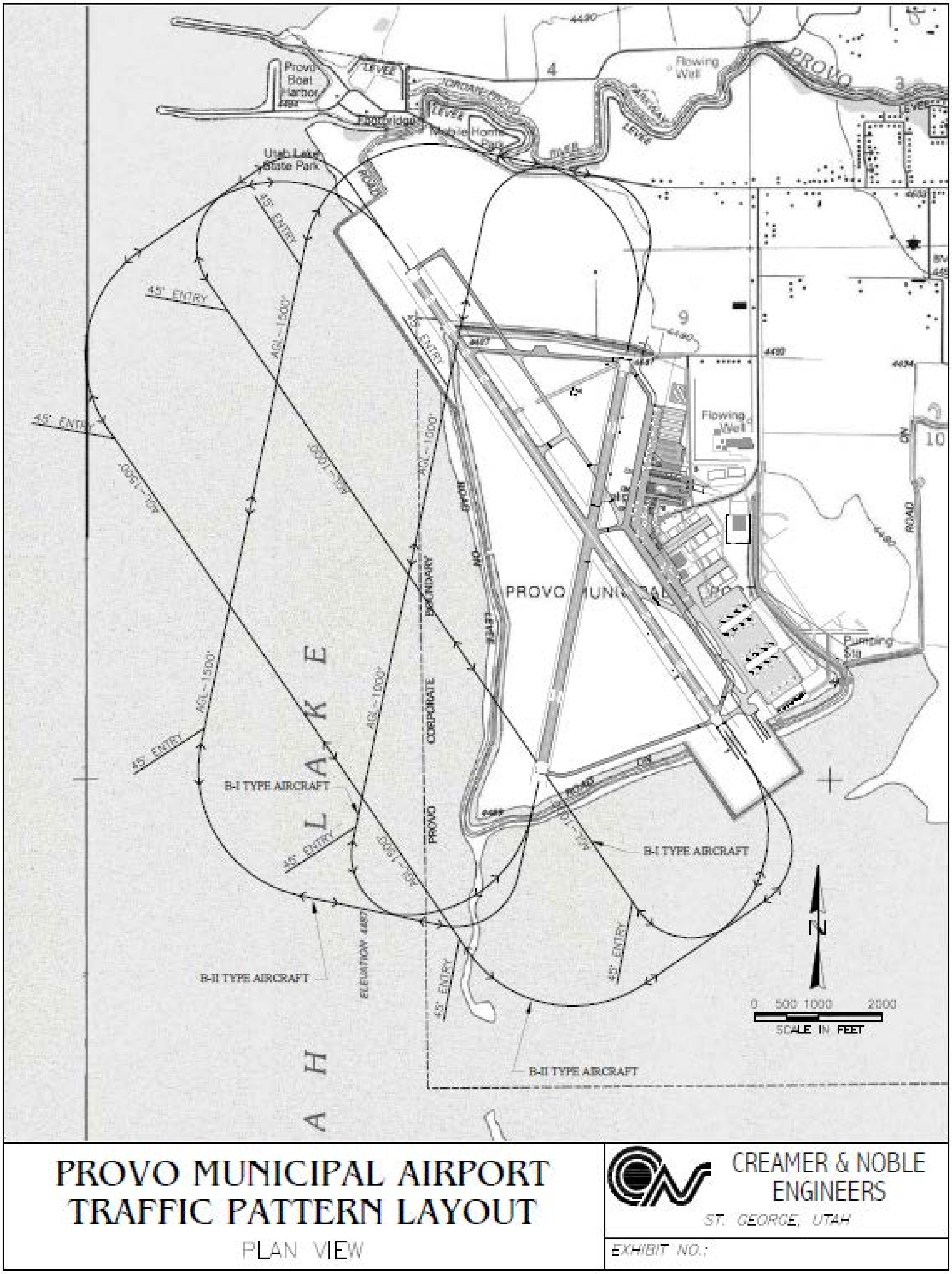

Figure 3-29. Provo Airport traffic pattern layout.

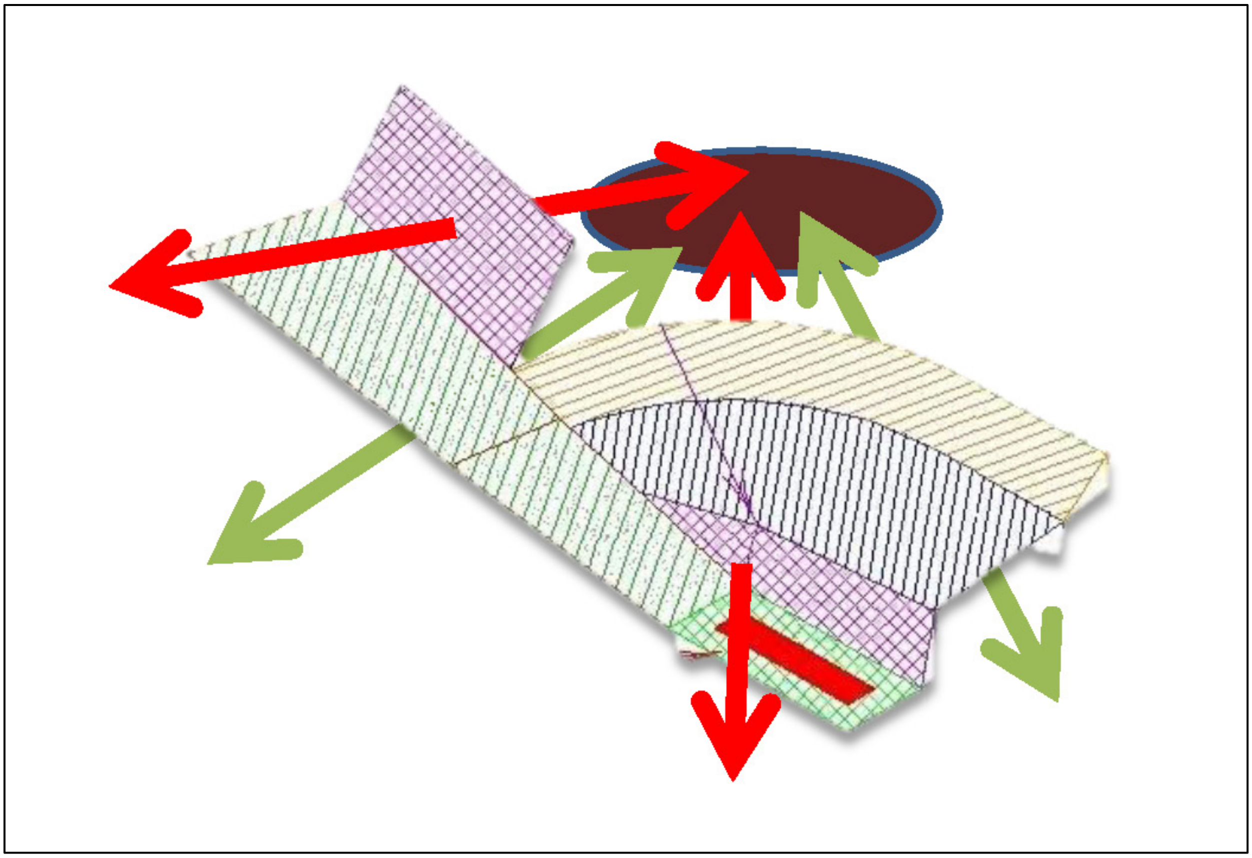

Figure 3-30. Potential bird flight paths from the study area in relation to airport airspace and runway (not to scale).

<u>Species-by-Species Discussion and Summary</u>

Geese

Geese, primarily Canada geese, are currently common in the study area on a year-round basis but are not particularly prevalent during fall in either Provo Bay or the study area. Being large-bodied and tending to fly in formation, they are a concern for aviation safety. Data from Salt Lake City International Airport eBird sites indicate that 5.6 percent of the recorded observations are Canada geese, whereas the FAA bird-strike database for the airport reports Canada geese as responsible for only 1 percent of reported airstrikes (URMCC 2015b). It should be considered, however, that Salt Lake City International Airport employs a very active wildlife hazard mitigation program, and the FAA airstrike data reflect the positive results of those efforts. It may also suggest that Canada geese may be responsive to various mitigation measures such as hazing. According to the UDWR (B. Stringham 2014, pers. comm., waterfowl in general and geese in particular are not as abundant at Utah Lake and in the airport vicinity as they are on and around Great Salt Lake. Although habitat in the Provo Airport vicinity is attractive to geese and other waterfowl, it may be of lower quality than available habitat at the Great Salt Lake. As a consequence, a less-active waterfowl mitigation program may be required for the Provo Airport. Under Alternative A, the only significant change in abundance was a decrease during spring due to loss of upland nesting/foraging habitat. Predicted increases during summer and winter involved relatively small numbers of animals. The same seasonal pattern is predicted for geese under Alternatives B and C. Therefore, predicted changes in abundance of geese do not represent substantial increased bird-aircraft strike risk under any alternative, and they represent decreased bird-strike risk under each alternative during spring. No significant change in flight movement pattern or frequency by geese through the aircraft operations area is anticipated. Geese are relatively abundant in the project area under baseline conditions and no Provo Airport strikes involving geese have been reported to the FAA database.

American White Pelican (Pelican)

Pelicans are a concern to aviation safety wherever they are found. They are currently common in and around Provo Bay/Provo Airport, accounting for 0.6 percent of all eBird occurrences reported earlier (Section 3.16.8) for 16 sites associated with the east shore of Utah Lake and 0.9 percent of all occurrences associated with Provo Airport. Survey data indicated they accounted for less than 1 percent of all sightings in the project study area and 6 percent of all observations at the Provo Bay observation site (URMCC 2015b). Based on field observations, pelicans documented as flying over the study area seem to travel as individuals or as pairs and at high altitudes (URMCC 2015b). Generally, pelican flyovers have been documented flying from north to south over the study area. At Salt Lake City International Airport eBird sites, pelican accounted for 2.3 percent of the recorded observations but only 0.3 percent of the FAA bird strike database reports (URMCC 2015b), again suggesting that pelicans may be responsive to various mitigation measures such as hazing. The predicted increased abundance in pelicans under alternatives A, B, and C may represent a potential adverse effect. However, as discussed earlier, it is highly unlikely that the increased abundance estimates represent increases in true population size. Rather, pelicans that might otherwise forage elsewhere in the Utah Lake ecosystem might be drawn to the restored project area instead (R. Norvell 2014, pers. comm.). Regional increases in pelican abundance may be attributed to increases in the abundance of carp in Wasatch Front fisheries, which includes Utah Lake (Flannery 1988). With a carp management program currently being implemented in Utah Lake, it is possible that the abundance of pelicans on Utah Lake could decrease as the availability of carp as a primary food source is reduced over time. The determination of effect would depend on whether the pelicans respond to the presence of this “new” habitat in a way that significantly increases their occurrence within the 3-D airspace of Provo Airport. This can only really be determined by conducting a monitoring program followed by a responsive mitigation program if it is found that a response is warranted. Based on the analysis, Alternative A would result in the greatest increase in pelican use of the project area, followed by Alternative C. Alternative B would cause the least increase in abundance. Pelicans would be expected to use the restored delta in the project area to some extent under any of the action alternatives. There is potential for increased pelican flight movement patterns and frequency within the aircraft operations area under Alternative A without mitigation (hazing) measures; this risk decreases under Alternatives C and B, respectively.

Ducks

Dabbling ducks and diving ducks have been included in the same category. When lumped together, data from the Salt Lake City International Airport indicate that ducks occur in the FAA airstrike database at about the same frequency (7.5 percent) as they occur in the eBird dataset (8 percent) (URMCC 2015b), perhaps suggesting that their behavior is not as influenced by air hazard mitigation measures as some other groups of birds (e.g., geese and pelicans). The proposed project would have an overall annual decrease in abundance of ducks under each alternative, with the largest relative change in abundance predicted to occur during spring (negative change in abundance due to inundation of upland/agricultural lands used for nesting). Positive changes in abundance of lesser magnitudes are predicted for every other season . Because ducks are highly migratory, it would be anticipated that much of the response predicted in spring and fall would result from shifts in local distribution, although there could also be local population effects due to loss of nesting habitat during spring. The predicted magnitude of abundance increase in summer and fall is minor under each alternative. The predicted increase in winter abundance represents a fairly large increase in bird numbers under Alternatives A and C (+691 and +1,593, respectively) but a proportionately, relatively minor increase over existing numbers for Alternative A (+15.5 percent). Under Alternative B there would be a significant predicted decrease (-22.5 percent) in abundance of ducks during winter. The only alternative that might cause an increased strike risk due to ducks prior to mitigation would be Alternative C during the winter.

Cranes

Cranes are anticipated to respond differently under each alternative. Under Alternative A, cranes are predicted to increase by 21.4 percent overall. However, cranes are not abundant in the study area to begin with. Under Alternative B cranes are predicted to decrease by 23.8 percent overall, with at least some level of decrease predicted for each season. The greatest change is predicted under Alternative C, with a 42.9 percent increase in abundance overall. Cranes are migratory, but their numbers peak in the spring in the study area and Provo Bay, suggesting that there may be some breeding/nesting activity in the vicinity. Cranes are reported less than 0.1 percent for the Salt Lake City International Airport eBird datasets and the FAA bird-strike datasets, so comparisons with that locale are difficult to make. Cranes are present in the study area, although not extremely abundant; Utah Lake is not a major stop-over area as are some other locations in the intermountain west such as Idaho's Gray's Lake and New Mexico's Bosque del Apache National Wildlife Refuge, and the proposed project would not create a habitat type that is so unique or singular that it would cause the area to become more attractive to cranes than it is currently.

Gulls

Several gull species occur in the study area and Provo Bay environs; however, they have not accounted for more than 1 percent of total survey observations in any season in either location under baseline conditions (URMCC 2015b), nor would their predicted abundances change substantially under the proposed project. The greatest predicted increase (+22 birds) would occur during winter under Alternative A, with a similar increase (+21 birds) predicted under Alternative C. Under Alternative B gull abundance is predicted to increase by 1 bird in summer and winter, and it would decrease by 16 and 19 birds in spring and fall, respectively. Therefore, Alternative B would have no effect on bird-aircraft strike risk due to changes in gull abundance. Gull abundance is predicted to decrease during spring, summer, and fall under Alternatives A and C. At Salt Lake City International Airport, gulls were detected in 5.3 percent of FAA-reported airstrikes, but they accounted for 9.5 percent of eBird dataset occurrences. Based on this limited analysis, gulls would not appear to be particularly susceptible to aircraft strikes, although they have been identified as being of particular concern by the FAA. These data may be confounded by the fact that over 35 percent of the reported airstrikes at Salt Lake City International Airport were caused by "unknown" bird species (17.2 percent classified as small, 17.8 percent classified as medium, and 2.7 percent classified as large). Gulls are generally regarded as a serious strike risk species. However, gulls would not appear to increase strike risk to aircraft at Provo Airport due to the proposed project, particularly under Alternative B.

Hawks (Buteos), Eagles, and American Kestrels

Hawks and kestrels are fairly common in the study area, while eagles, although rare, do occur. Raptors present a strike risk to aircraft especially because of their hunting behavior, which is to hover or circle over open expanses of meadow or other prey habitat or to perch on tall objects surrounding suitable prey habitat and strike their prey. Examination of the Salt Lake City International Airport data suggests that raptors may warrant a lot of concern. Hawks and kestrels accounted for 3.3 percent and 4.4 percent, respectively, of the FAA-reported bird-strikes at Salt Lake City International Airport, while they accounted for only 0.3 percent each of the eBird dataset reports. This suggests those two species may be involved in airstrikes 10 to 14 times more frequently than their proportion in the bird community. There are a number of valid reasons why this statistic may be fluid, but nonetheless it suggests that hawks and kestrels pose a risk to aircraft.

The proposed project would reduce the overall cumulative abundance of hawks, eagles, and kestrels under each alternative. The greatest overall decline in abundance would occur under Alternative A (-13 hawks in spring, -3 in summer, and -2 in winter), but there would be a predicted increase of four hawks during fall. Under Alternative C there would be an overall increase of seven kestrels; although there would be a net decrease of seven hawks annually, there would be an increase of eight hawks during fall and an increase of one eagle during winter. Under Alternative B the abundance of hawks (-9), eagles (-1), and kestrels (-5) would decrease with no seasonal upswings. Under Alternative C potentially increased strike risk would occur from a minor increase in numbers of kestrels and hawks (five and eight, respectively) especially during fall. However, the likelihood of a hawk or kestrel engaged in hunting behavior over the project area straying into the Provo Airport 3-D airspace, which is more than 1.5 miles away, is remote. The proposed project would not create any perching habitat (i.e., trees, towers) closer to the Provo Airport than currently exists. So the minor increase in abundance under Alternatives A and C is likely not significant. Alternative B would decrease the strike risk from hawks, eagles, and kestrels.

Shorebirds

Shorebirds as a group contain many species and include members of the order Charadriiformes, which includes the families Charadriidae (plovers), Recurvirostridae (avocets and stilts), and Scolopacidae (sandpipers, snipes, curlews, and phalaropes). Species identified during BIO-WEST surveys of the study area and Provo Bay include American avocet, black-necked stilt, greater yellowlegs (*Tringa melanoleuca*), lesser yellowlegs (*Tringa flavipes*), spotted sandpiper (*Actitis macularius*), willet (*Tringa semipalmata*), and Wilson's snipe (*Gallinago delicata*) (URMCC 2015b). Shorebirds, which generally have a tendency to congregate in large groups, are not overly abundant within the study area and only account for 2 percent of all birds documented during BIO-WEST surveys (URMCC 2015b). As indicated by those surveys, study area shorebird abundances peak during the spring and fall, likely the result of an influx of migrating birds or birds that are staging for migration. Shorebird numbers under all three alternatives are predicted to decrease during the spring with the greatest decreases predicted under Alternatives A and B (>200 decrease). Summer and fall shorebird abundances are predicted to increase across all alternatives; however, Alternative B is predicted to increase the number of shorebirds the least (+32 and +10 individuals, respectively). Winter shorebird numbers are predicted to change minimally. Given the results of the alternatives analysis, Alternative B is expected to result in the lowest effect to aircraft strike risk. Based on the examination of strike data reported for Salt Lake City International Airport, shorebirds do not appear to present substantial risk to aircraft. Of the 1,793 strikes reported for Salt Lake City International Airport, shorebirds accounted for less than 1 percent of all strikes. However, eBird data for sites surrounding Salt Lake City International Airport report only 210 individual shorebirds or 0.7 percent of all reported observations, which suggests that shorebirds are not very abundant around Salt Lake City International Airport and, as a consequence, they do not present very high risk to aircraft. Similarly, predicted shorebird abundances for the project area are not high, especially under Alternative B, and would not be expected to present increased risk to air traffic flying into or out of the Provo Airport.

Starlings

Starlings are the most abundant species in the study area. Only ducks, in the aggregate, are comparable in abundance. Their presence is largely influenced by the agricultural landscape and activity. Because of their tendency to fly in large, dense flocks, starlings are a big concern for aircraft safety, especially for smaller aircraft. However, when observed flying in the study area, starlings showed a tendency to stay very close to the ground. At Salt Lake City International Airport, starlings accounted for 23.5 percent of eBird occurrences, they but were listed as occurring in only 1.8 percent of reported bird strikes. Again, it is likely these data may be confounded by the fact that over 17 percent of the reported airstrikes at Salt Lake City International Airport were caused by “unknown small” bird species. Alternative A, the largest project restoration alternative, would affect (reduce) starling abundances by the most of any alternative, but despite the relative decrease in abundance (-295, -449, -1,404 in spring, summer, and fall, respectively) predicted abundance would increase substantially (+1,449) in winter for an annual change of -699 (-7.5 percent). So although Alternative A would lead to decreased risk during three seasons, there could be an increased strike risk during winter under Alternative A due to the predicted increase in abundance. Alternative B would reduce abundance of starlings in every season of the year (-165, -159, -86, -924 for spring through winter, respectively) and, therefore, would reduce the strike risk (based on abundance only) compared with existing conditions. Alternative C would follow a pattern similar to Alternative A, except the magnitude of the abundance increase in winter would be greater, with an increase of 2,376 birds predicted (+ 60.4 percent). In the study area starlings have been observed roosting near Provo River Parkway during winter. This location would not likely change under the project, so there would be little reason for starlings from the project area to fly through the Provo Airport airspace. A monitoring program could verify this once the project was implemented.

Blackbirds

Blackbirds are the third most abundant group of birds in the study area, after starlings and ducks, and are often associated with emergent wetland habitats. Where they occur, they are often the most abundant birds, especially during the breeding season (Orians 1980). Generally, blackbirds are highly social and nest in group territories. During the nonbreeding season, these birds often form large flocks that forage in uplands and roost in wetlands. Despite having been identified as a species of concern by the FAA, blackbirds rarely collide with moving objects such as aircraft because of their diurnal movement patterns (Twedt and Crawford 1995). Blackbirds are predicted to respond uniquely to the action alternatives. Under Alternative A abundance would increase in summer and winter but decrease in spring and fall, for an overall minor annual decrease of 2 percent. Under Alternative B abundance would decrease during every season for an overall annual decline of about 17 percent. Under Alternative C blackbird abundance would increase every season for an overall annual increase of about 18 percent. Therefore, Alternative C is the only alternative under which there is any real possibility of increased risk. However, the risk is likely minimal because of the species' diurnal movement patterns. Data from near Salt Lake City International Airport are not conclusive due to the high proportion of small birds of unknown species in the FAA bird strike database, but eBird data showed 4.0 percent abundance of blackbirds compared to 0.2 percent confirmed bird-strike reports.

Swallows

Swallows and related species (martins, swifts) can be a concern for airport operators because of their feeding behavior; they dart back and forth through swarms of insects to gather prey. Data from the Salt Lake City International Airport indicate that swallows were identified in 8.9 percent of the FAA-reported bird strikes. They were represented by 3.7 percent of eBird reports from the six eBird sites surveyed for this analysis. Considering the high proportion of unidentified or unknown small birds in the FAA bird strike dataset, it is conceivable that swallows could account for approximately 10 percent or so of all strikes at the Salt Lake City International Airport. Under baseline conditions in the study area, swallows are low to moderate in abundance. However, five of the eight bird strikes at Provo Airport reported by Utah Valley University during 2012–2013 involved swallows. Most strikes involved a single bird; only one involved hitting a flock of swallows, that was at runway level (within 10 feet of landing). All of the swallow strikes occurred in the August–October time period, which is consistent with the time of year these species were observed to be most abundant during the wildlife hazard assessment report (Airport Wildlife Consultants 2014) and BIO-WEST surveys (URMCC 2015b).

Alternatives A and C would be predicted to have almost the same effect on swallow abundance, causing an increase of 736 and 734 birds, respectively (+65 percent), which would be spread across the spring–fall seasons. Swallow abundance would be predicted to increase under Alternative B by about 14 percent overall, with the increase occurring during spring (+124) and summer (+68) and a decline (-32) occurring during fall. Most swallow species tend to nest in trees and communally roost on power lines or other similar structures (Ehrlich et al. 1988). Any new trees or structures created by the proposed project would be further from the airport than other suitable roosting sites already in existence that are closer to the airport. Therefore, Alternatives A and C would potentially have a moderate effect due to increases in abundance of swallows, and Alternative B would likely present a minor or no increase in strike risk to aircraft due to increases in abundance (small increase in summer, small decrease in fall).

American Coot

The American coot is not a species listed by the FAA among the "top 25" hazardous wildlife. However, it is ubiquitous and was fourth most abundant in the study area under baseline conditions. The proposed project would have seasonal effects on American coot abundance. The abundance in spring is predicted to decrease under each alternative (-579, -781, -140 for Alternatives A, B, and C, respectively) and increase in fall (+560, +314, +365, respectively). Abundances in summer and winter would remain essentially unchanged (very minor positive increases). Over the entire year, abundance would stay about the same (+7) for Alternative A, decrease for Alternative B (-448) and increase for Alternative C (+244). The coot is not typically a significant hazard to aircraft primarily because it is not a strong flyer. Although migratory, once in a location it tends to stay on the water and fly only short distances, commonly attaining a height of only a few feet above the water surface and seeking dense vegetation for cover. The relatively minor overall increase in abundance predicted under Alternative C or by Alternative B or C during fall would not be likely to increase the strike risk at Provo Airport. The relatively long distance of approximately 1–2 miles between the Provo Airport and the study area generally exceeds the distance that coots fly if/when disturbed. The only other likely flight into or out of the area would be migratory.

American Robin

The American robin is also a common species in the study area and is moderate in abundance under baseline conditions. Although loosely gregarious during the breeding season, the species is more tightly gregarious in the nonbreeding season and flocks together during the winter months to increase foraging success. Flock sizes can be large and often exceed 250 individuals. Roosting flocks are known to be much larger. Generally, robins take short, low flights over areas of suitable habitat (Sallabanks and James 1999). Within the study area, suitable roosting trees are present primarily along the existing Provo River, not near the Provo Airport. Although riparian forest habitat would be created under each of the action alternatives, none would be located in the vicinity of the airport. The absence of suitable roosting trees near the airport and the fact that robins are known to take short, low flights suggest that the species would not likely present any appreciable increased risk to aircraft.

Waterbirds

The term "waterbird" is defined and used differently by different organizations, but in general it includes a diverse variety of birds that are ecologically tied to bodies of water for some part of their lives. In the context of habitat use in the this document, waterbirds refers to the families Podicipedidae (grebes), Gaviidae (loons), Phalacrocoracidae (cormorants), and Rallidae (rails). At Utah Lake waterbirds occur on open water, shoreline, wet meadows, and emergent marshes. Generally, grebes, loons, and cormorants use deeper water than shorebirds and wading birds, typically deeper than 10 inches (Hatch and Weselow 1999, Knopf and Evans 2004). Under existing conditions, waterbirds are not very abundant and are nearly equally distributed across the study area. The majority of BIO-WEST waterbird observations occurred at Provo Bay and along the Provo Airport dike (URMCC 2015b). When considering each of the three alternatives, waterbird abundances would increase the most under Alternative A (net increase of 552 individuals), while under Alternative C waterbird abundances would increase the least (net increase of 307 individuals). Regardless of alternative, waterbirds are predicted to be the most abundant in the study area during the fall. Of the birds identified as responsible for aircraft strikes at Salt Lake City International Airport, only three waterbird species were reported in the FAA Wildlife Strike Database (double-crested cormorant [*Phalacrocorax auritus*], Virginia rail, horned grebe), each responsible for 0.1 percent of reported strikes since records were first kept. These results suggest that waterbirds do not pose a substantial risk to aircraft at Salt Lake City International Airport and would not likely present a substantial hazard to aircraft at the Provo Airport after project implementation.

White-faced Ibis

White-faced ibis are a wading bird that is frequently associated with open water, shoreline, wet meadow, and emergent marsh habitat (Paul and Manning 2002). This wading bird is a highly gregarious colonial nester that typically forages in flocks, often with other wading bird species. Ibis habitat, as is the case with other wading birds, is generally characterized as including shallow water (less than 12 inches deep), such as emergent marsh, shallow ponds, flooded pastures and agricultural fields, and wet meadows. Under existing conditions, white-faced ibis have only been documented utilizing habitat in the North Wetlands study site and then in small numbers (only 27 individuals). However, 74 individuals were documented flying over the study area without actually using available habitat. BIO-WEST surveys of Provo Bay documented 248 individuals across all seasons, which suggests that preferred habitat is located in Provo Bay (URMCC 2015b). Additionally, individuals identified as flyovers during study area surveys may actually be flying to Provo Bay through Provo Airport airspace to occupy available habitat. When considering each of the action alternatives, Alternative C is predicted to result in lowest increase in overall abundance of white-faced ibis (net increase of 28 individuals), while Alternative A is predicted to result in the highest net increase in abundance of the species (+78 individuals). Regardless of alternative, the abundance of ibis is predicted to increase the most during the winter. Of the 1,793 bird strikes reported by Salt Lake City International Airport in the FAA Wildlife Strike Database, only 8 (0.4) were attributed to encounters with white-faced ibis, suggesting that white-faced ibis may not be a species of high concern for aircraft strike risk.

Airport Hazard Conclusions

Survey data and eBird datasets (eBird 2012) verify that many migratory birds and species that move over large areas throughout the breeding season are present within 2 miles of Provo Airport and along the eastern shore of Utah Lake under existing conditions. Overall bird abundances and movements within this broad space ,especially during migration, are not expected to be significantly affected by relatively small habitat changes in the study area (relative to habitats throughout the Utah Lake, Great Salt Lake, and northern Utah (e.g., Bear River Migratory bird Refuge) that migratory birds are known to utilize). However, the discrete changes in abundance and mass predicted for certain species and groups of species known to be a concern to aviation safety were nonetheless examined using bird survey count data because local abundances and movement patterns can change and, therefore, can affect wildlife (bird) strike risk by aircraft at Provo Airport. With only very few exceptions noted previously for Alternatives A and C, it was concluded that there would be no net adverse effect on aviation safety from the proposed project based solely on anticipated changes in bird abundance due to the project. Alternative B would have no increased risk of bird-strikes based on anticipated changes in bird abundance due to the proposed project, with the possible exception of increasing the abundance of pelicans. However, pelicans are utilizing the area under baseline conditions (flyovers), and eBird datasets (eBird 2012) verify their distribution all along the eastern Utah Lake shoreline (0.6 percent) and Provo Bay sites (0.9 percent). Under Alternative B the abundances of many other species known to be hazardous to aircraft are predicted to decrease, thus leading to overall net decreased potential strike risk based on abundance and mass alone.

Overall, the proposed project would have minor effects on distribution and abundance of migratory waterfowl, shorebirds, other waterbirds, and neotropical migrants in the Pacific Flyway of which Utah Lake and its associated wetlands are a very small part. At a local level, the Preferred Alternative (Alternative B) would result in a predicted net increase of about 25 acres of wetlands (about +8 percent) compared with existing conditions in the proposed project area.

However, if an action alternative is implemented the potential exists for altered flight movement patterns by some birds utilizing the project area. Changes in flight frequency through the Provo Airport aircraft operations area could potentially increase bird-aircraft strike risk above baseline condition levels. For most species, based on known life history information, there is little or no predicted overall change or increase in flight frequency through the Provo Airport aircraft operations area as a result of implementing the proposed project, especially under Alternative B, the Preferred Alternative. Under the proposed project, the establishment of a functional river/lake interface habitat and expanded open water (lacustrine aquatic bed) habitat would be expected to attract pelicans, whereas they currently do not often use the wetlands located north of Boat Harbor Drive and east of Skipper Bay dike. Their flight patterns to and from the project area, therefore, are not known and would need to be monitored. Those pelicans could traverse the Provo Airport aircraft operations area; however, such occurrence or frequency of occurrence cannot be accurately predicted. Hazard mitigation (hazing, lethal control, etc.) might be required. Similarly, some other species could alter its current habitat use and flight patterns in the project area, thus affecting its flight patterns or frequency through the Provo Airport aircraft operations area and potential bird-aircraft strike risk.

Proposed Monitoring and Mitigation Program

In the time between release of the Draft EIS and release of this Final EIS, the JLAs worked with the USDA Wildlife Services group to develop a monitoring plan that includes a flight movement study to determine local bird abundances, flight patterns, and frequencies through the aircraft operations area. This monitoring effort would begin as soon as possible following a decision to implement the proposed project and continue as determined necessary by Provo Airport wildlife specialists. The goal of the monitoring and movement study would be to determine actionable threshold levels which, if exceeded in terms of increased levels of bird abundances and/or movements through the aircraft operations area due to the proposed project, would trigger an appropriate mitigation response by the JLAs. The JLAs may carry out the mitigation through agreement with Provo City, USDA Wildlife Services, FAA, and/or others, as appropriate.

Typical mitigation strategies include measures to manage wildlife or measures to manage their resources (habitat). Wildlife management measures include use of deterrents (visual, chemical, tactile, and auditory) to haze birds away from an area, exclusion methods (e.g., fencing, wire netting), translocation strategies, and population management (which may include lethal control). For example, Salt Lake City International Airport and USDA Wildlife Services translocated more than 900 raptors from the vicinity of the Salt Lake City International Airport in 2014 (M. Linnell 2015, pers. comm.). Other measures may be aimed at managing the resources used by wildlife to reduce the attractiveness of areas near the airport to wildlife (birds) in general or to certain target species. The JLAs would cooperate with Provo Airport, FAA, and others to attempt to reduce the attractiveness of the project area to wildlife hazardous to aircraft while still meeting the purpose and need of the project, which involves restoring, creating, and enhancing habitat for

June sucker. The measures could include temporarily closing the public access to the project area to safely and effectively haze or remove problem birds; installing and implementing bird-detection and warning systems; conducting research; or implementing other measures yet to be determined to ensure an effective mitigation program.

According to USDA Wildlife Services, current approaches to reducing wildlife strikes with aircraft primarily fall under one or more of the following four research areas: (1) habitat management; (2) wildlife dispersal, removal, and exclusion; (3) detection/prediction of wildlife movements and behaviors so that aircraft can avoid high-risk activities, both temporally and spatially; and (4) manipulating visual stimuli such as aircraft landing lights to enhance the detection and avoidance of aircraft by birds (USDA Wildlife Services 2013).

3.16.12 Bird Strike Risk – Temporary, Indirect, and Cumulative Impacts

Temporary Impacts during Construction

The assessment of impacts to aviation safety has assumed that habitat within the study area would be of the highest quality (i.e., supporting the highest number of birds). However, during project implementation, habitat quality and the disturbance caused by construction activities are expected to temporarily reduce bird use substantially. The risk of bird-aircraft strike during construction is anticipated to be less than under completed project conditions. Construction activities are likely to keep most birds of most species away from the immediate construction zone, which would reduce the local abundance compared with baseline conditions. Movement of birds that might be displaced by construction activities would be monitored. The resultant habitat changes expected from the proposed project would not be expected to occur during construction or even incrementally during construction; the critical element of providing a water supply to the restored habitats of the delta area by routing Provo River into and allowing Utah Lake to enter into the area, would not occur until the very end of the construction period (expected to be at least 3–5 years from project initiation). From that date forward, vegetation would progressively grow and, therefore, habitat conditions would change over time.

Indirect Impacts

Regarding indirect effects to avian wildlife and bird strike risk, it is expected that indirect effects would be minor and temporary and result from activities related to construction of berms, dikes, and the redirection of the river channel (noise and vibration). The value of habitat in portions of the study area would likely be temporarily reduced until the disturbed ground becomes revegetated. Habitat quality, however, would improve over time once construction has concluded. In particular, the trees and associated structures in new riparian areas would take the longest to reestablish. Other areas, such as wet meadow and emergent marsh, would reestablish relatively quickly. As a consequence, the risk of bird strikes may be temporarily reduced.

Other indirect effects are not expected as a result of project implementation.

Cumulative Impacts

In terms of cumulative impacts, there are a number of past and reasonably foreseeable future wetland mitigation projects that affect avian abundance and habitat quality and, therefore, potentially aviation hazard risk near Provo Airport. It is not clear how these many and varied factors associated with avian habitat quality and bird occurrence have affected and would affect bird strike risk. However, the size of the study area relative to the amount of prime avian habitat within a 5-mile radius of Provo Airport is relatively small. As such, it is expected that cumulative effects on bird strike risk would be proportionate to the size of the particular affected area and the amount of habitat the project would convert from one type to another.

From December 2001 to 2004, the FFSL and Provo City, with local support from Utah County and the City of Orem, purchased a conservation easement to establish the K. Dale and Sonja Despain Cattle Ranch and Bird Refuge (see Figure A-27, Appendix A). Although several benefits of the project are described, the project is intended to benefit wildlife by protecting habitat that attracts waterfowl, shorebirds, and other wildlife species. The Despain Cattle Ranch and Bird Refuge is a 333-acre parcel located within the boundaries of the study area. The associated conservation easement helps to ensure this area would not be developed in the future, preserving its value for wildlife and agriculture.

Within the vicinity of the study area, there are a number of past and future wetland mitigation projects that affect avian habitat quality and potentially bird abundance and aviation hazard risk near the Provo Airport. Within the study area there are two sites, the Provo City wetland mitigation site (16.7 acres) and the BLB Drywall wetland mitigation site (3.7 acres), that have provided enhancements to existing study area wetlands. A recently issued Individual Permit from the Corps for the proposed Provo Westside Connector arterial road in southwest Provo required 26.4 acres of wetland establishment and 48.6 acres of habitat enhancement in Provo Bay within a 1–2 mile range of the Provo Airport. In the broader Utah Lake environment, the Hobble Creek restoration project in Provo Bay (22 acres) and the Utah Lake Wetlands Preserve (up to 21,750 acres) also provided habitat enhancements supporting wildlife including avian species. The proposed project, depending upon the alternative implemented, would incrementally add somewhere between 300-510 acres of enhanced habitat to lake wide habitat restoration efforts.

Since 2008 the FFSL, the Utah County Weed Control Division, and the Utah Lake Commission have been treating sections of the Utah Lake shoreline to remove Phragmites, tamarisk, and Russian olive. By 2012, 25 miles of shoreline had been treated, with the goal of clearing the whole shoreline (approximately 75 miles) in 10 years (Utah Lake Commission 2013). In particular, large stands of phragmites surrounding the Provo Airport have been treated in recent years and additional treatments are ongoing. This lakewide habitat enhancement will have many benefits for avian species, particularly waterbirds such as pelicans and cormorants, ducks, and shorebirds.

As a component of the JSRIP, carp are being commercially harvested from Utah Lake (JSRIP 2011). Large quantities of fish are off-loaded at two locations, both near the Provo Airport. This important habitat-improvement effort also inadvertently creates a bird attraction for gulls in particular, as well as other FAA-listed species.

The National Audubon Society, in partnership with Birdlife International, administers the Important Bird Areas program throughout the United States. As of 2008 the National Audubon Society reported that over 2,100 state, 9 continental, and 151 global Important Bird Areas had been established to identify, monitor, and conserve a network of sites to help maintain naturally occurring bird populations for which a site-based approach is appropriate. To date, 21 Important Bird Areas covering 2.12 million acres have been established in the State of Utah. Included on the list of Utah Important Bird Areas is Provo Bay, which is located adjacent to the Provo Airport. The Provo Bay Important Bird Areas is described as one of the most important freshwater wetland systems in Utah. The importance of Provo Bay to birds is largely dependent on Utah Lake water elevations. When water elevations are high, birds congregate elsewhere on the lake; however, when lake water elevations are low, habitat in Provo Bay is of considerable importance because it provides birds with flat, shallow foraging areas. It has been suggested that the Provo Bay Important Bird Areas could eventually include approximately 6,400 acres with an average lake elevation of 4,489 feet (Evans and Martinson 2008). The current status of Provo Bay relative to other portions of Utah Lake and other birding hotspots in the State further illustrates the fact that the Provo Airport is located in an area that is widely recognized as being of great significance to both resident and migratory bird communities. As such, the current risk to aircraft from birds associated with wetlands and other attractive habitat that surrounds the airport will remain, independent of proposed project implementation.

3.16.13 Mitigation Measures

Mosquito Abatement

Under any action alternative, the mosquito abatement plan (Appendix C) would be implemented as required mitigation.

Bird-Aircraft Strike Risk

If the proposed project is implemented, the abundance of various bird species is expected to increase or decrease in various seasons and localities. Under certain circumstances, increases together with altered movement patterns could pose implications for public and aviation safety within the aircraft operations area of the Provo Airport.

If the JLAs implement one of the action alternatives in the Record of Decision, the following mitigation measures will be taken.

1. The JLAs will invite USDA Wildlife Services, Provo Airport, and FAA to participate in design of the selected alternative to help identify any wildlife hazard-reduction measures (e.g., plant species, design features) that might be compatible with the delta restoration project.

2. The JLAs will commit to conducting a monitoring and movement study and to mitigating any increased bird-aircraft strike risk caused by the proposed project. The Mitigation Commission will execute an agreement or contract to conduct the baseline monitoring/movement study and mitigation efforts.

3. The JLAs will endeavor to execute an Memorandum of Agreement among Provo City, Provo Airport, USDA Wildlife Services, and the FAA to establish cooperation and coordination among the parties for implementing the monitoring and mitigation efforts.

4. The JLAs will coordinate with FAA and Provo Airport prior to project construction activities to alert them of pending land use changes that may require recalibration of radar systems.

3.16.14 Public Health and Safety Summary

During scoping and through subsequent public involvement activities and agency consultations, concerns have been expressed that the proposed project would increase mosquito production, which would become a nuisance and health risk for area residents and recreationists. Another concern is whether changes in bird species composition, abundance, and movement patterns would result in an increased risk of aircraft-bird strike, given the proximity of the study area to Provo Airport. Under existing conditions, the study area supports significant production of mosquitoes and a majority of bird species that are known to present a risk to aviation; however, any of the action alternatives would create new areas of open water and wetland habitats. Some of these areas would support mosquito production, resulting in the need to mitigate this impact. A mosquito management plan is included as a component of the proposed project (Appendix C).

While many lakewide factors would influence the abundance and diversity of avian species and movement patterns of birds in relation to Provo Airport, none of the action alternatives are anticipated to have an overall net increase in bird abundance for the list of species identified by FAA as of most concern for bird-aircraft strikes. Many species would decrease in overall abundance; however, certain individual species, such as pelicans, would be projected increase in abundance at certain times of the year. Movement patterns might also change as a result of the proposed project. Consequently, the JLAs would continue to coordinate with Provo City, USDA Wildlife Services, and the FAA to carry out appropriate pre- and post-project implementation wildlife monitoring and mitigation.

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3.17 Cultural and Paleontological Resources

Cultural resources include architectural and archaeological resources, which are defined as those physical manifestations or remains of past human activity that are at least 50 years old. The National Historic Preservation Act of 1966, as amended (16 USC § 470 *et seq*.), and implementing regulations (36 CFR § 800 as amended) establish the national policy and procedures regarding cultural resources.

The study area was also evaluated for potential paleontological resources. Paleontological resources, often referred to as fossils, are the remains, traces, or imprints of ancient organisms preserved in or on the Earth's crust that provide information about the history of life on Earth.

3.17.1 Issues Addressed in the Impact Analysis

The study area was determined to have known cultural resources; therefore, cultural resources were determined to be a relevant issue for the proposed action.

Regulatory Setting

Section 106 of the National Historic Preservation Act requires consideration of the effects of federal undertakings on cultural resources. In Utah, regulations related to the Utah Antiquities Act are described in UCA 9-8-404. This act provides protection for "all antiquities, historic and prehistoric ruins, and historic sites, buildings, and objects which, when neglected, desecrated, destroyed or diminished in aesthetic value, result in an irreplaceable loss to the people of this state." The UCA 9-8-404(1)(a) describes agency responsibilities regarding historic properties for State-funded or approved projects in much the same way as Section 106 of the National Historic Preservation Act. The definitions of terms used in UCA 9-8-404 are also the same as those used in 36 CFR 800.

Consultation

In accordance with Section 106 of the National Historic Preservation Act, the JLAs will take into account the effects of this undertaking on cultural resources.

By letter dated March 3, 2011, the Corps designated the Mitigation Commission as the lead federal agency in consultations with the State Historic Preservation Office with regard to compliance with their responsibilities under Section 106 of the National Historic Preservation Act as it applies to Section 404 of the Clean Water Act. The JLAs initially met with State Historic Preservation Office on February 21, 2012. A letter requesting initiation of formal consultation with State Historic Preservation Office pursuant to Section 106 was sent from the JLAs on March 26, 2012, at which time offers were extended to the following entities to be Consulting Parties pursuant to 36 CFR 800.2(c)(5): the Utah Public Lands Policy Coordination Office, the Utah Statewide Archaeological Society, and the Utah Professional Archaeological Council. The JLAs met again with State Historic Preservation Office and the Consulting Parties on June 25, 2014.

In accordance with 36 CFR 800.2(a)(4), a letter dated April 28, 2011, was sent to the following Native American tribes with Notice of Intent to prepare an EIS and an invitation to participate in consultation regarding religious or culturally significant properties:

- Confederated Tribes of the Goshute Reservation
- Northwestern Band of the Shoshone Nation
- Eastern Shoshone Tribe of the Wind River Reservation
- Shoshone-Bannock Tribes of the Fort Hall Reservation
- Skull Valley Band of the Goshute Indians
- Ute Indian Tribe of the Uintah and Ouray Reservation

Follow-up letters were sent to the Tribes listed above on July 23, 2014, along with new letters and invitations to the Zuni and Hopi Nations. The Zuni and Hopi Nations have aboriginal interests in the project area. All of the aforementioned Tribes were contacted by phone in the fall and summer of 2014 and only the Hopi Nation has expressed interest in continued coordination on the proposed project.

In accordance with 36 CFR 800.1, the Advisory Council on Historic Preservation was invited to comment on the undertaking. By letter dated January 30, 2015, the Advisory Council on Historic Preservation has concluded that it does not need to participate in the consultations to resolve adverse effects of the proposed project.

3.17.2 Issues Eliminated from Further Analysis or Addressed in Other Sections

Consultation with the Utah Geological Survey determined that the study area does not have any paleontological localities recorded and has low potential for yielding significant fossil localities. Due to the low likelihood of fossil occurrence, paleontological resources were not evaluated further in the EIS. A discovery clause has been incorporated into project mitigation to assure that construction crews would alert appropriate officials should any fossils be discovered as a result of construction activities.

3.17.3 Area of Potential Effects

The area of potential effects is larger than the project implementation area for any of the action alternatives and was inclusive of the portion of the existing channel where either Option 1 or Option 2 would be implemented. A map of the area of potential effects is depicted in the Programmatic Agreement (Section 3.17.8).

3.17.4 Affected Environment (Baseline Conditions)

The area of potential effects was surveyed for cultural resources in November 2013, to the extent that access was granted by private property owners (LSD 2013). The inventory was conducted by walking parallel 15-meter-wide transects. Transect lines were maintained by following a northing or easting provided by GPS with real-time correction. Spacing between crew members was measured at the beginning of each transect and visual contact between crew members was maintained to ensure consistent spacing. Several natural drainage channels were encountered within the inventory area and these were inspected for exposed subsurface cultural profiles by examining the drainage sidewalls. Several earthen mounds were present in portions of the inventory area. In addition to maintaining parallel 15-meter transects across the mounds, additional inventory was conducted within mounded areas by stopping the inventory line and allowing a crew member(s) to intensively examine each mound as it was encountered. Numerous rodent burrows were also common throughout the area; as they were encountered, excavated dirt piles associated with the burrows were examined for exhumed artifacts.

Prior to the intensive field survey, background research was conducted by reviewing existing publications—including a Class I literature review (Sagebrush Consultants 2011). Electronic files were checked through the Utah Division of State History's GIS database, Preservation Pro, to determine whether additional sites have been identified in the area of potential effects subsequent to the 2011 Class I review. Thirty-two archaeological sites have been recorded within 1 mile of the area of potential effects. The majority of the sites, 25 out of 32, are associated with the prehistoric period. Twenty-two of the prehistoric sites are large habitation sites with numerous artifacts and two prehistoric sites are human burials.

The intensive ground survey (LSD 2013) resulted in the identification of a short segment of a historic ditch that was recommended as not eligible for listing to the National Historic Preservation Act. However, several environmental factors suggest that buried, undocumented, and/or buried portions of known prehistoric sites are present in the area of potential effects. Utah Lake and the Provo River, in particular, provided permanent water and a variety of fish, animal, and plant resources throughout prehistory. Naturally occurring food resources would have been particularly plentiful along the river corridor and in wetlands near the lake. The availability of water and fertile soil also allowed for agriculture and the use of corn and other cultivated plants during the Fremont period (Janetski 1990). The combination of reliable water and food supported high site densities and the establishment of long-term prehistoric villages in the area.

3.17.5 Impacts of the No-Action Alternative

Under the No-Action Alternative, there would be no impacts on cultural resources. However, cultural resource sites that remain in private ownership would not receive the same level of regulatory protection under federal law as they would if held in federal ownership.

3.17.6 Impacts of Action Alternatives

Under Section 106, an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register of Historic Places. An adverse effect occurs when the undertaking alters the eligible property in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative (36 CFR § 800.5).

It is probable that potentially eligible buried prehistoric sites are located within the area of potential effects. Prehistoric residential sites can be large, and considering the presence of previously documented sites of this type in the vicinity, there is a high probability that one or more of these sites would be inadvertently discovered during ground-disturbing activities associated with any of the three action alternatives.

3.17.7 Indirect and Cumulative Impacts

It is not anticipated that the action alternatives would have any indirect or cumulative effects to cultural resources.

3.17.8 Mitigation Measures

A Class III pedestrian survey (LSD 2013) did not identify any eligible cultural resource sites within the surveyed area of the area of potential effects. It was determined, however, that there was a high probability that buried sites would be uncovered during construction. Since those sites are now covered and the effects to historic properties cannot be fully determined prior to selection of an action alternative, it was determined, in consultation with the State Historic Preservation Office and the Consulting Parties and pursuant to 36 CFR 800.14(B0(1)(ii), that a Programmatic Agreement would be the best method for addressing potential impacts to eligible resources. The Programmatic Agreement represents a commitment on the part of the JLAs to implement a plan to mitigate the effects of the undertaking. The Programmatic Agreement includes the development of a testing plan, which would be implemented prior to construction. The purpose of the testing plan is to identify potential subsurface historic properties through the use of hand testing, heavy machinery, or other appropriate methods. Testing would focus on areas of high archaeological probability and/or low ground visibility. If the testing plan results in the identification of eligible resources, then the JLAs would evaluate design changes that would eliminate or minimize impacts. If the impact cannot be fully eliminated through design changes, then a treatment plan would be developed and implemented. The treatment plan would identify nondesign measures that would be implemented to mitigate for residual impacts. The Programmatic Agreement also provides for an archaeological construction inspector to be onsite during construction. If buried resources are uncovered during construction, construction activity would be stopped in the vicinity of the uncovered site and the eligible site would be mitigated in accordance with the treatment plan.

The Programmatic Agreement has gone through several iterations and is in the final stages of review and signing at the printing of this Final EIS. The final signed copy of the Programmatic Agreement will be included with the Record of Decision.

3.17.9 Cultural Resources Summary

It is probable that potentially eligible buried prehistoric sites are located within the area of potential effects. Prehistoric residential sites can be large, and considering the presence of previously documented sites in the nearby vicinity, there is a probability that one or more sites would be discovered during ground-disturbing activities associated with any of the three action alternatives. A Programmatic Agreement has been developed in consultation with State Historic Preservation Office and the Consulting Parties. The Programmatic Agreement represents a commitment on the part of the JLAs to mitigate for the effects of the undertaking.

3.18 Climate Change

3.18.1 Existing Conditions

For more than a century, humans have been adding to the amount of greenhouse gasses in the atmosphere, primarily by burning fossil fuels such as coal, natural gas, oil, and gasoline. The added gases are enhancing the natural greenhouse effect of the atmosphere and likely contributing to an increase in global average temperature and related climate changes (EPA 2012a). In a 2007 report to Utah's Governor (BRAC 2007), a panel of elected officials, agency representatives, scientists, and other key stakeholders advised that it is likely increases in greenhouse gas concentrations are contributing to several climate trends that have been observed in Utah and most of the western United States during the past 50 years. These trends include the following:

- a several-day increase in the frost-free growing season,
- an earlier and warmer spring,
- earlier flower blooms and tree leaf out for many plant species,
- an earlier spring snowmelt and runoff, and
- a greater fraction of spring precipitation falling as rain instead of snow.

Globally, the most prevalent greenhouse gas that enters the atmosphere as a result of human activities is carbon dioxide (CO2); therefore, CO2 is used as a reference for other gases related to their respective global warming potential. Global warming potential refers to the capability of a gas to trap heat in the atmosphere over a 100-year period. Similarly, quantities of various gasses can be measured in CO2 equivalence units (CO2e), a quantity that describes, for a given mixture and amount of greenhouse gasses, the amount of CO2 that would have the same global warming potential when measured over a specified timescale. At present, the United States contributes approximately 6.8 billion metric tons of CO2e per year (EPA 2012b).

The principal source of Utah's greenhouse gas emissions is electricity use, accounting for 37 percent of the State's gross emissions in 2005. The next-largest contributors are the transportation sector (25 percent) and the residential, commercial, and industrial fossil fuel combustion sector (18 percent). The combustion of fossil fuels for electricity generation used in-State and for transportation accounted for 61 percent of Utah's gross greenhouse gas emissions in 2005. Ninety-nine percent of the greenhouse gasses emitted as a result of electricity generation in Utah is caused by the burning of coal (CCS 2007).

3.18.2 Project-Level Effects

Over the long term and under any project alternative, including No-Action Alternative, the study area is unlikely to experience any major changes to land use or human activity that would significantly alter regional greenhouse gas emissions. In particular, the study area is unlikely to experience development that would contribute to increased electricity consumption, either under the No-Action Alternative or any of the action alternatives. Under the No-Action Alternative, the study area is within a flood zone and the majority of lands within the area are protected from development by an existing conservation easement. Motorized equipment is currently used for agriculture purposes, including diesel fuel for pumping. With implementation of an action alternative, motorized construction equipment used for building berms and establishing river channels would contribute a relatively small volume of fossil fuel emissions to the quantity generated annually in the region for a temporary period of time. Depending on the alternative selected, some portion of the study area would be converted to a naturally functioning river delta and function as a carbon sink. These lands would not be developed and would not generate a significant amount of energy consumption over the long term. Therefore, the project action alternatives would provide a net reduction of fossil fuel combustion and other energy consumption in the region and globally.

3.18.3 Cumulative Effects

Due to the diffuse nature of fossil fuel combustion and other energy consumption, significant reductions in greenhouse gas emissions are best accomplished at the level of national policy. On October 5, 2009, President Barack Obama issued Executive Order 13514, directing federal agencies to reduce greenhouse gas emissions. The U.S. Department of the Interior is taking actions that include developing a baseline assessment of department-wide greenhouse gas emissions, installing renewable-energy power sources, increasing energy efficiency at department facilities, purchasing fuel-efficient vehicles, reducing employee travel, and other actions (Interior 2013).

In terms of the potential effects of climate change on natural resources, the U.S. Department of the Interior is taking actions to conduct research, integrate data, and develop adaptive management strategies for the nation’s natural resources (Interior 2013). In terms of western water resources, the U.S. Bureau of Reclamation, under provisions of the SECURE Water Act, is actively involved in assessing risks of climate change and is coordinating closely with other entities to ensure long-term water supplies in the region (Reclamation 2011). Although small from a global perspective, this wetland restoration project, along with other restoration projects like it, would cumulatively help reduce climate change.

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3.19 Irreversible and Irretrievable Commitments of Resources

Materials and fuels used during construction of a selected action alternative would be permanently committed to the project, and lands acquired for the project that are currently used for grazing would no longer be available for that purpose. Funds used for the construction and operation of the project would be permanently committed and would not be available for other purposes.

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PROVO RIVER DELTA RESTORATION PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

Chapter 4: Consultation and Coordination

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CHAPTER 4: CONSULTATION AND COORDINATION

The Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission), the U.S. Department of the Interior's (DOI) Central Utah Project Completion Act Office, and the Central Utah Water Conservancy District (CUWCD) are joint lead agencies (JLAs) in preparing this Environmental Impact Statement (EIS). The JLAs, on behalf of the June Sucker Recovery Implementation Program (JSRIP), have jointly prepared this Final EIS for public review of a proposed stream channel and delta restoration project within the lower Provo River and its interface with Utah Lake to facilitate the recovery of the endangered June sucker (*Chasmistes liorus*) fish species.

The Final EIS has been prepared under the provisions of the National Environmental Policy Act (NEPA) (42 U.S. C. 4321 et seq.) and the Council on Environmental Quality regulations (40 CFR 1500–1508). Public and agency involvement are essential components in developing an EIS. This chapter provides an overview of consultation and coordination at each stage of the process. Copies of correspondence referred to in this chapter are included in Appendix E.

4.1 Project Planning

A substantial amount of interagency coordination preceded the initiation of the NEPA process for the current project. Development of the June Sucker Recovery Plan (USFWS 1999a) was an interagency effort involving the U.S. Fish and Wildlife Service (USFWS), the Utah Division of Wildlife Resources (UDWR), Utah State University, and other entities. The USFWS prepared a programmatic Environmental Assessment (EA) (66 FR 56840, November 13, 2001) related to the decision to form the JSRIP. The EA completed a programmatic analysis of the impacts of implementing the June Sucker Recovery Plan through forming and participating in the JSRIP. The EA led to the decision to establish the JSRIP in 2002 as a joint effort to coordinate the efforts of federal and State agencies in concert with local entities while concurrently allowing water development and operations to continue. The JSRIP has had ongoing interagency coordination in implementing recovery elements and has provided substantial public outreach efforts over its 13-year existence.

The JSRIP, Mitigation Commission, DOI, CUWCD, and other entities have implemented numerous complimentary recovery efforts on the lower Provo River and such efforts are anticipated to continue into the future. Initially, the USFWS developed a Reasonable and Prudent Alternative for the Provo River Project[1] to "avoid the likelihood of jeopardy… and to avoid

[1] The Provo River Project provides a supplemental water supply for the irrigation of 48,156 acres of highly developed farmlands in Utah, Salt Lake, and Wasatch Counties, as well as an assured domestic water supply for Salt Lake City, Provo, Orem, Pleasant Grove, Lindon, American Fork, and Lehi, Utah. The key structure of the project, Deer Creek Dam, is located on the Provo River about 16 miles northeast of Provo, Utah. Provo It forms a reservoir of 152,570 acre-foot capacity. The capacity of the spillway is 12,000 cubic feet per second. Releases are controlled by two tube valves. The outlet works has a capacity of 1,500 cubic feet per second. The other major structures are the power plant at the dam, the 42-mile Salt Lake Aqueduct and Terminal Reservoir, Weber-Provo Diversion Canal, Duchesne Tunnel, Murdock Diversion Dam, Provo Reservoir Canal (now enclosed), Jordan Narrows Siphon and Pumping Plant, and the South Lateral.

destruction or adverse modification of … critical habitat" for June sucker (USFWS 1994). Additional intensive efforts to acquire in-stream flows to benefit June sucker (CUWCD 2004, Stamp et al. 2008) have been ongoing for more than 20 years. An interagency June Sucker Flow Workgroup was established in 1994 and meets each spring to evaluate anticipated runoff conditions based on snowpack conditions, reservoir storage, etc. The workgroup uses a consensus-based approach to determine the timing and quantity of dedicated flows to be released or bypassed to the Provo River that will best support June sucker spawning success and ecosystem maintenance. Detailed flow recommendations for the Provo River to help guide the delivery of the Utah Lake System supplemental flows was completed in 2008 (Stamp et al. 2008). Modifications to the Fort Field Diversion on the lower Provo River were completed in 2009 to improve fish passage.

Leading up to initiation of the NEPA process for the current project, an interdisciplinary team of resource specialists conducted background research and initial site visits in 2008 and 2009. Prior to formal scoping (described in Section 4.3), preliminary meetings and data gathering sessions with other agencies were held as follows:

- January 21, 2009–agency preplanning meeting;
- April 20, 2009–meeting with Provo City Mayor and staff;
- May 20, 2009–meeting with Provo City department staff (public works, recreation, airport, water);
- May 26, 2009–meeting with Utah Department of Natural Resources and UDWR representatives;
- October 1, 2009–meeting with Utah County Commissioners;
- November 17, 2009–meeting with Mountainland Association of Governments;
- November 23, 2009–meeting with Utah Department of Transportation;
- February–March 2010–met with or discussed the project with numerous landowners north of Boat Harbor Drive and west of 3110 West; and
- March 9, 2010–meeting with Provo City Mayor and staff.

4.2 Identification of Cooperating Agencies

Agencies that have jurisdiction or special expertise with respect to any environmental issue for a given project are invited to be cooperating agencies in preparing the EIS (40 CFR 1501.6). Lead agencies have responsibility to invite involvement of all such agencies at the earliest possible time. Cooperating agencies for this EIS are as follows:

- U.S. Fish and Wildlife Service;
- U.S. Army Corps of Engineers (Corps);

- U.S. Bureau of Reclamation (Reclamation);
- Federal Aviation Administration (FAA);
- State of Utah;
- Provo City, Utah; and
- Utah County, Utah.

A Memorandum of Agreement among the JLAs and cooperating agencies was developed that described the roles and responsibilities of the parties involved. A copy of the Memorandum of Agreement is included in the project administrative record.

As described in other sections of this chapter, these and numerous other agencies, organizations, and stakeholders participated in the development of project alternatives, the identification of issues, and the determination of impact assessment methodologies.

4.3 Scoping

"Scoping" is the process of identifying the issues that must be addressed in an EIS. A Notice of Intent to prepare an EIS and announcement of public scoping was published in the Federal Register on March 16, 2010. Direct mailing of the scoping meeting notice was distributed to over 225 agencies, property owners, and other interested parties on the project mailing list. The public scoping comment period extended until April 30, 2010.

A public scoping meeting of March 25, 2010, was announced by official Public Notice in three area newspapers on March 10 and March 21, 2010 (*The Daily Herald*, *The Salt Lake Tribune*, and *The Deseret News*). Thirty-seven persons attended the meeting. Seventeen comment forms, letters, or email messages were received during the formal comment period. Table 4-1 provides a brief summary of the public scoping meeting and subsequent public meetings during the EIS process.

Additional public and agency comments were obtained through a series of meetings with key stakeholders during the formal scoping period, including the following:

- Utah Lake Commission, March 25, 2010;
- Provo City Municipal Council Study Meeting, April 6, 2010;
- presentation at annual assessment meeting of JSRIP, April 27, 2010;
- meeting with Provo City Mayor, the Mayor's staff, and Mr. Dale Despain, landowner, April 28, 2010; and
- meeting with John McMullin, Utah County Engineering Division, April 28, 2010.

Table 4-1. Public meetings during the Environmental Impact Statement (EIS) process.

PUBLIC MEETINGS	PURPOSE	DETAILS
March 25, 2010—public scoping meeting	Provide project overview and identify issues of concern	Notices and advertisement: newspaper ads, press release, direct mailings to nearby neighborhoods, stakeholders, and agencies Attendance: 37 Comments: 17
December 7, 2011—alternatives development open house	Present alternatives selected for detailed analysis, obtain comments on these and options for the existing river channel	Notices and advertisement: newspaper ads, press release, email distribution list, and direct mailing Attendance: 44 Comments: 18
January 12, 2012—public workshop 1	Obtain additional comments and suggestions for existing river channel and recreation opportunities	Notices and advertisement: newspaper ads, press release, email distribution list, and direct mailing Attendance: 100+ Comments: group-level input, see report
January 26, 2012—public workshop 2	Same as first workshop, to accommodate additional persons not able to attend the first workshop due to facility capacity limitations	Notices and advertisement: newspaper ads, press release, email distribution list, and direct mailing Attendance: 71 Comments: group-level input, see report
April 2, 2014—Draft EIS public open house	Opportunity for the public to ask questions about the Draft EIS and provide comments	Notices and advertisement: newspaper ads, press release, email distribution list, and direct mailing Attendance: 54 Comment letters (meeting and subsequent): 29

Scoping issues were summarized in a scoping report (URMCC 2010). These issues guided the development of project alternatives and the determination of issues to be evaluated in detail in the EIS.

A project website and an email distribution list were developed to provide public access to project documents, provide updates, and receive comments outside of public workshops and formal comment periods. A project newsletter was distributed periodically to update all interested parties regarding project developments. Copies of newsletters were posted on the project website.

4.4 Alternatives Development Process

The determination of alternatives to be evaluated in detail relied upon extensive input from cooperating and participating agencies, potentially affected landowners, other stakeholders, and the public. The alternative development process is described in detail in an *Alternatives Development Technical Memorandum* (URMCC 2011) and summarized here as it relates to consultation and coordination. The Technical Memorandum is available on the project website, www.provoriverdelta.us, or by contacting the Mitigation Commission.

4.4.1 Technical Assistance Team and Technical Memorandum

The alternatives screening process described in the technical memorandum was developed by a Technical Assistance Team (TAT), composed of individuals from federal, state, local, and private organizations with special knowledge or expertise related to the study area and June sucker recovery. The TAT met twice as an entire group to review the project purpose and need and to brainstorm possible alternatives that could possibly meet the purpose and need. Through these meetings and follow-up individual meetings, the TAT helped define the project purposes, the range of alternatives, and criteria for evaluating alternatives.

In addition to the TAT and informal consultations with agency personnel, a request for formal comments regarding potential project issues was sent to regulatory agencies that may have an interest or role in the project. These included the Corps, the U.S. Environmental Protection Agency (EPA), USFWS, Federal Emergency Management Agency, and State of Utah resource agencies. The Technical Memorandum was finalized in October 2011 (URMCC 2011), summarizing involvement of the TAT and the alternatives development process. The TAT process resulted in the initial specification of four delta restoration action alternatives to be evaluated in detail in the EIS.

As another component of the alternatives development process, a technical assistance group comprised of individuals with particular interest in recreation and the existing Provo River Channel met on April 21, 2011, to discuss ideas for the existing lower Provo River channel. Participating entities included Provo City, Utah County, UDWR, USFWS, EPA (via telephone), the Utah Division of Forestry, Fire, and State Lands, and outdoor recreation interest groups. In addition to discussing options for the physical characteristics of the channel, the group discussed recreation opportunities that could be accommodated with each option.

Based on input from the group, the JLAs developed preliminary concepts for the existing river channel area. These concepts were then presented to the public in newsletters and workshops, as detailed below.

4.4.2 Public Involvement Activities Related to Alternatives Development

A status update newsletter was sent in early November 2011 to local area residents and others on the project electronic and postal mailing lists. The distribution list included residents of neighborhoods near the study area, attendees from the public scoping meeting, stakeholder interest groups, and everyone else who had requested to receive notices. (Including cooperating agencies, the combined distribution lists had approximately 315 individuals.)

A second newsletter was sent in late November 2011 to announce a public open house scheduled for December 7. The second newsletter also provided detail about the alternatives screening process and provided descriptions of preliminary options for the existing Provo River channel.

The JLAs held a public alternatives development open house on December 7, 2011, to inform the public regarding the alternatives selected for detailed analysis and to obtain comments. Forty-four persons signed the meeting registration form. At the meeting, the public was invited to provide comments either by completing provided comment forms or by writing comments on flip charts positioned at various stations around the room. In total, 18 different ideas were expressed in either comment forms or on the flip charts. These ideas were used by the JLAs to help refine alternatives and impact assessments to be completed for the EIS. At the meeting, the public was also invited to attend additional upcoming workshops in which they could provide more input on options for the existing river channel.

A third newsletter was sent in January 2012 to provide additional background regarding the project need and the project's relationship to water development in Utah.

The JLAs held two public recreation workshops, on January 12 and January 26, 2012, to help refine options for the existing river channel and recreation opportunities associated with the existing trail and the proposed project. These workshops were open to the public. A "save-the-date" announcement of the January 12 workshop was sent to the project email list, and a postcard announcement was mailed to those entities on the list. A news release was also sent to *The Daily Herald*, *The Salt Lake Tribune*, *Deseret Morning News*, KUTV, KSL, KSTU, and KTVX. The January 12 workshop was held at Utah Lake State Park Visitor's Center. One hundred persons signed in, but Utah Lake State Park officials estimated that close to 200 individuals were present. This number could not be accommodated in the meeting space, so persons who did not get into the meeting room were asked to sign up for a second workshop. There were 45 individuals who signed up to participate in the second workshop. In addition to notifying these individuals about the second workshop, invitations were provided through a press release, a notice sent to the project email list, and direct mailing, and a notice posted on the project website. The second workshop was held on January 26 at Lakeview Elementary School. There were 71 individuals that signed in at the second workshop. A report summarizing results of the workshops was completed (Wilkinson Ferrari & Co. 2012) and was made available on the project website in February 2012.

4.4.3 Landowner Meetings and Additional Coordination

Following the public workshops in January 2012, the JLAs arranged for and hosted a number of guided tours of the proposed study area. These tours included Utah Congressional representatives, Utah County Commissioners, Utah County staff, Provo City Council, other political leaders, landowners and businesses. The JLAs and affiliated agency representatives from the JSRIP also participated in several additional meetings with groups such as Utah County Republican Caucus, various State of Utah department leaders, the editorial boards of the three area daily newspapers, and other interest groups. These additional tours and meetings were helpful in identifying additional issues to be addressed in the refinement of the alternatives and ultimately in preparation of the Draft EIS.

In January 2012 the JLAs reached out to local Congressional leaders for their assistance in arranging a meeting among the JLAs and several key landowners and business operators who would appear to be directly affected by implementing the preliminary draft alternatives. The purpose and focus was to gather additional input from those persons and businesses that would be most directly affected by restoring a delta interface at the mouth of the Provo River, whether by acquisition of their private land for the project, or by direct effect on adjacent businesses. This led to a number of brainstorming sessions among the landowners and business operators with JLA staff and consultants. At times local political leaders also attended the meetings. The input received during the meetings from January 2012 through February 2014 led to revisions to one of the preliminary alternatives, and dropping of another alternative from the list to be carried forward for detailed analysis. The meetings were very constructive and many good ideas were generated, which have been incorporated in the Draft EIS and Final EIS. An additional landowner update meeting was held on March 18, 2015, prior to public release of the Final EIS.

4.4.4 Revisions to Alternatives based on Public and Stakeholder Input

Input obtained from the public, local landowners, and agencies resulted in revision of the alternatives carried forward for detailed analysis. Specifically, Alternative B was revised through an iterative process in consultation with study area landowners and business operators. It was developed with the intention of minimizing the amount of private, agricultural land necessary for meeting the project needs. A previous version of Alternative A, which included acquisition of the land west of Alligator Park between Boat Harbor Drive and the Provo River for proposed recreational developments was eliminated from further consideration. Alternative D (which was the same as Alternative A with respect to the delta restoration component but excluded the area between Boat Harbor Drive and the Provo River) was retained as the Alternative A evaluated in detail in the Draft and Final EIS.

Various options for the existing Provo River channel were also considered. Following public meetings described in Section 4.4.2, additional information was obtained regarding the existing Provo River channel vegetation community and groundwater elevations in the proposed study area. Expanded water quality data were also collected through September, 2014. The JLAs also evaluated available surface water supplies to determine amounts that would potentially be available to maintain some flow in the existing river channel. These efforts resulted in improved and more detailed designs for the existing river channel options that were advanced for detailed analysis.

4.5 Development of the Draft Environmental Impact Statement (EIS)

The Draft EIS was developed with ongoing coordination between the JLAs, the cooperating agencies, and other entities as appropriate. Internal JLA coordination meetings were held weekly to assess progress and to identify and respond to ongoing agency and stakeholder consultation needs. Cooperating agencies were asked to review and respond to chapter drafts as they were developed. The JLAs involved all appropriate federal, state, and local agencies and stakeholder groups in developing impact assessment methods and data collection efforts, as summarized here. Consultations are documented in the project administrative record.

To assess hydrologic changes and stream channel conditions, available existing information from United States Geological Survey streamflow gage data for the lower Provo River, the Utah Lake System EIS (CUWCD 2004), the lower Provo River ecosystem flow recommendations report (Stamp et al. 2008), Central Utah Water Conservancy District gage data for Utah Lake, the Utah Lake Distribution Plan (UDWRT 1992), and United States Geological Survey hydrogeology information for the area (Anderson et al. 1994, Cederberg et al. 2009) were collected and examined. To supplement this existing information, water level stage recorders were installed on Utah Lake and in 31 groundwater monitoring wells installed in the study area. Property owners and Provo City staff were also contacted to acquire additional information regarding irrigation ditches and pumping practices in the study area. A hydraulic model was developed for the study area to predict water surface elevations during various flooding scenarios under the action alternatives and the No-Action Alternative. Coordination occurred with Federal Emergency Management Agency, Utah County, and Provo City in assessing potential changes to study area floodplains. The Utah Division of Water Quality was consulted to help identify water quality issues and develop criteria for evaluation. Coordination occurred with the Natural Resources Conservation Service and the Utah Department of Agriculture and Food in evaluating study area soils, geology, and farmland impacts.

Existing fishery resources in the lower Provo River/Utah Lake interface were characterized by reviewing recent studies and monitoring reports by the UDWR, JSRIP, and by consulting regional fisheries biologists. Fish communities were assessed by determining each species' unique life history requirements, their current status in the systems, and their functional niche occupancy (i.e., what role a species plays within the system). Additionally, empirical evidence from similar drainage systems was incorporated to help predict the effects of each alternative. An interdisciplinary team of fisheries biologists also assisted in developing criteria for evaluating project alternatives, as documented in the *Alternatives Development Technical Memorandum* (URMCC 2011).

The wildlife assessment is based on a literature review of general habitat requirements for species common to Utah County and site visits by a wildlife resources specialist to identify existing habitats and habitat conditions. Database sources, such as the Utah Conservation Data Center (UDWR 2014) and eBird.org (National Audubon Society and Cornell Lab of Ornithology 2011) provided additional information about habitats and species occurrences.

During scoping and through subsequent interagency consultations, concern was expressed about the potential for increased risk of bird-aircraft strikes in association with air traffic at Provo Airport. Several approaches were taken to evaluate bird-aircraft strike risk and assessment methods were developed in consultation with wildlife specialists from the FAA and U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service, Wildlife Services (USDA Wildlife Services). A technical memorandum was prepared in support of the Draft EIS and was subsequently updated (URMCC 2015b) in support of additional information and analyses that are included in this Final EIS.

Information on mosquito breeding, habitats and treatments in Utah County was obtained from the Utah County Health Department and available literature. Through a funded agreement with the Utah County Health Department, two mosquito-monitoring stations were added in the project study area. Mosquitos were trapped from the first week in June through the second week of September 2013. A draft mosquito management plan was reviewed by the Utah Department of Health in 2012. The plan was revised to incorporate their recommendations. Under any of the action alternatives, this mosquito abatement plan would be implemented (Appendix C).

Potential land use and socioeconomic effects were evaluated using available information on land use from Provo City and Utah County community planning documents and through consultations with personnel from relevant departments at the city and County.

Existing recreation opportunities and potential recreation enhancements were determined in consultation with state agencies (Utah Division of State Parks and Recreation, UDWR, and Utah Division of Forestry, Fire, and State Lands), local governments (Utah County and Provo City), and private citizens. This TAT group (described in Section 4.4) also assisted with identifying recreation resources and opportunities in the study area and vicinity.

An administrative review copy of the Draft EIS was made available to cooperating agencies prior to release of the public Draft EIS and a meeting was held with those agencies on September 12, 2013. Comments on the administrative draft document were received from the USFWS, Corps, FAA, Provo City, Utah County, Utah Division of Water Quality, Utah Division of State Parks and Recreation, Utah Department of Natural Resources, and the UDWR.

4.6 Additional Coordination and Analysis Supporting the Final Environmental Impact Statement (EIS)

4.6.1 Recreation Facilities and Long-Term Ownership and Management

Several public comments on the Draft EIS (Appendix F) requested inclusion of an equestrian trail as a project component. A comment letter from Provo City also suggested an additional trail segment and an additional parking area/trailhead. The JLAs met with representatives of Provo City's planning and recreation departments on December 9, 2014, and with a similar group from Utah County on January 6, 2015.

In response to comments from Provo City, an additional new parking area and a new trailhead were added to the proposed project near the existing river channel. Also, in response to Provo City comments, an additional trail segment to the Utah Lake shoreline was added as a component of Alternatives A and B. This trail segment would be built only if and when the proposed Provo Lakeview Parkway and Trail are constructed. In response to public comments, an unpaved trail that would be appropriate for equestrian use was also added. Provo City and Utah County agreed that the equestrian trail would be an asset and could be integrated into their plans for recreation facilities in the area. Provo City and Utah County were also agreeable to assuming long-term ownership and management of trails and parking areas that would be constructed within their respective jurisdictions.

4.6.2 Water Quality

Following release of the Draft EIS, the JLAs responded to comments from the EPA concerning the adequacy of water quality impact assessments and the feasibility of aeration as a means of improving existing water quality problems in the lower Provo River (existing channel). Coordination efforts included several site visits with water quality experts from the University of Utah and the Utah Division of Water Quality, follow-up correspondence, and two additional studies.

In the first additional study, the JLAs contracted with the University of Utah to complete a sediment oxygen demand study to further understand causes of existing water quality problems in the lower Provo River (Goel et al. 2014). Results of the study, summarized in detail in Chapter 3, Section 3.4.4, confirmed that proposed aeration for the existing channel would improve water quality conditions.

In the second additional study, the JLAs further investigated the technical requirements and feasibility of proposed aeration by contracting with an aeration expert to visit the site and provide a technical feasibility report (Kling 2014). The report describes recommended aeration equipment for the physical characteristics of the lower Provo River channel and the feasibility of relying on aeration in the lower Provo River to maintain State water quality standards for dissolved oxygen.

These two additional studies improved understanding of the existing water quality problems in the lower Provo River and confirmed the technical feasibility of the proposed aeration strategy as a component of the two proposed options for retaining the existing river channel as a recreation resource.

4.6.3 Bird-Aircraft Strike Risk Hazard Mitigation

Various meetings, conference calls, and correspondence occurred between the development of the Draft EIS and Final EIS involving the JLAs and Provo City/Provo Municipal Airport, USDA Wildlife Services, and the FAA. Objectives of this coordination were to review proposed additions and modifications to the bird-aircraft strike risk impact assessment and to develop a Memorandum of Agreement.

Key meetings and exchanges included the following:

- December 5, 2012–The JLAs and others met with FAA Air Traffic Control in Salt Lake City to discuss the proposed project and obtain feedback from FAA regarding potential impacts. The radar systems at Provo Airport were discussed, as was the possible need to recalibrate them following implementation of the project, and references from FAA in Denver were obtained.

- August 22 and November 6, 2013–The JLAs and others met with USDA Wildlife Services to discuss the proposed project and request input and guidance. Conducted field tour of the study area on August 26, 2013.

- December 6, 2013–The Mitigation Commission met with the FAA in Denver to provide an overview of the proposed project and discuss project concerns.

- January 28, 2014–The JLAs, USDA Wildlife Services, and Provo Airport met with the FAA in Denver to discuss concerns regarding the proposed project and development of a Memorandum of Agreement to guide monitoring and mitigation measures.

- May 6, 2014–Utah Valley University Aviation Sciences Program and Provo Municipal Airport invited representatives of the JLAs to discuss aviation safety concerns and see the study area from the perspective of aircraft using the Provo Airport. Representatives of Utah Valley University provided pilots and aircraft.

- July 30, 2014–A follow-up meeting was held with Provo City Airport and Utah Valley University to discuss bird movement monitoring and mitigation for the entire airport vicinity, including the study area, using a combination of ground- and air-monitoring techniques.

Following these interactions, Provo City provided the JLAs with a copy of its completed wildlife hazard assessment (Airport Wildlife Consultants 2014), and Utah Valley University provided data from its bird strike records at Provo Airport from 2012 to 2013. The JLAs added information to Chapter 3 (Section 3.16) based on these additional sources. Further development of this cooperative monitoring and mitigation plan potentially involving Utah Valley University was not pursued at the university's request.

- September 3, 2014–The Mitigation Commission met with FAA in Denver to update the FAA on the status of the Final EIS and request that FAA provide a list of key points needed in the monitoring/mitigation Memorandum of Agreement.

- Summer and fall, 2014–The JLAs exchanged numerous correspondence and phone calls with USDA Wildlife Services in Salt Lake City and USDA Wildlife Services' Ohio Field Station to discuss ideas for monitoring avian wildlife movement patterns near airports. These ideas were further developed into a monitoring plan.

- October to November, 2014–The JLAs worked with the USDA Wildlife Services to review a draft monitoring plan. A draft Interagency Agreement was prepared for the reimbursement of monitoring and mitigation costs and sent to USDA Wildlife Services for review. The Interagency Agreement was not executed.

- December 9, 2014–The JLAs met with Provo City and Provo Airport to present and discuss the draft Memorandum of Agreement regarding monitoring and mitigation.

- March 10–21, 2015–Several conference calls were held involving the JLAs, FAA, Provo City, and USDA Wildlife Services to discuss the draft MOA and develop a final MOA.

4.7 Coordination Related to Specific Federal Laws, Regulations, and Executive Orders

4.7.1 Fish and Wildlife Coordination Act, P.L. 85-624

The JLAs coordinated with the USFWS regarding impacts to wildlife resources and habitat. The USFWS participated as a cooperating agency from the early stages of the project, assisting with identification of relevant issues and assessment methods, specification of project purpose and need, and the range of alternatives evaluated.

4.7.2 Endangered Species Act of 1973, P.L. 93-205

The USFWS participated as a cooperating agency throughout development of the EIS. The JLAs and the FWS met on May 16, 2013, to discuss information and analyses needed for Section 7 compliance. A Biological Assessment was developed and submitted to the USFWS between release of the Draft EIS and the Final EIS. A meeting was held between the JLAs and the USFWS on February 6, 2015, to discuss finalization of the Biological Assessment, proposed conservation measures for Ute Ladies'-tresses (*Spiranthes diluvialis*), and completion of a Biological Opinion from the USFWS. The Final EIS (Chapter 3, Section 3.9) includes the JLA's determinations of effect and all proposed conservation measures for threatened and endangered species.

4.7.3 National Historic Preservation Act of 1966, P.L. 89-665, as amended by P.L. 95-515

The JLAs met with the State Historic Preservation Office (SHPO) on February 21, 2012. A letter requesting initiation of formal consultation with SHPO, pursuant to Section 106, was sent from the JLAs on March 26, 2012, at which time offers were extended to the following entities to be Consulting Parties pursuant to 36 CFR 800.2(c)(5): the Utah Public Lands Policy Coordination Office, the Utah Statewide Archaeological Society, and the Utah Professional Archaeological Council. By letter dated March 3, 2011, the Corps designated the Mitigation Commission as the lead federal agency in consultations with the SHPO with regard to compliance with their responsibilities under Section 106 of the National Historic Preservation Act as it applies to Section 404 of the Clean Water Act. The JLAs met again with SHPO and the consulting parties on June 25, 2014. In accordance with 36 CFR 800.1, the Advisory Council on Historic Preservation was invited to comment on the undertaking. In a letter dated January 30, 2015, the Advisory Council on Historic Preservation concluded that its participation was not needed in the consultations to resolve adverse effects of the undertaking. Consultation with SHPO and the consulting parties resulted in the development of a Programmatic Agreement, which is described in more detail in Section 3.17.8. The Programmatic Agreement represents a commitment on the part of the JLAs to mitigate for the potential effects of the undertaking. If an action alternative is selected, a signed copy of the Programmatic Agreement will be included with the Record of Decision.

Consultation with the Utah Geological Survey determined that the study area did not have any paleontological localities recorded and had low potential for yielding significant fossils.
An intensive Class III survey of features within the area of the selected alternative will be completed for areas that have not been surveyed prior to project implementation according to the

terms of the Programmatic Agreement negotiated among the JLAs, SHPO, and consulting parties.

4.7.4 Clean Water Act of 1977 (P.L. 95-217) and Executive Order 11990, Protection of Wetlands

A water quality analysis has been prepared and integrated in this EIS. A general construction activity stormwater permit (401 Certification) would be required for implementing the project. This is included in the list of required permits in Chapter 1, Section 1.6.

A detailed wetland analysis has been incorporated into this EIS (Chapter 3, Section 3.5) and was developed in consultation with the EPA, Corps, and other appropriate entities. Coordination of evaluating wetland impacts included:

- coordinating with the Corps to obtain a preliminary jurisdictional determination of existing wetlands;
- completing a wetland functional assessment, in consultation with the Corps, USFWS, and UDWR; and
- conducting a field trip and site review with the EPA, USFWS, and Corps on June 10, 2014.

4.7.5 Executive Order 11988, Floodplain Management

Floodplain modifications and potential impacts on flooding hazards in the study area vicinity have been analyzed in this EIS (Chapter 3, Section 3.2) in consultation with federal, state, and local authorities.

4.7.6 Executive Order 12898, Environmental Justice

Under this executive order, federal agencies are required to identify and address any disproportionately high and adverse human health or environmental effects of programs, policies, and activities on minority and low-income populations. Agencies must also ensure that no persons are excluded from participation in or denied benefits of programs, policies, and activities because of their race, color, or national origin. As evaluated in Chapter 3 (Section 3.14), none of the project alternatives would affect any populated areas and benefits associated with any of the action alternatives would be equally available to all citizens.

4.7.7 Executive Order 13112, Invasive Species

Under any action alternative, a vegetation management plan (Appendix B) would be implemented. During the construction phase, best management practices would be implemented to reduce the potential of construction activity to introduce and spread noxious weeds. These BMPs would be developed and included as a component of construction documents and the Stormwater Pollution Prevention Plan.

4.6.8 *Executive Order 13186, Protection of Migratory Bird Habitat*

Conservation measures to protect migratory birds during project construction have been developed in consultation with the USFWS and UDWR and are included in the list of mitigation measures (Chapter 2, Section 2.10.2).

4.8 Native American Consultation

In accordance with 36 CFR 800.2(a)(4), a letter dated April 28, 2011, was sent to the following Native American tribes with Notice of Intent to prepare an EIS and with an invitation to participate in consultation regarding religious or culturally significant properties:

- Confederated Tribes of the Goshute Reservation,
- Northwestern Band of the Shoshone Nation,
- Eastern Shoshone Tribe of the Wind River Reservation,
- Shoshone-Bannock Tribes of the Fort Hall Reservation,
- Skull Valley Band of the Goshute Indians, and
- Ute Indian Tribe of the Uintah and Ouray Reservation.

Follow-up letters were sent to the Tribes listed above on July 23, 2014, along with new letters and invitations to the Zuni and Hopi Nations. The Zuni and Hopi Nations have aboriginal interests in the study area. All of the aforementioned Tribes were contacted by phone in the fall and summer of 2014, and only the Hopi Nation has expressed interest in continued coordination on the proposed project.

4.9 Indian Trust Assets

Indian Trust Assets are legal interests in assets held in trust by the U.S. government for Native American tribes or individuals. Examples of Indian Trust Assets are lands, minerals, water rights, hunting and fishing rights, other natural resources, money, or claims. An Indian Trust Assets cannot be sold, leased, or otherwise alienated without the approval of the U.S. government. There are no known Indian Trust Assets in the study area.

4.10 Document Distribution

The Draft EIS and Final EIS documents were made available in electronic form on the project website, www.provoriverdelta.us, and on CD-ROM. Notice of availability was provided in the *Federal Register*, local newspapers (*The Daily Herald*, *The Salt Lake Tribune*, and *The Deseret News*), and by direct notice to all persons on the project mailing list. Print copies were made available for on-site public review at the following locations:

Provo City Public Library
550 North University Avenue
Provo, Utah 84601

Salt Lake City Public Library
210 East 400 South
Salt Lake City, Utah 84111

Department of the Interior, Central Utah Project Completion Act Office
302 East 1860 South
Provo, Utah 84606

Central Utah Water Conservancy District
355 West University Parkway
Orem, Utah 84058

Utah Reclamation Mitigation and Conservation Commission
230 South 500 East, Suite 230
Salt Lake City, Utah 84102

Entities that received direct notice of the availability of the Draft EIS and the Final EIS included:

- Cooperating agencies
    - U.S. Fish and Wildlife Service–Utah Field Office
    - U.S. Army Corps of Engineers–Utah Regulatory Office
    - U.S. Bureau of Reclamation–Provo Area Office
    - Federal Aviation Administration
    - State of Utah
    - Provo City
    - Utah County
- Other federal, State, and local agencies
    - Mountainland Association of Governments
    - U.S. Department of Agriculture–Natural Resources Conservation Service
    - U.S. Department of Agriculture–Animal and Plant Health Inspection Service, Wildlife Services
    - Utah Governor's Public Lands Policy Coordination Office and Resource Development Coordinating Committee (RDCC)[2]
    - Utah Lake Commission
    - Utah State Historic Preservation Office
- Elected officials
    - Provo City Mayor John Curtis
    - Utah County Commissioners

[2] The RDCC is the clearinghouse for State agencies in Utah; personnel from various State agencies that had involvement with resource issues and analysis methods also received direct notice.

- Utah State Legislature, Senator Deidre Henderson (District 7) and Representative Keith Grover (District 61)
- U.S. House of Representatives, Representative Jason Chaffetz (District 3)
- U.S. Senate, Senators Orrin Hatch and Mike Lee

- Tribes
  - Confederated Tribes of the Goshute Reservation
  - Northwestern Band of the Shoshone Nation
  - Eastern Shoshone Tribe of the Wind River Reservation
  - Shoshone-Bannock Tribes of the Fort Hall Reservation
  - Skull Valley Band of the Goshute Indians
  - Ute Indian Tribe of the Uintah and Ouray Reservation

- Private organizations
  - Brigham Young University
  - Friends of the Great Salt Lake
  - Lake Bottom Irrigation Company
  - National Audubon Society
  - Provo River Water Users Association
  - Questar Gas
  - Rocky Mountain Anglers
  - Sierra Club
  - Southern Utah Wilderness Alliance
  - Stonefly Society
  - Strawberry Anglers/Friends of Strawberry Valley
  - Terra Firma University of Utah
  - The Nature Conservancy
  - Trout Unlimited
  - Utah Bass Federation
  - Utah County Birders
  - Utah Nature Study Society
  - Utah Open Lands
  - Utah Professional Archaeological Council
  - Utah Rivers Council
  - Utah Statewide Archaeological Society
  - Utah Waterfowl Association
  - Utah Wetlands Foundation
  - Visions of Utah Lake
  - Water Watch of Utah
  - Western Rivers Fly Fishing

- Other interested parties
    - Potentially affected landowners, nearby residents, and neighborhood council representatives
    - Private citizens who had previously provided comments, attended meetings, or requested to receive information about the project

4.11 Public Review Periods

A 60-day comment period was provided when the Draft EIS was released for public review; information on how to comment and a comment deadline were provided on the Draft EIS cover page. Comments received assisted the JLAs in making revisions, clarifications, and updates to the project alternatives, impact assessments, and mitigation measures, as presented in this Final EIS. Individualized meetings were held with cooperating agencies between publication of the Draft and Final EIS to clarify the comments provided by each of the agencies and propose to address comments. Appendix F includes copies of all comments received; JLAs have provided responses indicating how comments have been addressed in this Final EIS.

A Record of Decision will be issued no sooner than 30 days following release of the Final EIS.

4.12 List of Preparers

The persons listed in Table 4-2 contributed to preparation of the EIS.

Table 4-2. List of preparers.

NAME	TITLE	CONTRIBUTION
Utah Reclamation Mitigation and Conservation Commission		
Mark Holden, M.S.	Project Manager	Project management and coordination
Richard Mingo, M.S.	Project Coordinator	Project coordination, maps, figures, website, and newsletters
Michael Weland, J.D.	Executive Director	Project review
Maureen Wilson, M.S.	Project Coordinator	Vegetation management and mosquito abatement plans, project review
U.S. Department of the Interior–Central Utah Project Completion Act Office		
Lee Baxter, M.S., P.E.	Program Coordinator	Project review
W. Russ Findlay, M.S.	Program Coordinator	Project oversight
Reed Murray, M.S.	Program Director	Project review
Central Utah Water Conservancy District		
Sarah Johnson, B.S.	Environmental Programs Manager	Project coordination, NEPA oversight
Mike Mills, M.S.	June Sucker Recovery Implementation Program Local Coordinator	Project coordination, oversight, and review
Reed Oberndorfer, Ph.D.	Water Quality Director	Water quality data collection support
Gene Shawcroft, M.S., P.E.	General Manager	Project review

Table 4-2. Continued.

NAME	TITLE	CONTRIBUTION
BIO-WEST, Inc.		
Brandon Albrecht, M.S.	Senior Fisheries Biologist and Aquatic Ecologist	Fisheries analysis
Gary Armstrong, M.A.	NEPA Specialist	Recreation, land use, farmlands, and utilities
Glen Busch, M.S.	GIS Analyst and Planner	Spatial analysis and maps
Mary Cheney, B.S.	Wildlife Biologist	Avian surveys and analysis
Sandy Davenport, M.L.A.	Landscape Architect and Planner	Maps and illustrations
Alyson Eddie, B.S.	Ecologist	Vegetation surveys and analysis
Craig Fosdick, M.S.	Wildlife Biologist	Avian surveys and analysis
Elise Guymon, B.S.	Assistant Editor	Document preparation
Sean Keenan, Ph.D.	NEPA Specialist	Assistant project management, socioeconomic analysis, document preparation
Darren Olsen, M.S.	Project Manager and Senior Hydrologist	Project management, hydrology, geomorphology, water quality, project design
Zachary Shattuck, M.S.	Senior Fisheries Biologist and Aquatic Ecologist	Fisheries analysis
Mike Sipos, M.S.	Senior Wildlife Biologist	Wildlife analysis
Melissa Stamp, M.S.	Watershed Scientist	Hydrology, channel surveys, water rights, water quality analysis
Bob Thomas, B.S.	Professional Wetland Scientist	Wetland delineations and analysis
Sandra Livingston Turner, B.S.	Managing Editor	Document preparation
Chadd VanZanten, B.S.	Editor	Document preparation
Allred Restoration, Inc.		
Tyler Allred, M.S.	Watershed Scientist	Hydrology, hydraulic modeling, groundwater monitoring, project design
Logan Simpson Design, Inc.		
Danny Mullins, M.S., R.P.A.	Director of Cultural Resources	Class III Cultural Resources Inventory
Sagebrush Consultants, Inc.		
Mike Polk, M.A., R.P.A.	Principal Archaeologist	Class I Cultural Resources Inventory
Wendy Simmons Johnson, M.A.	Senior Archaeologist	Class I Cultural Resources Inventory
Utah State University College of Engineering		
Robert Pack, Ph.D.	Research Associate Professor	LiDAR Imaging
University of Utah Civil and Environmental Engineering		
Ramesh Goel, Ph.D.	Associate Professor	Sediment oxygen demand study
Mitch Hogsett, Ph.D.	Graduate Student	Sediment oxygen demand study
Sachiyo Tanaka Mukherjee, Ph.D.	Research Scientist	Sediment oxygen demand study
CLEAN-FLO International		
Brian Kling, PE	Engineer	Aeration feasibility

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Chapter 5: References

CHAPTER 5: REFERENCES

Airport Wildlife Consultants. 2014. Wildlife hazard assessment for the Provo Municipal Airport. Cave Creek (AZ): Airport Wildlife Consultants, LLC. 44 p.

Albrecht, B., P.B. Holden, R.B. Kegerries, and M.E. Golden. 2010a. Razorback sucker recruitment in Lake Mead, Nevada-Arizona, why here? Lake and Reservoir Management 26:336-344.

Albrecht, B., R. Kegerries, P. Holden, and R. Rogers. 2010b. Razorback sucker investigations at the Colorado River inflow area Lake Mead, Nevada and Arizona. Logan (UT): U.S. Bureau of Reclamation. PR-1310-1.

Aldrich, T.W., and D.S. Paul. 2002. Avian ecology of Great Salt Lake. Pages 343–374 *in*: Gwynn, J.W. editor. Great Salt Lake: an overview of change. Salt Lake City: Utah Department of Natural Resources, Utah Geological Survey.

Allan, J.D. 1995. Stream ecology: structure and function of running waters. Dordrecht, Netherlands. 388 p.

Allred, T. 2013. HEC RAS model of the existing and proposed lower Provo River. Hydraulic modeling report provided to BIO-WEST, Inc., by Allred Restoration, Inc., describing water surface elevations within and upstream of the study area under project alternatives and various lake and streamflow scenarios.

Anderson, B.W., and S.A. Laymon. 1989. Creating habitat for the yellow-billed cuckoo (*Coccyzus americanus*). USDA Forest Service General Technical Report PSW-110.

Anderson, P.B., D.D. Susong, S.R. Wold, V.M. Heilweil, and R.L. Baskin. 1994. Hydrogeology of recharge areas and water quality of the principal aquifers along the Wasatch Front and adjacent areas, Utah: U.S. Geological Survey water-resources investigations report 93-4221, plates 1–5. Salt Lake City: U.S. Geological Survey.

Anderson, S.H., and K.J. Gutzwiller. 1994. Habitat evaluation methods. Pages 592–606 *in* T.A. Bookhout, editor. Research and management techniques for wildlife and habitats. Fifth edition. Bethesda (MD): The Wildlife Society.

Arft, A.M. 1995. The genetics, demography, and conservation management of the rare orchid *Spiranthes diluvialis* [Ph.D. dissertation]. Boulder (CO): University of Colorado. 170 p.

Beckstrom, G. 2011. Deputy public works director, Provo City Public Works Department. Personal communication with Melissa Stamp of BIO-WEST, Inc., Logan, Utah, regarding function and operational practices of pumping facility near Harbor Drive and 3100 West. 01/06/2011.

Belk, M., S. Peck, and G. Borrowman. 2004. Life-stage model for June suckers: a report submitted to the June Sucker Recovery Program. Provo (UT): Department of Integrative Biology, Brigham Young University. 20 p.

Belliston, N., R. Whitesides, S. Dewey, J. Meritt, and S. Burningham. 2009. Noxious weed field guide for Utah. Logan (UT): Utah State University Extension Service and Uintah County Weed Department. 65 p.

[BIO-WEST] BIO-WEST, Inc. 2015. Provo River delta restoration wetland functional assessment. Logan (UT): BIO-WEST, Inc. 66 p.

[BIO-WEST] BIO-WEST, Inc. 2013. Provo River Delta restoration project Ute ladies'-tresses surveys. Salt Lake City: Utah Reclamation Mitigation and Conservation Commission. 14 p.

Blockpoel, H. 1976. Bird hazard to aircraft. Buffalo (NY): Books Canada, Inc.

[BRAC] Blue Ribbon Advisory Council on Climate Change. 2007. Climate change and Utah: the scientific consensus. *In*: Blue Ribbon Advisory Council on Climate Change report to Governor Jon M. Huntsman, Jr. Salt Lake City: Utah Governor's Office. 31 p.

Brotherson, J.D. 1981. Aquatic and semiaquatic vegetation of Utah Lake and its bays. Great Basin Naturalist Memoirs, No. 5. Provo (UT): Brigham Young University.

Buelow, K.A. 2006. Movement behavior and habitat selection for the endangered June sucker (*Chasmistes liorus*) in Utah Lake, Utah [MS Thesis]. Logan (UT): Utah State University.

Burdick, S.M., and D.T. Brown. 2010. Distribution and condition of larval and juvenile Lost River and shortnose suckers in the Williamson River delta restoration project and upper Klamath Lake, Oregon: 2009 annual data summary. U.S. Geological Survey Open-File Report 2010-1216. Reston (VA): U.S. Geological Survey. 78 p.

Bursik, R., and B. Moseley. 1992. Prospectus for the valley peat wetlands ecosystem project, Idaho. Boise: Conservation Data Center, Idaho Department of Fish and Game, September. 17 p.

Carter, D.R. 2003. Utah Lake: Legacy. Salt Lake City: June Sucker Recovery Implementation Program. 165 p.

Cassel, M., and R. King (PSOMAS). 2005. Memorandum (15 July 2005) to Dave Wham, Utah Division of Water Quality, regarding Utah Lake TMDL data validation and evaluation. 169 p. Available online: http://www.waterquality.utah.gov/TMDL/UtahLake_Task1memo07-15-05.pdf.

[CCS] Center for Climate Strategies. 2007. Final Utah GHG inventory and reference case projections, 1990–2020. Salt Lake City: Utah Department of Environmental Quality. 13 p.

Cederberg, J.R., P.M. Gardner, and S.A. Thiros. 2009. Hydrology of northern Utah Valley, Utah County, Utah, 1975–2005. Scientific investigations report 2008–5197, v. 2.0, February. Reston (VA): U.S. Geological Survey. 114 p.

Chadde, S.W., J.S. Shelly, R.J. Bursik, R.K. Moseley, A.G. Evenden, M. Mantas, F. Rabe, and B. Heidel. 1998. Peatlands on national forests of the northern Rocky Mountains: ecology and conservation. General technical report RMRS-GTR-11. Ogden (UT): U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 75 p.

Chapra, S.C. 2008. Surface water-quality modeling. Long Grove (IL): Waveland Press. 844 p.

Cleary, E.C., and R.A. Dolbeer. 2005. Wildlife hazard management at airports: a manual for airport personnel. U.S. Department of Agriculture, National Wildlife Research Center, staff publications. Paper no. 133. 348 p.

[Conservation Data Center] Idaho Department of Fish and Game Conservation Data Center. 1992. Valley peatlands ecosystem project, Idaho. Boise: Idaho Department of fish and Game.

Cooper, D.J., L.H. MacDonald, S.K. Wenger, and S. Woods. 1998. Hydrologic restoration of a fen in Rocky Mountain National Park, Colorado. Wetlands 18: 335–345.

Cooperman, M.S., and D.F. Markle. 2004. Abundance, size, and feeding success of larval shortnose suckers and Lost River suckers from different habitats of the littoral zone of upper Klamath Lake. Environmental Biology of Fishes 71:365–377.

Cowardin, L.M., V. Carter, F.C. Golet, E.T. Laroe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/classwet/classwet.htm (Version 04DEC98)

Coyner, J. 1991. The Ute ladies'-tresses, *Spiranthes diluvialis*. Survey report prepared for the Bureau of Land Management and Red Butte Gardens. Salt Lake City: University of Utah.

Coyner, J. 1990. Report for population study: *Spiranthes diluvialis*. Mutual project between the Bureau of Land Management and Red Butte Gardens. Salt Lake City: University of Utah.

Crowl, T.A., H.M. Thomas, and D. Vinson. 1998. June sucker and Utah Lake fisheries management studies: 1995–1997. Final report. Salt Lake City: Utah Division of Wildlife Resources and Central Utah Commission. 112 p.

[CUWCD] Central Utah Water Conservancy District. 2007. Utah Lake water level fluctuation study. Final report, project no. III.05.07. Orem (UT): Central Utah Water Conservancy District. 94 p.

[CUWCD] Central Utah Water Conservancy District. 2004. Utah Lake drainage basin water delivery system final Environmental Impact Statement. Orem (UT): Central Utah Water Conservancy District.

[CUWCD] Central Utah Water Conservancy District, Utah Department of Natural Resources, U.S. Fish and Wildlife Service, Utah Reclamation Mitigation and Conservation Commission, U.S. Department of the Interior, U.S. Bureau of Reclamation, Provo River Water Users Association, Provo Reservoir Water Users Company, and Outdoor and Environmental Interests. 2002. Program document for the June Sucker Recovery Implementation Program. Orem (UT): Central Utah Water Conservancy District. 29 p.

[CUWCD] Central Utah Water Conservancy District. 1999. Final Supplement to the Final Environmental Impact Statement for the Diamond Fork System. Orem (UT): Central Utah Water Conservancy District.

eBird. 2012. Cornell Laboratory of Ornithology and National Audubon Society. 2012. eBird: An online database of bird distribution and abundance. Ithaca, New York. <www.avianknowledge.net>. Data accessed: 4/10/2012.

Ellsworth, C.M., M.C. Belk, and C.J. Keleher. 2010. Residence time and drift patterns of larval June sucker (*Chasmistes liorus*) in the lower Provo River as determined by otolith microstructure. Journal of Fish Biology 77:526–537.

[EPA] U.S. Environmental Protection Agency. 7/24/2013. EJView Census 2010 Summary Report. Location: http:// http://www.epa.gov/compliance/ej/mapping.html.

[EPA] U.S. Environmental Protection Agency. Dissolved oxygen, water quality standards criteria summaries: a compilation of state/federal criteria. 1988. Washington (DC): U.S. EPA, Office of Water Regulations and Standards. EPA 460/15-88/024. 34 p.

[EPA] U.S. Environmental Protection Agency. 12/21/2012a. Climate change indicators in the United States, greenhouse gases. Location: http://www.epa.gov/climatechange/science/indicators/ghg/index.html.

[EPA] U.S. Environmental Protection Agency. 2012b. Inventory of U.S. greenhouse gas emissions and sinks: 1990–2010. EPA 430-R-12-001. Washington, D.C.: U.S. Environmental Protection Agency. 481 p.

Erdman, C.S., and H.A. Hendrixson. 2010. Larval Lost River and shortnose sucker response to large scale wetland restoration at the Williamson River Delta Preserve. The Nature Conservancy 2009 annual data summary. Klamath Falls (OR): Klamath Basin Field Office. 38 p.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The birder's handbook: a field guide to the natural history of North American birds. New York (NY): Simon & Schuster, Inc.

Evans, K., and W. Martinson. 2008. Utah's featured birds and viewing sites: A conservation platform for IBAs and BHCAs. Salt Lake City: Sun Litho. 364 p.

[FAA] U.S. Department of Transportation, Federal Aviation Administration. 2/2/2015. Wildlife strike database and reporting system. Location: http://wildlife.faa.gov.

[FAA] U.S. Department of Transportation, Federal Aviation Administration and U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. 2012. Wildlife Strikes to Civil Aircraft in the United States, 1990–2011. Report of the Associate Administrator of Airports, Office of Airport Safety and Standards, Washington, DC, July. 105 p.

[FEMA] Federal Emergency Management Agency. 1/9/2014. Flood insurance rate map community panel number 4955170240A, Effective Date: October 15, 1982. FEMA Map Service Center. Location: https://msc.fema.gov.

[FEMA] Federal Emergency Management Agency. 1988. Flood insurance study, City of Provo, Utah, Utah County. All U.S. Government Documents (Utah Regional Depository). Paper 187.

Fertig, W., R. Black, and P. Wolken. 2005. Rangewide status review of Ute ladies'-tresses (*Spiranthes diluvialis*). Salt Lake City: U.S. Fish and Wildlife Service and Central Utah Water Conservancy District.

Flannery, A.W. 1988. Foraging habitat of white pelicans on Great Salt Lake marshes. [Master's thesis]. Logan: Utah State University.

Forman, R.T., and M. Gordon. 1986. Landscape ecology. New York: John Wiley and Sons.

Gecy, L. 1994. Central Utah Project irrigation and drainage system 1993 *Spiranthes diluvialis* (Ute ladies'-tresses) survey results, Diamond Fork and Spanish Fork Canyons. *In*: Miscellaneous information about Ute ladies'-tresses orchid (*Spiranthes diluvialis*). Proceedings of the Ute ladies'-tresses information exchange meeting. Salt Lake City: Utah Department of Natural Resources and U.S. Fish and Wildlife Service. March 29, 1994.

Gill, M., and B. Peterson. 2013. Employees of Questar Gas. Personal communication with Richard Mingo, Utah Reclamation Mitigation and Conservation Commission, regarding natural gas pipeline segment in the project area. 05/02/2013.

Goel, R., M. Hogsett, and S.T. Mukherjee. 2014. Sediment oxygen demand in the lower Provo River. Final Report. Salt Lake City: University of Utah.

Headwaters Economics. 7/24/2013. Demographic Profile of the State of Utah, Provo-Orem Census County Division, and Utah County, Utah, generated from available data sources using the Economic Profile System-Human Dimensions Toolkit [software], developed and distributed by Headwaters Economics, Bozeman, MT. (http:// http://headwaterseconomics.org/tools/eps-hdt).

Heathwaite, A.L., R. Eggelsmann, K. Gottlich, and G. Kaule. 1993. Ecohydrology, mire drainage and mire conservation. Mires: Process, Exploitation and Conservation. New York: John Wiley & Sons.

Hatch, J.J., and D.V. Weseloh. 1999. Double-crested cormorant (*Phalacrocorax auritus*) *in* The Birds of North America Online (A. Poole, editor.). Ithaca (NY): Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/441.

Hepworth, R.D., and D.E. Wiley. 2004. Lower Provo River electrofishing surveys: 2000–2004. Salt Lake City: Utah Division of Wildlife Resources. 13 p.

Hill, R.W., J.B. Barker, and C.S. Lewis. 2011. Crop and wetland consumptive use and open water surface evaporation for Utah, Final Report. Utah Agricultural Experiment Station, State of Utah.

Hines, B.A. 2010. Relative importance of environmental variables for spawning cues and tributary use by an adfluvial lake sucker [MS Thesis]. Logan (UT): Utah State University.

Hopkinson, R., Director of safety, aviation sciences, Utah Valley University. 6/13/2014. Personal communication with Darren Olsen of BIO-WEST, Inc. regarding Utah Valley University bird strike reports at Provo Municipal Airport.

Howe, F.P., and M. Hanberg. 2000. Willow flycatcher and yellow-billed cuckoo surveys along the Green and San Juan Rivers in Utah, 2000. Salt Lake City: Utah Division of Wildlife Resources. Publication number 00-31.

[IACWD] Interagency Advisory Committee on Water Data. 1982. Guidelines for determining flood-flow frequency: bulletin 17B of the Hydrology Subcommittee. Reston (VA): U.S. Geological Survey Office of Water Data Coordination. 183 p. Available at: http://water.usgs.gov/osw/bulletin17b/bulletin_17B.html.

[Interior] U.S. Department of the Interior. 3/1/2013. Departmental climate change response information. Location: http://www.doi.gov/whatwedo/climate/index.cfm.

[Interior] U.S. Department of the Interior, Central Utah Project Completion Act Office, Central Utah Water Conservancy District, and Utah Reclamation Mitigation and Conservation Commission. 2013. East Hobble Creek restoration project Final Environmental Assessment and Finding of No Significant Impact, April. 144 p.

International Peat Society and International Mire Conservation Group. 2002a. Statement on the wise use of peat wetlands, March. 4 p.

International Peat Society and International Mire Conservation Group. 2002b. Wise use of mires and peat wetlands - background and principles including a framework for decision making. Distributed by NHBS Ltd, 2-3 Wills Road Totnes, Devon TQ9 5XN, UK Copyright © 2002 International Mire Conservation Group and International Peat Society.

Janetski, J.C. 1990. Wetlands in Utah Valley prehistory. *In:* Wetland adaptations in the Great Basin. Edited by Joel Janetski and David Madsen. Brigham Young University Museum of Peoples and Cultures. Occasional Paper No. 1.

Jennings, W.F. 1990. *Spiranthes diluvialis* and *Sisyrinchium pallidum* final report. Boulder (CO): The Nature Conservancy. Colorado Natural History Small Grants Program.

Jerome, E.A. 1976. Birdstrikes: menace to pilots. Flight Operations 65:29–32, 41.

Joosten, H., and D. Clarke. 2002. Wise use of mires and peat wetlands. Saarijärven Offset Oy, Saarijärvi, Finland: International Mire Conservation Group and International Peat Society. 304 p.

[JSRIP] June Sucker Recovery Implementation Program. 3/3/2011. Achieving recovery: nonnative and sportfish management. Location: http://www.junesuckerrecovery.org/achi-nonn.html.

[JSRIP] June Sucker Recovery Implementation Program, Program Office. 2009. Program accomplishments: calendar year 2008. Salt Lake City: Utah Department of Natural Resources. 97 p.

K.A. Smith Consulting, Inc. 2009. Provo City Despain property wetland mitigation monitoring report. Provo (UT): Provo City Economic Development Department. U.S. Army Corps of Engineers permit no. SPK-2008-1227. 8 p.

Kaemingk, M.A., B.D.S. Graeb, C.W. Hoagstrom, and D.W. Willis. 2007. Patterns of fish diversity in a mainstem Missouri River and reservoir and associated delta in South Dakota and Nebraska, USA. River Research and Applications 23:786–791.

Kappenman, K., M. Webb, E. Cureton, J. Ilgen. 2010. Determination of upper temperature tolerance in June sucker larvae: is the transition to Utah Lake temperatures a recruitment bottleneck? Transactions of the American Fisheries Society 139:1386–1398.

Keleher, C.J. 1999. Approach for providing flows for June sucker spawning in the lower Provo River: draft. Salt Lake City: Central Utah Water Conservancy District. 12 p.

Keleher, C.J., L.D. Lentsch, and C.W. Thompson. 1998. Evaluation of flow requirements of June sucker (*Chasmistes liorus*) in the Provo River: an empirical approach. Salt Lake City: Utah Division of Wildlife Resources. Publication Number 99-06.

Kettenring, K.M., and K.E. Mock. 2012. Genetic diversity, reproductive mode, and dispersal differ between the cryptic invader, *Phragmites australis,* and its native conspecific. Biological Invasions 14:2489–2504.

Kettenring, K.M., S. de Blois, and D.P. Hauber. 2012. Moving from a regional to a continental perspective of *Phragmites australis* invasion in North America. AoB Plants 2012: pls040; doi:10.1093/aobpla/pls040.

Killgore, K., and J. Baker. 1996. Patterns of larval fish abundance in a bottomland hardwood wetland. Wetlands 16(3): 288–295. Available online: http://springerlink.com/content/m140687j46r774g4/.

Kling, B. 2014. Aeration feasibility for the lower Provo River. Final letter report. Clean-Flo International.

Knopf, F.L., and R.M. Evans. 2004. American white pelican (*Pelecanus erythrorhynchos*) *in* The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/057 [Accessed 5/1/12].

Kraft, S.A. 2009. Naïve prey versus nonnative predators: a role for behavior in endangered species conservation [MS Thesis]. Logan (UT): Utah State University.

Kreitzer, J.D., M.C. Belk, D.B. Gonzalez, R.C. Tuckfield, D.K. Shiozawa, and J.E. Rasmussen. 2010. Ontogenetic diet shift in the June sucker *Chasmistes liorus* (Cypriniformes, Catostomidae) in the early juvenile stage. Ecology of Freshwater Fish 19:433–438.

Landom, K., and T.A. Crowl. 2010. Ecological evaluation of June sucker spawning and larval production in Utah Lake tributaries: 2009 data summary. Logan (UT): Ecology Center and Watershed Sciences Department, Utah State University. June Sucker Recovery Program, 2010 report, V.09.10.

Landress, C., and J. Watson. 2008. Monitoring trends in June (*Chasmistes liorus*) and Utah sucker (*Catostomus ardens*) populations in the Utah Lake system. Springville (UT): Utah Division of Wildlife Resources. June Sucker Recovery Program, 2007 report, V.07.02.

Laymon, S.A. 1998. Yellow-billed cuckoo (*Coccyzus americanus*). *In* the riparian bird conservation plan: a strategy for reversing the decline of riparian-associated birds in California. California Partners in Flight.

Linnell, M.A. 2015. Utah State director, U.S. Department of Agriculture, Wildlife Services. Personal communication with Mark Holden of the Utah Reclamation Mitigation and Conservation Commission regarding potential involvement of USDA Wildlife Services in monitoring bird abundance and movement following implementation of the Provo River Delta Restoration Project. 1/7/2015.

[LSD] Logan Simpson Design, Inc.. 2013. A class III cultural resources inventory for the Provo River Delta Restoration Project, Utah County, Utah. Technical report no. 135480. Salt Lake City: LSD. 24 p.

Lucas, R.E., 1982, Organic soils (histosols)—Formation, distribution, physical and chemical properties and management for crop production: Michigan State University Farm Science Research Report 435. 77 p.

[MAG] Mountainland Association of Governments. 2007. Regional transportation plan, 2007–2030. Orem (UT): Mountainland Metropolitan Planning Organization.

Manci, K. and E. Wheeling, 1994. Populations of *Spiranthes diluvialis* in the Fort Collins, CO, vicinity. *In*: Miscellaneous information about Ute ladies'-tresses orchid (*Spiranthes diluvialis*). Proceedings of the Ute ladies'-tresses information exchange meeting. Salt Lake City: Utah Department of Natural Resources and U.S. Fish and Wildlife Service. March 29, 1994.

Martin, S.G., and T.A. Gavin. 1995. Bobolink (*Dolichonyx oryzivorus*), The Birds of North America Online (A. Poole, editor). Ithaca (NY): Cornell Lab of Ornithology. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/176.

Millward, D. 9/25/2013. Bird strikes damage three aircraft a week. Location: http://www.telegraph.co.uk/news/aviation/10257036/Bird-strikes-damage-three-aircraft-a-week.html

Mitsch, W.J. and J.G. Gosselink. 2007. Wetlands, 4th Edition. Hoboken (NJ): John Wiley & Sons.

Modde, T., and N. Muirhead. 1990. Emergence patterns and feeding behavior of larval June sucker. Salt Lake City: Utah Division of Wildlife Resources. Final Report. Contract no. 90-0081.

Mower, R.C. 2012. Manager, Utah County mosquito abatement. Personal communication with Utah Reclamation Mitigation and Conservation Commission, regarding the Provo River Delta Restoration Project and mosquito abatement. 04/06/2012.

National Audubon Society and Cornell Lab of Ornithology. 5/9/2011. eBird on-line birding observations. Location: http://ebird.org/ebird/eBirdReports?cmd=Start.

Neubauer, J.C. 1990. Why birds kill: cross-sectional analysis of U.S. Air Force bird strike data. Aviation, Space, and Environmental Management 61:343–348.

Nielsen, L.T., R.J. Brand, and G.C. Collett. 2002. An identification guide to the mosquitoes of Utah. Salt Lake City: Utah Mosquito Abatement Association. 97 p.

Northern Ireland Peat Wetlands and Uplands Biodiversity Delivery Group. 2010. Guidelines for peatland restoration. October. 27 p.

Norvell, R. 2014. Nongame avian ecologist, Utah Division of Wildlife Resources. Personal communication with Mike Sipos of BIO-WEST, Inc., Logan, Utah, regarding pelican abundance in northern Utah and likely project effects. 01/14/2014.

[NRCS] U.S. Department of Agriculture, Natural Resources Conservation Service. 2011. Custom Soil Resource Report for Utah, County, Utah – Central Part, May 23. 41p.

[NRCS] U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey Staff. 8/20/2010. Official soil series descriptions. Location: http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/class/.

[NTSB] National Transportation Safety Board. 2010. Loss of thrust in both engines after encountering a flock of birds and subsequent ditching on the Hudson River, US Airways Flight 1549, Airbus A320-214, N106US, Weehawken, New Jersey, January 15, 2009. Aircraft Accident Report NTSB/AAR-10 /03. Washington, DC.

[NTSB] National Transportation Safety Board. 2009. Aircraft accident report: Crash of Cessna 500, N113SH, following an in-flight collision with large birds, Oklahoma City, Oklahoma, March 4, 2008. Aircraft Accident Report NTSB/AAR-09/05. Washington, DC.

Oliver, G.V. 2000. The bats of Utah: a literature review. Salt Lake City: Utah Division of Wildlife Resources. Publication no. 00-14. 140 p.

Orians, G.H. 1980. Some adaptations of marsh-nesting blackbirds. Princeton (NJ): Princeton University Press.

Parrish, J.R., F.P. Howe, and R.E. Norvell. 2002. Utah partners in flight avian conservation strategy version 2.0. Salt Lake City: Utah Division of Wildlife Resources, Utah Partners in Flight Program. Utah Division of Wildlife Resources Publication Number 02–27. i–xiv + 302 p.

Paul, D.S., and A.E. Manning. 2002. Great Salt Lake waterbird survey five-year report (1997–2001). Salt Lake City (UT): Utah Division of Wildlife Resources. Publication number 08-38. 56 p.

Petersen, M.E. 1996. Effects of prey growth, physical structure, and piscivore electivity on the relative prey vulnerability of gizzard shad (*Dorosoma cepedianum*) and June sucker (*Chasmistes liorus*) [MS Thesis]. Logan (UT): Utah State University. 63 p.

Poulin, R., L.D. Todd, E.A. Haug, B.A. Millsap, and M.S. Martell. 2011. Burrowing owl (*Athene cunicularia*), The Birds of North America Online (A. Poole, editor). Ithaca (NY): Cornell Lab of Ornithology. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/061.

Pritchett, C.L., H.H. Frost, and W.W. Tanner. 1981. Terrestrial vertebrates in the environs of Utah Lake. Great Basin Naturalist Memoirs 5:128–169.

Provo City. 2/21/2013. Provo City Vision 2030. Location: http://www.provo.org/current_issues.visioning.html.

Provo City. 2009. Provo City general plan as amended by the 2009 comprehensive update. Provo (UT): Provo City. Available online: http://www.provo.org/commdev.planning.html.

Provo City. 2000. Provo Municipal Airport Master Plan. Provo (UT): Provo City.

PSOMAS and SWCA. 2007. Utah Lake TMDL: pollutant loading assessment and designated beneficial use impairment assessment. Salt Lake City: Utah Division of Water Quality. Final draft. 88 p.

Radant, R.D., and D.K. Sakaguchi. 1981. Utah Lake fisheries inventory. Salt Lake City: Utah Division of Wildlife Resources. U.S. Bureau of Reclamation contract no. 8-07-40-50634. 244 p.

Radant, R.D., and D.S. Shirley. 1987. June sucker: Utah Lake investigations. Salt Lake City: Utah Division of Wildlife Resources. U.S. Bureau of Reclamation contract no. 8-07-40-S0634, modification no. 5. 46 p.

Radant, R.D., M. Wilson, and D.S. Shirley. 1987. June sucker: Provo River instream flow analysis. Salt Lake City: Utah Division of Wildlife Resources. U.S. Bureau of Reclamation contract no. 8-07-40-S0634, modification no. 4. 45 p.

[Reclamation] U.S. Department of the Interior, Bureau of Reclamation. 2011. SECURE Water Act Section 9503(c) – Reclamation climate change and water, Report to Congress, April 2011. Denver: Policy and Administration, Bureau of Reclamation. 226 p.

[Reclamation] U.S. Bureau of Reclamation. 1994. Olmstead diversion and intake structure replacement project, Provo River, Utah, Final Environmental Assessment. Salt Lake City: U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region. 190 p.

Riedel, L, T. Naumann, and S. Petersburg. 1994. *Spiranthes diluvialis* monitoring and habitat management in Dinosaur National Monument, National Park Service. *In:* Miscellaneous information about Ute ladies'-tresses orchid (*Spiranthes diluvialis*). Proceedings of the Ute ladies'-tresses information exchange meeting. Salt Lake City: Utah Department of Natural Resources and U.S. Fish and Wildlife Service. March 29, 1994.

Robinson, W.L., and E.G. Bolen. 1989. Wildlife ecology and management. New York: Macmillan.

Polk, M.R., and W.S. Johnson. 2011. A class I cultural resource report for the proposed Provo River restoration project, Provo, Utah County, Utah. Report number 1820. Ogden (UT): Sagebrush Consultants, LLC. 26 p.

Sallabanks, R., and F.C. James. 1999. American robin (*Turdus migratorius*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/462.

Scheffer, M. 2004. Ecology of Shallow Lakes. Norwell, MA: Kluwer Academic Publishers.

Schmidt, O.L. 1993. The statement of underlying need determines the range of alternatives in an environmental document. Pages 42–65 *in* Hildebrand, S.G., and J.B. Cannon, editors. Environmental analysis: the NEPA experience. Boca Raton (FL): Lewis Publishing.

Schmidt, O.L. 1988. The statement of underlying need defines the range of alternatives in environmental documents. Environmental Law 18:371–381.

Shirley, D.S. 1983. Spawning ecology and larval development of the June sucker. Proceedings of the Bonneville Chapter of the American Fisheries Society. pp. 18–36.

Sigler, W.F., and J.W. Sigler. 1996. Fishes of Utah: a natural history. Salt Lake City: University of Utah Press. 375 p.

Sipes, S.D., and V.J. Tepedino. 1995. Reproductive biology of the rare orchid, *Spiranthes diluvialis*: breeding system, pollination, and implications for conservation. Conservation Biology 9(4):929–938.

Sommer, T.R., M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer. 2001. Floodplain rearing of juvenile chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Science 58(2): 325–333. Available online: http://rparticle.web-p.cisti.nrc.ca/rparticle/AbstractTemplateServlet?calyLang=eng&journal=cjfas&volume=58&year=2001&issue=2&msno=f00-245.

Stamp, M., D. Olsen, and T. Allred. 2008. Lower Provo River ecosystem flow recommendations. Final report by BIO-WEST, Inc., and Allred Restoration, Inc. Salt Lake City: Utah Reclamation Mitigation and Conservation Commission. 69 p. plus appendices.

Stamp, M., P. Abate, T. Welker, S. Hill, and D. Olsen. 2002. Feasibility analysis of establishing an additional spawning location to benefit the endangered June sucker. Final report by BIO-WEST, Inc. Salt Lake City: Utah Department of Natural Resources. 71 p. plus appendix.

Stamp, M., T. Eddie, D. Olsen, and T. Allred. 2009. Lower Hobble Creek ecosystem flow recommendations. Final report by BIO-WEST, Inc., and Allred Restoration, Inc. Salt Lake City: Utah Reclamation Mitigation and Conservation Commission. 50 p. plus appendix.

Steenhof, K., S.S. Berlinger, and L.H. Fredrickson. 1980. Habitat use by wintering bald eagles in South Dakota. Journal of Wildlife Management 44:798–805.

Stephens, S.E., D.N. Koons, J.J. Rotella, and D.W. Willey. 2003. Effects of habitat fragmentation on avian breeding success: a review of the evidence at multiple spatial scales. Biological Conservation 115:101–110.

Stringham, B. 2014. Waterfowl program coordinator, Utah Division of Wildlife Resources. Personal communication with Mike Sipos of BIO-WEST, Inc., Logan, Utah, regarding waterfowl abundance in northern Utah and likely project effects. 01/16/2014.

SWCA. 2002. Nonnative fish control feasibility study to benefit June sucker in Utah Lake. Final report to the June Sucker Recovery Implementation Program and Utah Department of Natural Resources. Salt Lake City: SWCA, Inc. Project Number 4989-014.

Thorpe, J. 2003. Fatalities and destroyed civil aircraft due to bird strikes, 1912–2002. International Bird Strike Committee, IBSC26/WP-SA1, Warsaw, May 5–9. 28 p.

Tirmenstein, D. 7/8/2011. *Gutierrezia sarothrae*. *In*: Fire effects information system [online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, producer. Location: http://www.fs.fed.us/database/feis/.

Toth, R.E., T.C. Edwards, R.J. Lilieholm, J.A. MacMahon, J.M. Payne, and G.A. Busch. 2004. Alternative future growth scenarios for conserving open space along Utah's Wasatch Front: a case study for the Mountainland Association of Governments. Final project report no. 2004-1. Logan (UT): College of Natural Resources, Utah State University.

Twedt, D.J., and R.D. Crawford. 1995. Yellow-headed blackbird (*Xanthocephalus xanthocephalus*). The Birds of North America Online (A. Poole, editor.). Ithaca (NY): Cornell Lab of Ornithology. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/192

[UDWQ] Utah Division of Water Quality. 2011. 2008 final Utah 305(b) report: part 2 integrated report. Salt Lake City: Utah Division of Water Quality, Utah Department of Environmental Quality. 14 p.

[UDWQ] Utah Division of Water Quality. 2010. Draft 2010 Utah integrated report: 303(d) list of impaired waters, October 2010. Salt Lake City: Utah Division of Water Quality, Utah Department of Environmental Quality.

[UDWR] Utah Division of Wildlife Resources. 3/9/2015. Utah Conservation Data Center. Location: http://dwrcdc.nr.utah.gov/ucdc/.

[UDWR] Utah Division of Wildlife Resources. 2012. Utah Lake synthesis report of sucker and fish community monitoring. Final report to the June Sucker Recovery Implementation Program. 79 p.

[UDWR] Utah Division of Wildlife Resources. 2007. Monitoring trends in adult June sucker (*Chasmistes liorus*) populations in Utah Lake and Provo River in 2006, Project Number: V.06.02. Springville (UT): Utah Division of Wildlife Resources. 17 p.

[UDWR] Utah Division of Wildlife Resources. 2006. Monitoring adult June sucker (*Chasmistes liorus*) populations in Utah Lake and Provo River in 2005, Project Number: V.05.02. Springville (UT): Utah Division of Wildlife Resources. 24 p.

[UDWR] Utah Division of Wildlife Resources. 2005. Utah comprehensive wildlife conservation strategy. Salt Lake City: Utah Division of Wildlife Resources. 280 p.

[UDWR] Utah Division of Wildlife Resources. 2004. Monitoring adult June sucker (*Chasmistes liorus*) populations in Utah Lake and Provo River in 2003, Project Number: V.03.03. Springville (UT): Utah Division of Wildlife Resources. 15 p.

[UDWR] Utah Division of Wildlife Resources. 2003. Monitoring adult June sucker populations in Utah Lake and Provo River in 2002, Project Number: V.02.06. Springville (UT): Utah Division of Wildlife Resources. 17 p.

[UDWRT] Utah Division of Water Rights. 03/19/2015a. Utah Division of Water Rights point of diversion shapefile. Location: http://www.waterrights.utah.gov/gisinfo/wrcover.asp.

[UDWRT] Utah Division of Water Rights. 03/19/2015b. Utah Division of Water Rights WRRPRINT water right info viewer. Location: http://www.waterrights.utah.gov/cgi-bin/wrprint.exe?Startup.

[UDWRT] Utah Division of Water Rights. 1992. Utah Lake interim water distribution plan. Available online: http://www.waterrights.utah.gov/wrinfo/policy/ut_lake/plan.htm.

[UGOPB] Utah Governor's Office of Planning and Budget. 12/21/2012. LeRay McAllister Critical Land Conservation Fund. Location: http://www.governor.state.ut.us/planning/leraymcallister.htm.

[UGOPB] Utah Governor's Office of Planning and Budget. 2/10/2009. Demographic and economic analysis. Location: http://governor.utah.gov/dea.

[UGOPB] Utah Governor's Office of Planning and Budget. 2008. 2008 Utah baseline: current conditions, trends, and projections. Salt Lake City: Governor's Office of Planning and Budget.

[UNHP] Utah Natural Heritage Program. 1994. Records of all Ute ladies'-tresses occurrences for Utah from the Natural Heritage Program database.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2015a. Provo River delta restoration project water quality technical memorandum. Report prepared by BIO-WEST, Inc., Logan, Utah. 45 p.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2015b. Provo River delta restoration project existing bird communities and bird-aircraft strike risk assessment technical memorandum. Report prepared by BIO-WEST, Inc., Logan, Utah. 175 p.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2013. Provo River delta restoration project riparian vegetation technical memorandum. Report prepared by BIO-WEST, Inc., Logan, Utah. 64 p.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2012a. Pesticide management plan. 276 p.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2012b. Integrated pest management plan. Updated. Mitigation Commission. 230 South 500 East, Suite 230. Salt Lake City, UT 84102. 44 p plus Appendices.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2011. Provo River delta restoration project alternatives development technical memorandum. Report prepared by BIO-WEST, Inc., Logan, Utah. 183 p.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2010. Provo River delta restoration project scoping summary. Report prepared by BIO-WEST, Inc., Logan, Utah. 66 p.

[URMCC] Utah Reclamation Mitigation and Conservation Commission. 2001. Provo River diversion dams evaluation. Final draft report prepared by BIO-WEST, Inc. 90 p.

[URMCC] Utah Reclamation Mitigation and Conservation Commission, Central Utah Water Conservancy District, and U.S. Department of the Interior. 2008. Fort Field diversion reconstruction environmental assessment. 40 p.

[USAF] U.S. Air Force. 3/9/2012. United States avian hazard advisory system. Location: http://www.usahas.com/home/.

U.S. Census Bureau. 7/24/2013. American Fact Finder. Location: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

[USDA] Weeds of the week. 2006. Weed of the week: crack willow (*Salix fragilis*). Available at: http://www.na.fs.fed.us/fhp/invasive_plants/weeds/crack-willow.pdf.

[USDA Wildlife Services] U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center. 2013. Development of management strategies to reduce wildlife hazards to aircraft. Available at: http://www.aphis.usda.gov/wildlife_damage/nwrc/research/aviation/.

[USFWS] U.S. Fish and Wildlife Service. 2/11/2015. Environmental conservation online system, species profile for yellow-billed cuckoo (*Coccyzus americanus*). Location: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B06R.

[USFWS] U.S. Fish and Wildlife Service. 2013. Status for the western distinct population segment of the yellow-billed cuckoo (*Coccyzus americanus*). Federal Register 78:61621–61666.

[USFWS] U.S. Fish and Wildlife Service. 2010a. Final Environmental Assessment for removal and control of nonnative carp in Utah Lake to support June sucker recovery. Available online: http://www.fws.gov/mountain-prairie/federalassistance/nepa/utah-lake-carp/Carp-Removal-NEPA-FEA-1-26-10-mdm.pdf.

[USFWS] U.S. Fish and Wildlife Service. 2010b. Least chub (*Iotichthys phlegethontis*) species description. Available online: http://www.fws.gov/mountain-prairie/species/fish/leastchub/.

[USFWS] U.S. Fish and Wildlife Service. 05/07/2010c. Mountain-Prairie Region Species Descriptions, Ute ladies'-tresses orchid. Location: http://www.fws.gov/mountain-prairie/species/plants/uteladiestress/.

[USFWS] U.S. Fish and Wildlife Service. 2002. Utah field office guidelines for raptor protection from human and land use disturbances. Salt Lake City (UT): U.S. Fish and Wildlife Service, Utah Field Office. 45 p.

[USFWS] U.S. Fish and Wildlife Service. 1999a. June sucker (*Chasmistes liorus*) recovery plan. Denver: Region 6, U.S. Fish and Wildlife Service. 61 p.

[USFWS] U.S. Fish and Wildlife Service. 1999b. Biological opinion for the Diamond Fork System Final Supplement to the Final Environmental Impact Statement, Central Utah Project Bonneville Unit. Salt Lake City: Utah Field Office, U.S. Fish and Wildlife Service.

[USFWS] U.S. Fish and Wildlife Service. 1995. Ute ladies'-tresses (*Spiranthes diluvialis*) draft recovery plan. Denver: U.S. Fish and Wildlife Service. 46 p.

[USFWS] U.S. Fish and Wildlife Service. 1994. Biological opinion regarding formal consultation of effects of operation of the Provo River Project. Salt Lake City: Utah Field Office, U.S. Fish and Wildlife Service.

[USFWS] U.S. Fish and Wildlife Service. 1993. Biological opinion regarding federally listed threatened, endangered, candidate, and proposed species that may be affected by the construction and operation of Olmstead Diversion Structure Replacement Study, Provo River, Utah. Salt Lake City: USFWS Ecological Services. 7/26/1993.

[USFWS] U.S. Fish and Wildlife Service. 1992. Endangered and threatened wildlife and plants: final rule determining Ute ladies'-tresses (*Spiranthes diluvialis*) to be a threatened species. Federal Register 57(12):2048–2054.

[USU] Utah State University, Department of Landscape Architecture and Environmental Planning. 2006. Utah Department of Transportation wetland functional assessment method. Logan (UT): Utah State University.

Utah County. 6/26/2013. Utah County land records. Location: http://www.utahcountyonline.org/LandRecords/.

Utah County. 2/28/2012a. Information regarding Utah County mosquito species, larval mosquito control, and adult mosquito control. Location: http://www.utahcountyonline.org/Dept2/Health/Mosquito%20Abatement/home.asp.

Utah County. 2/28/2012b. Mosquito Abatement. http://www.utahcountyonline.org/Dept2/Health/Mosquito%20Abatement/control.html.

Utah County. 2007. Utah County general plan as amended through March 20, 2007. Provo (UT): Utah County Community Development Department. 34 p.

Utah Division of State Parks and Recreation. 3/30/2011. Utah state park visitation estimates. Location: http://stateparks.utah.gov/about/visitation.

Utah Lake Commission. 6/15/2013. Vile weed! Restoring shoreline with controlled reed removal. Location: http://utahlake.gov/vile-weed-restoring-shoreline-with-controlled-reed-removal/.

Utah Lake Commission. 2009. Utah Lake master plan: awake Utah Lake—planning the heart of the valley. 52 p.

Utah State Engineer. 1992. Interim water distribution plan for the Utah Lake drainage basin. Salt Lake City: Utah Division of Water Rights.

[UWCA] Utah Weed Control Association. 7/8/2011. Utah's noxious weed list. Location: http://www.utahweed.org/weeds.htm.

Valdez, R.A., A. Widmer, and J. Kehmeir. 2006. Population assessment and mechanical control of common carp (*Cyprinus carpio*) in Utah Lake. Final report. Salt Lake City: Utah Division of Wildlife Resources.

VanDruff, L.W., E.G. Bolen, and G.J. San Julian. 1994. Management of urban wildlife. Pages 507–530 *in*: Bookhout, T.A., editor. Research and management techniques for wildlife and habitats, 5th ed. Bethesda (MD): The Wildlife Society.

Waggy, M.A. 7/8/2011. *Solanum dulcamara*. *In*: Fire effects information system [online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, producer. Location: http://www.fs.fed.us/database/feis/.

Watson, J. 2012. June sucker biologist, Utah Division of Wildlife Resources. Personal communication with Zachary Shattuck, fisheries biologist/aquatic ecologist, BIO-WEST, Inc., Logan, Utah, regarding Provo River and Utah Lake fishery. 01/28/2012.

Watson, J. 2011. June sucker biologist, Utah Division of Wildlife Resources. Personal communication with Melissa Stamp, watershed scientist, BIO-WEST, Inc., Logan, Utah, regarding Provo River and Utah Lake fishery population monitoring. 06/01/2011.

Watson, J., and C. Landress. 2011. Monitoring trends in Utah Lake sucker populations and Utah Lake fish community monitoring. Springville (UT): Utah Division of Wildlife Resources. June Sucker Recovery Program, 2010 report, V.10.02a, V.10.02b.

Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins. 2003. A Utah flora. Provo (UT): Brigham Young University.

Wiggins, D.A., D.W. Holt, and S.M. Leasure. 2006. Short-eared owl (*Asio flammeus*). The Birds of North America Online (A. Poole, editor). Ithaca (NY): Cornell Lab of Ornithology. Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/062.

Wilkinson Ferrari & Co. 2012. Provo River delta restoration project stakeholder recreation workshops report and analysis. Salt Lake City: Wilkinson Ferrari & Co. 13 p.

Wilson, K.W. and C.W. Thompson. 2001. Evaluation of June sucker larvae movement (*Chasmistes liorus*) in the Provo River in 1998. Salt Lake City: Utah Division of Wildlife Resources. Final Report. 34 p.

Wingert, S. 2008. Final report: PCBs in Utah Lake sediment study. Salt Lake City: Utah Division of Water Quality. 7 p. Available online: http://www.fishadvisories.utah.gov/docs/111708_PCBs_in_Utah_Lake_Sediment_Study.pdf.