Chapter 14: Floodplains

14.1 Introduction

This chapter discusses the floodplains in the floodplain impact analysis area and the effects of the proposed alternatives on these floodplains. For a discussion of aquatic resources associated with floodplains, see Chapter 13, *Ecosystem Resources*.

Floodplain Impact Analysis Area. The floodplain impact analysis area includes floodplains that are adjacent to and near State Route (S.R.) 210 from the intersection at Fort Union Boulevard (S.R. 190) in Cottonwood Heights to its terminus in the town of Alta (see Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*, beginning on page 14-7). The floodplain impact analysis area also includes the Alta Bypass Road between Snowbird and Alta and the proposed mobility hubs at the gravel pit and 9400 South and Highland Drive.

What is the floodplain impact analysis area?

The floodplain impact analysis area includes floodplains that are adjacent to and near S.R. 210 from the intersection at Fort Union Boulevard to its terminus in the town of Alta. It also includes the Alta Bypass Road and the proposed mobility hubs at the gravel pit and 9400 South and Highland Drive.

14.2 Regulatory Setting

Two terms that are used in floodplain regulatory guidance are *100-year flood* and *floodplain*.

Floods are usually described in terms of their statistical frequency. A 100-year floodplain is the area that would be flooded by a water body during a 100-year flood. A 100-year flood (also referred to as a *base flood*) is a level of flood water that has a 1% chance of occurring in a given location in any given year.

This concept does not mean that such a flood will occur only once in 100 years. If a 100-year flood occurs in a given location during one year, there is still a 1% chance of a similar flood in the same location the following year.

Since floodplains can be mapped, the boundary of the 100-year flood is commonly used in floodplain mitigation programs to identify areas where risk of flooding is significant.

What are a 100-year floodplain and 100-year flood?

A 100-year floodplain is the area that would be flooded by a water body during a 100-year flood. A 100-year flood (also referred to as a *base flood*) is a level of flood water that has a 1% chance of occurring in a given location in any given year.

14.2.1 Federal Emergency Management

In response to escalating taxpayer costs for flood disaster relief, Congress established the National Flood Insurance Program. This program is a voluntary mitigation program administered by the Federal Emergency Management Agency (FEMA). Under this program, the federal government makes flood insurance available in those communities that practice sound floodplain management. This incentive encourages state and local governments to develop and implement floodplain-management programs. FEMA requirements for land management and use, and for identifying and mapping

special flood hazard areas, are described in 44 Code of Federal Regulations (CFR) Parts 60 and 65, respectively.

In the 1970s and 1980s, FEMA performed location hydrologic and hydraulic studies to identify and map the most significant special flood hazard areas within developed or developing areas of the communities participating in the National Flood Insurance Program. A result of the FEMA studies is the development of Flood Insurance Rate Maps that show the floodplain for each river, lake, or other surface water resource that was studied.

A *special flood hazard area* is the area that would be inundated by a 100-year flood, also referred to by FEMA as the *base flood*. National Flood Insurance Program regulations are based on these special flood hazard areas; therefore, this analysis is focused on areas affected by a 100-year flood. Other types of zones representing greater or lesser flood risk may be defined. Special flood hazard areas are given a zone designation based on the level of detail of the FEMA study and the anticipated type of flooding. There are several types of zones in the floodplain impact analysis area, but the following special flood hazard area zones are pertinent to this project:

- **Zone A:** Areas subject to inundation by a base flood. These areas are identified by approximate studies, and no base flood elevations are established (FEMA 2018a).
- **Zone AE:** Areas subject to inundation by a base flood as determined by detailed methods. Base flood elevations are established (FEMA 2018b).

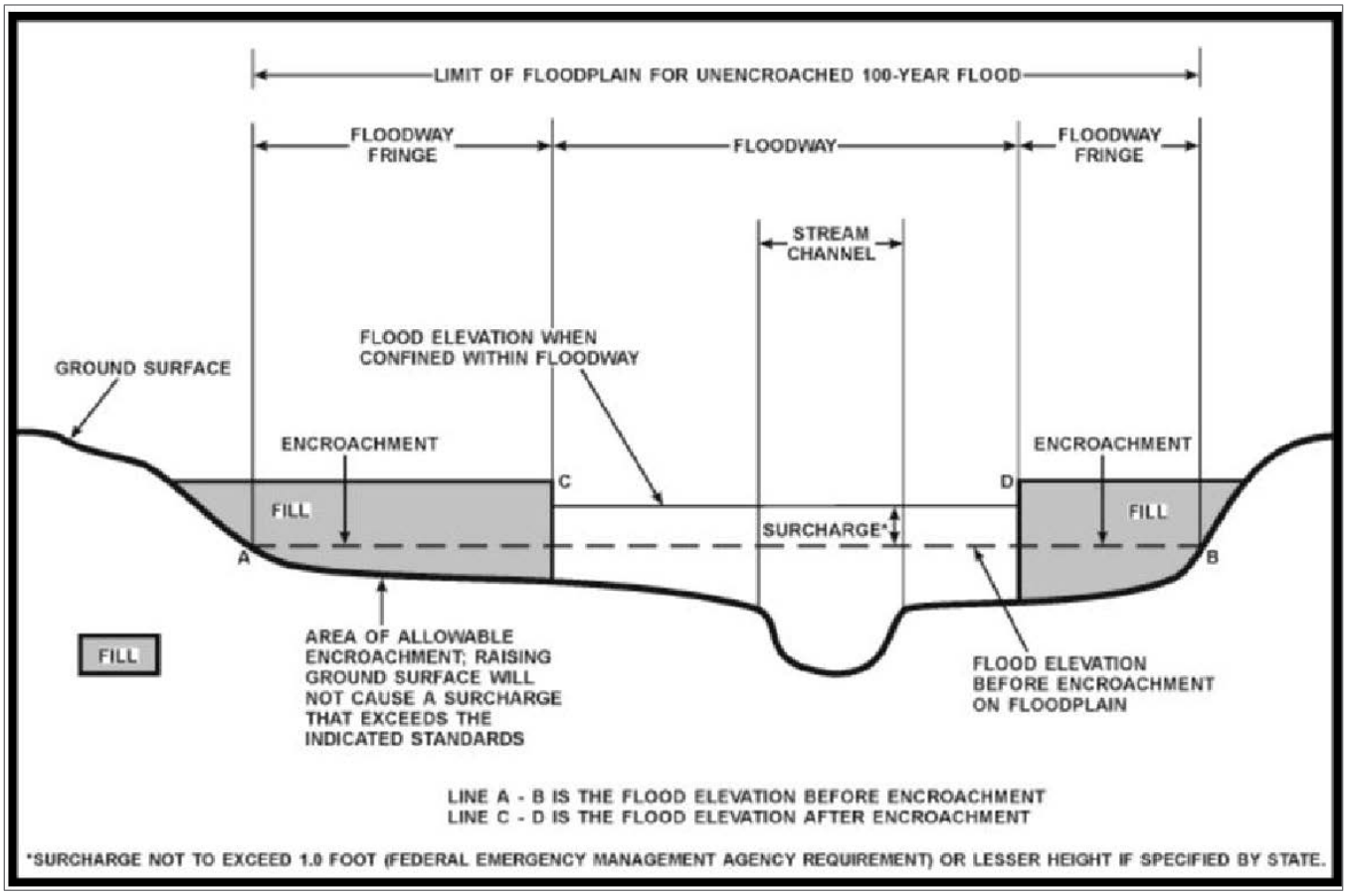
The 100-year floodplain for streams is the area in and around the stream that would be inundated by a 100-year flood. In AE zones, this floodplain might consist of both the floodway and the floodway fringe, as shown in Figure 14.2-1. The *floodway* is the defined stream channel and the adjacent areas that must be kept free of encroachment to pass the 100-year flood without increasing the water surface elevation by more than a designated height. The *floodway fringe* is the area between the floodway and the boundary of the floodplain.

What is a stream?

In this chapter, *stream* is used as a general term to describe waterways such as rivers, creeks, canals, and washes.

Similarly, the 100-year floodplain for lakes and reservoirs is the area in and around the lake or reservoir that would be inundated by a 100-year flood.

Figure 14.2-1. FEMA Floodplain Schematic



Source: FEMA 2018c

14.2.2 Executive Order 11988, Floodplain Management

Executive Order 11988, *Floodplain Management* (May 24, 1977), established federal policy "to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative." This floodplain evaluation relies on the regulations that the Federal Highway Administration (FHWA) adopted based on Executive Order 11988; these regulations govern the development of projects that could affect floodplains (23 CFR Part 650, Subpart A).

These regulations require that a location hydraulic report be prepared to demonstrate how the requirements of 44 CFR Parts 60 and 65 have been met by the project. These regulations state that the project proponent (in this case, the Utah Department of Transportation [UDOT]) will not approve a project that involves a "significant encroachment" on a floodplain unless the project proponent finds that the proposed significant encroachment is the "only practicable alternative" (23 CFR Section 650.113). This regulation also clearly states that the project must conform to 44 CFR Parts 60 and 65 as well as the floodplain management ordinance of the affected community.

If the project impacts exceed the standards defined in the regulations, the project could be subject to conditional approval from FEMA in accordance with 44 CFR Section 65.12. What constitutes a "significant encroachment" is determined on a case-by-case basis by considering adjacent development. FEMA has set a 1-foot increase in the 100-year flood elevation as the upper limit of the allowable encroachment caused by the cumulative development (in conjunction with past and future encroachments).

Under FHWA's regulations, a significant encroachment can arise from any of the following situations:

- A significant potential for interfering with a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route
- A significant risk of upstream flooding
- A significant adverse impact to natural and beneficial floodplain values (natural and beneficial floodplain values include flood conveyance, storage, and control; groundwater recharge; water quality function; and wildlife habitat and diversity)

As UDOT designs the selected alternative, it would include the supporting floodplain and hydraulic analyses to address FHWA regulations. UDOT's design process includes preparing technical memoranda that, together with roadway and drainage plans and profiles, demonstrate compliance with various regulations, permitting requirements, and design criteria. Using the floodplain impact analysis in Section 14.4, *Environmental Consequences and Mitigation Measures*, as a basis, UDOT would compare the elevations of the designed roadways to the elevations of the surrounding floodplains to determine the potential for floodplains to interfere with the transportation facility. Additionally, UDOT would evaluate the roadway embankments and other features to determine their effect on flood conveyance and risks.

According to guidance issued by FEMA, the 100-year floodplain should be used for developing Flood Insurance Rate Maps. Accordingly, the 100-year flood was used by UDOT in this floodplain impact analysis and would be used by UDOT throughout its design process.

As it designs the selected alternative, UDOT would perform a detailed hydraulic analysis of each drainage facility crossed to confirm that the bridges and culverts identified during the preliminary design would adequately convey flood waters. Overall impacts to the floodplains and floodplain values would be measured against the impacts and requirements documented in this Environmental Impact Statement (EIS).

For this project and based on the floodplain impact analysis that was performed, the action alternatives would not cause a significant impact to any floodplain; therefore, a finding of a practicable alternative as required by 23 CFR Part 650, Subpart A, is not required.

14.3 Affected Environment

The creeks that cross the floodplain impact analysis area originate in the Wasatch Mountains in Salt Lake County and flow to the west and north through the communities in Salt Lake County.

For the purpose of identifying streams and floodplains, the impact analysis area is described from north to south. Information about the impact analysis area was gathered from a variety of sources including FEMA's Community Status Book, flood insurance studies, National Flood Hazard Layer (NFHL) data, U.S. Geological Survey topographic maps, and the Utah Geographic Information Systems (GIS) Portal.

14.3.1 Communities Participating in FEMA's National Flood Insurance Program

The floodplain impact analysis area includes parts of communities in Salt Lake County as well as unincorporated areas of Salt Lake County. All of the communities in the impact analysis area participate in FEMA's National Flood Insurance Program, which requires communities to enact ordinances to protect natural floodplains, prevent damage to property, and protect the safety of the public. The identification numbers for each community are listed in Table 14.3-1.

Table 14.3-1. Identification Numbers for Communities Participating in the National Flood Insurance Program

Community	FEMA Community Identification Number
Salt Lake County[a]	490102
Cottonwood Heights City	490028
Town of Alta	490251

Source: FEMA 2018d

[a] Effective floodplain data (NFHL data) are organized by county.

14.3.2 Floodplains in the Floodplain Impact Analysis Area

What is a regulatory floodplain?

A water body has a regulatory floodplain if the floodplain has been identified and mapped by FEMA.

Streams and floodplains in the floodplain impact analysis area are described below and include named waterways and isolated areas for which regulatory floodplains are defined. Current effective floodplain maps for the analysis area are based on the latest study performed for Salt Lake County in 2012, the latest Letters of Map Revision (LOMR) in 2011 and 2013, and the latest Letters of Map Amendment (LOMA) from 2010 to 2018 (FEMA 2019). (A LOMR and a LOMA are FEMA's modifications to an effective floodplains map.) Stream names are based on the FEMA data and are consistent with the names found on the U.S. Geological Survey topographic quadrangle (USGS 1998).

In the following descriptions, references to Salt Lake County refer to unincorporated parts of the county. Streams and floodplains in the impact analysis area are shown in Figure 14.3-1 through Figure 14.3-4.

Big Cottonwood Creek. Big Cottonwood Creek flows from east to west starting in the upper portion of Big Cottonwood Canyon near Brighton and flows to the west and north through Salt Lake County and the cities of Cottonwood Heights, Midvale, and Murray, where the creek then flows into the Jordan River. In the floodplain impact analysis area, the creek is located north of S.R. 210 and is generally confined within the channel and immediate overbank areas. East of the intersection of S.R. 210 and S.R. 190 in Big Cottonwood Canyon, the creek's regulatory floodplain is designated as Zone A and does not have defined base flood elevations. Continuing downstream from the S.R. 210/S.R. 190 intersection, the creek's regulatory floodplain is designated as Zone AE, with a regulated floodway, through the local communities to the Jordan River. Base flood elevations for Big Cottonwood Creek are provided for Zone AE in the NFHL data. Big Cottonwood Creek in the impact analysis area is shown in Figure 14.3-1.

Little Cottonwood Creek. Little Cottonwood Creek flows from east to west starting in the upper portion of Little Cottonwood Canyon near Alta and flows to the west through Salt Lake County and the cities of Sandy, Midvale, and Murray, where the creek then flows into the Jordan River. In the floodplain impact analysis area, the creek is located south of S.R. 210 and is generally confined within the channel and immediate overbank areas. From the town of Alta downstream to the S.R. 210/S.R. 209 intersection, the creek's regulatory floodplain is designated as Zone A and does not have defined base flood elevations. Continuing downstream from the S.R. 210/S.R. 209 intersection, the creek's regulatory floodplain is designated as Zone AE, with a regulated floodway, through the local communities to the Jordan River. Base flood elevations for Little Cottonwood Creek are provided for Zone AE in the NFHL data. Little Cottonwood Creek in the impact analysis area is shown in Figure 14.3-2 through Figure 14.3-4.

Floodplain Areas adjacent to S.R. 210 near 3500 East. Regulatory floodplains designated as Zone A are located on both the east and west sides of S.R. 210 just north of the 3500 East intersection. The floodplain area on the east side of S.R. 210 is described on FEMA documents as "Oaks at Wasatch Basin," and the floodplain area on the west side of S.R. 210 north of the park-and-ride lot is described as "3500 East Street Basin." These floodplain areas are shown in Figure 14.3-2.

Floodplain Area Crossing S.R. 210 near 9000 South. A regulatory floodplain designated as Zone A crosses S.R. 210 near 9000 South. This floodplain area is associated with Deaf Smith Canyon Creek/Little Willow Creek and is shown in Figure 14.3-2. (This floodplain area might need to be remapped by FEMA, since it does not appear to be correct as shown on the FEMA floodplain map.)

Figure 14.3-1. Floodplains in the Floodplain Impact Analysis Area (1 of 4)

Figure 14.3-2. Floodplains in the Floodplain Impact Analysis Area (2 of 4)

Figure 14.3-3. Floodplains in the Floodplain Impact Analysis Area (3 of 4)

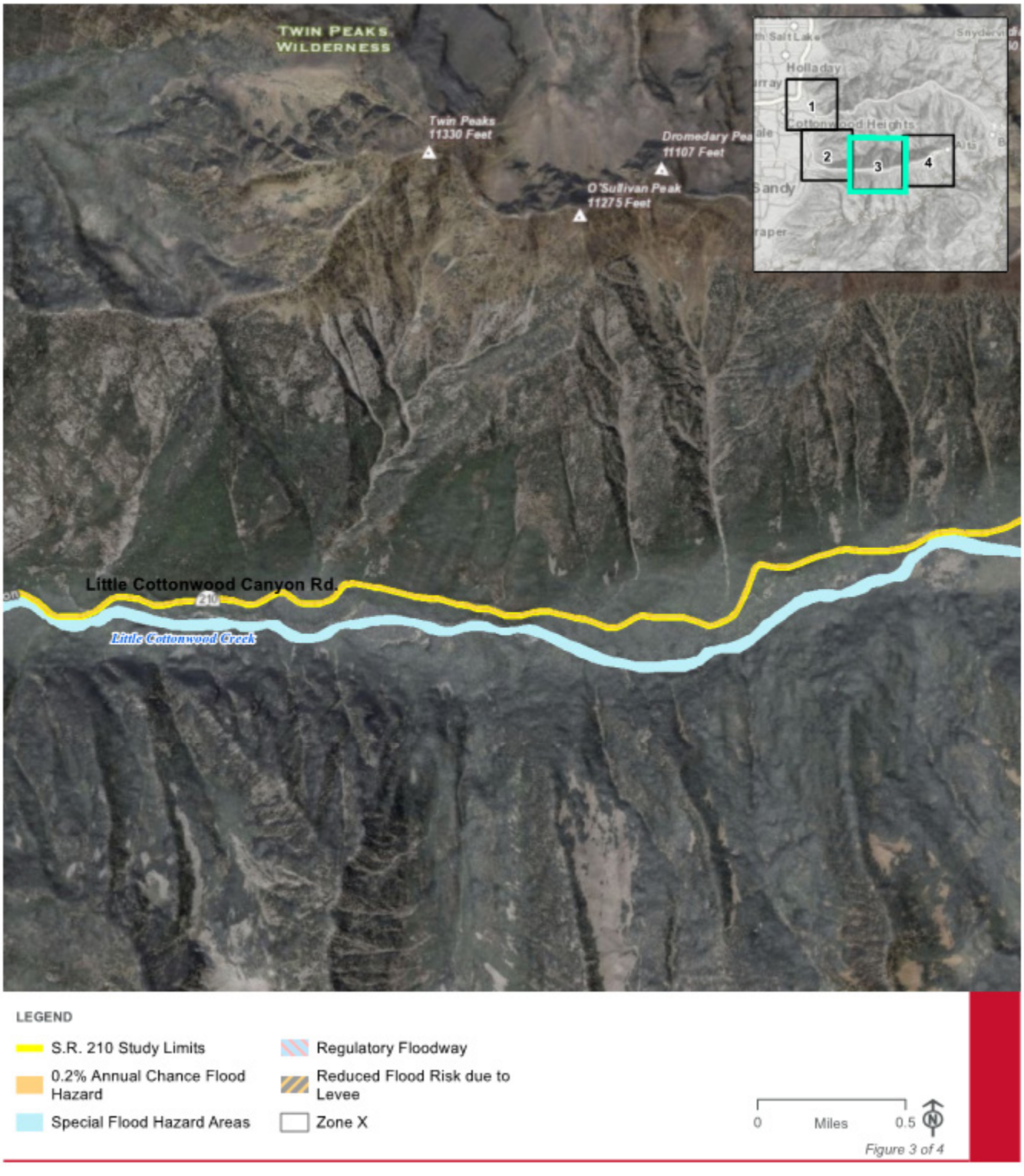


Figure 14.3-4. Floodplains in the Floodplain Impact Analysis Area (4 of 4)

14.4 Environmental Consequences and Mitigation Measures

This section discusses the floodplain impacts from each of the project alternatives based on the preliminary impact boundary for each alternative. The impact boundary includes the roadway surface, embankment limits, and temporary impacts from construction.

14.4.1 Methodology

UDOT determined the floodplain impacts from the action alternatives by comparing FEMA NFHL data to the proposed preliminary impact boundary of each alternative to identify crossings of regulatory floodplains in the floodplain impact analysis area. The regulatory floodplain analysis is based on current FEMA floodplain maps. When reviewing the floodplain impacts described in Sections 14.4.2 through 14.4.7, readers should take the following factors into consideration.

- A regulatory floodplain can be defined for all reaches, partial reaches, or no reaches of a stream. The analysis performed for and documented in Sections 14.4.2 through 14.4.7 is an analysis of the impacts to the regulatory floodplains, not an analysis of the impacts to all streams (either perennial or intermittent and those without defined regulatory floodplains).
- A stream located in the impact analysis area might not intersect with an alternative.
- New bridges and culverts would be designed for a 50-year or 100-year stormwater event to meet the more stringent of UDOT or FEMA requirements, and this design criterion would not affect floodplains. Culverts and bridges located where no regulatory floodplain has been defined would be designed to accommodate a 50-year or greater-magnitude storm event (one with a 2% chance of occurring in a given year). To satisfy FEMA requirements, in locations where a regulatory floodplain is present, culverts and bridges would be designed to accommodate the 100-year flood (one with a 1% chance of occurring in a given year). The hydraulic design described in this EIS is based on a preliminary roadway design at a sufficient level of detail to conduct the floodplain analysis. During the final design process for the selected alternative, more-detailed hydraulic studies would be conducted. All floodplain designs would meet FEMA's and FHWA's regulatory requirements for roadway design in a floodplain.

UDOT determined the floodplain impacts of the action alternatives using a GIS approach. The FEMA NFHL data were compared to the impact footprints of each alternative to identify the locations of regulatory floodplain crossings and to quantify the floodplain impact area (the area where the impact boundary and a floodplain intersect). Floodplain crossings along the project corridor can be transverse or longitudinal.

The effective NFHL data were obtained for Salt Lake County (FEMA 2017). Floodplain impact areas are reported by flooding source, crossing type, and FEMA-designated special flood hazard area zones.

What are transverse and longitudinal crossings?

Transverse crossings are crossings that are perpendicular or nearly perpendicular to the direction of stream flow. Longitudinal crossings are crossings that are parallel or nearly parallel to a stream or the edge of a lake.

14.4.2 No-Action Alternative

With the No-Action Alternative, the S.R. 210 Project would not be implemented, and no floodplains would be affected by the action alternatives. However, floodplain impacts could occur as a result of other infrastructure and development projects in the floodplain impact analysis area—projects that have not been addressed or analyzed in this EIS. These projects could occur with the No-Action and/or the action alternatives. Regulatory floodplains would continue to be managed by local floodplain administrators based on local ordinances and National Flood Insurance Program requirements.

14.4.3 Enhanced Bus Service Alternative

This section describes the floodplain impacts from the Enhanced Bus Service Alternative, which includes improvements to the Wasatch Boulevard segment of S.R. 210, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

14.4.3.1 S.R. 210 – Wasatch Boulevard

Table 14.4-1 summarizes the impacts to regulatory floodplains from the Imbalanced-lane and Five-lane Alternatives, which would both widen the Wasatch Boulevard segment of S.R. 210. Impacts are identified by FEMA zone and impact type (transverse or longitudinal) as well as quantified by the number of acres impacted. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

Table 14.4-1. Regulatory Floodplain Impacts from the Imbalanced-lane and Five-lane Alternatives

Stream	FEMA Zone(s)[a]	Acreage of Floodplain Impacts by Type		
		Type of Impact	Imbalanced-lane Alternative	Five-lane Alternative
Big Cottonwood Creek	A / AE / AE Floodway	No impacts		
Little Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is outside this segment		
Adjacent to S.R. 210 near 3500 East	A	Longitudinal	0.32	0.32
Crossing S.R. 210 near 9000 South	A	Longitudinal	0.19	0.19
		Transverse	0.66	0.66

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.
[b] Determined based on the project impact footprint.

As shown above in Table 14.4-1, the Imbalanced-lane and Five-lane Alternatives would have transverse and longitudinal crossings of regulatory floodplains in Salt Lake County. Sections 14.4.3.1.1 and 14.4.3.1.2 below discuss the impacts from each of these alternatives.

14.4.3.1.1 Imbalanced-lane Alternative

The Imbalanced-lane Alternative would impact a total of about 1.17 acres of Zone A special flood hazard area adjacent to S.R. 210 near 3500 East and at the S.R. 210 crossing of Deaf Smith Canyon Creek near 9000 South. These impacts are classified as both transverse and longitudinal.

14.4.3.1.2 Five-lane Alternative

The Five-lane Alternative would add one additional travel lane, which would require about 12 feet more pavement than the Imbalanced-lane Alternative. However, the floodplain impacts from the Five-lane Alternative would be the same as from the Imbalanced-lane Alternative.

14.4.3.2 S.R. 210 – North Little Cottonwood Road to Alta

The Enhanced Bus Service Alternative does not include S.R. 210 roadway improvements or expanded embankments between North Little Cottonwood Road and the town of Alta and the proposed bus stops at Snowbird and Alta Ski resorts would be outside of any floodplain. Therefore, no floodplain impacts have been identified from the Enhanced Bus Service Alternative in Little Cottonwood Canyon.

14.4.3.3 Mobility Hubs Alternative

The Enhanced Bus Service Alternative includes two mobility hubs: a mobility hub at the gravel pit and a mobility hub at the park-and-ride lot at 9400 South and Highland Drive.

The proposed mobility hub footprints at the gravel pit and at 9400 South and Highland Drive do not encroach on any regulatory floodplains; therefore, no floodplain impacts have been identified.

What is a mobility hub?

A mobility hub is a location where users can transfer from their personal vehicle to a bus.

What is the gravel pit?

The gravel pit is an existing aggregate (gravel) mine located on the east side of Wasatch Boulevard between 6200 South and Fort Union Boulevard.

14.4.3.4 Avalanche Mitigation Alternatives

The Enhanced Bus Service Alternative includes two alternatives for avalanche mitigation: the Snow Sheds with Berms Alternative and the Show Sheds with Realigned Road Alternative.

Table 14.4-2 summarizes the impacts to regulatory floodplains from the avalanche mitigation alternatives with the Enhanced Bus Service Alternative. Impacts are identified by FEMA zone and impact type (transverse or longitudinal), as well as quantified by the number of acres impacted. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

Table 14.4-2. Regulatory Floodplain Impacts from the Avalanche Mitigation Alternatives with the Enhanced Bus Service Alternative

Stream	FEMA Zone(s)[a]	Acreage and Type of Floodplain Impacts[b]		
		Type of Impact	Snow Sheds with Berms Alternative	Snow Sheds with Realigned Road Alternative
Big Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is outside this component		
Little Cottonwood Creek	A	Longitudinal	0.01	0.14
Little Cottonwood Creek	AE / AE Floodway	No impacts; floodplain is outside this component		
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain is outside this component		
Crossing S.R. 210 near 9000 South	A	No impacts; floodplain is outside this component		

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.

[b] Determined based on the project impact footprint.

As shown above in Table 14.4-2, the avalanche mitigation alternatives with the Enhanced Bus Service Alternative would have longitudinal crossings of regulatory floodplains in Salt Lake County. Sections 14.4.3.4.1 and 14.4.3.4.2 below discuss the impacts from each of the avalanche mitigation alternatives with the Enhanced Bus Service Alternative.

14.4.3.4.1 Snow Sheds with Berms Alternative

The Snow Sheds with Berms Alternative would result in 0.01 acre of longitudinal Zone A floodplain impacts on Little Cottonwood Creek. These impacts are classified as longitudinal crossings because the flow in Little Cottonwood Creek is parallel to S.R. 210 near the proposed snow shed location. The snow sheds with berms would be above Little Cottonwood Creek. Because data about a base flood elevation are not available, it is unclear whether the footprint of this alternative would be in the floodway fringe or outside and above it.

14.4.3.4.2 Snow Sheds with Realigned Road Alternative

The Snow Sheds with Realigned Road Alternative would result in 0.14 acre of longitudinal Zone A floodplain impacts to Little Cottonwood Creek. Similar to the Snow Sheds with Berms Alternative, these impacts are classified as longitudinal crossings because the flow in Little Cottonwood Creek is parallel to S.R. 210 near the proposed snow shed location. Because data about a base flood elevation are not available, it is unclear whether the footprint of this alternative would be in the floodway fringe or outside and above it.

14.4.3.5 Trailhead Parking Alternatives

The Enhanced Bus Service Alternative includes three alternatives to address trailhead parking:

- Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative
- Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative
- No Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

14.4.3.5.1 Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative

Table 14.4-3 summarizes the impacts to regulatory floodplains from the Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative with the Enhanced Bus Service Alternative. Impacts are identified by FEMA zone and impact type (transverse or longitudinal) as well as quantified by the number of acres impacted. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

Table 14.4-3. Regulatory Floodplain Impacts from the Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative with the Enhanced Bus Service Alternative

Stream	FEMA Zone(s)[a]	Acreage and Type of Floodplain Impacts[b]				
		Type of Impact	Bridge Trailhead	Gate Buttress Trailhead	Lisa Falls Trailhead	White Pine Trailhead
Big Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is not in this segment				
Little Cottonwood Creek	A	Longitudinal	No impacts	0.01	No impacts	No impacts
Little Cottonwood Creek	AE / AE Floodway	No impacts; floodplain is not in this segment				
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain is not in this segment				
Crossing S.R. 210 near 9000 South	A	No impacts; floodplain is not in this segment				

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.
[b] Determined based on the project footprint.

As shown above in Table 14.4-3, the Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative would result in 0.01 acre of longitudinal Zone A floodplain impacts to Little Cottonwood Creek at the Gate Buttress Trailhead. The impact would occur from a drainage pipe and the energy-dissipation measure (riprap) placed at the pipe's outfall. Because no base flood elevations are provided and no detailed hydraulic modeling has been performed on Little Cottonwood Creek, it is unclear whether the drainage pipe would be above or below the floodplain elevation. Since the impact area is small,

UDOT does not anticipate that this alternative would change floodwater surface elevations. The proposed improvements at the other three trailheads would not cause impacts to the regulatory floodplain. The impacts are classified as longitudinal crossings because Little Cottonwood Creek flows parallel to S.R. 210 near the Gate Buttress Trailhead.

14.4.3.5.2 Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

The floodplain impacts from this alternative would be the same as those from the Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative.

14.4.3.5.3 No Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

No additional pavement or roadway embankment is proposed with this alternative. For this reason, there would be no identified encroachments on, or impacts to, regulatory floodplains.

14.4.3.6 No Winter Parking Alternative

Eliminating winter parking on S.R. 210 with the No Winter Parking Alternative does not include any additional proposed pavement or roadway embankment. For this reason, there would be no identified encroachments on, or impacts to, regulatory floodplains.

14.4.3.7 Summary of Regulatory Floodplain Impacts

The floodplain impacts from the Enhanced Bus Service Alternative (between about 1.18 and 1.32 total acres) would occur as a result of longitudinal and transverse crossings of regulatory floodplains. The majority of these impacts (about 1.17 acres) are necessary to widen Wasatch Boulevard from Fort Union Boulevard to North Little Cottonwood Road and meet UDOT's safety standards. Therefore, completely avoiding floodplain encroachments from this alternative is not feasible. The impacted regulatory floodplains are classified as Zone A, meaning that no base flood elevations have been established. Without measures to reduce or mitigate floodplain impacts, this alternative could reduce the natural and beneficial floodplain values including flood conveyance, storage, and control; groundwater recharge; water quality function; and wildlife habitat and diversity.

Following the appropriate design standards and criteria would reduce floodplain impacts to adjoining properties, adjacent stream segments, and flooding risks to the highway infrastructure and the traveling public. Roadway elevations would continue to be above the adjacent floodplain elevations, where those elevations are defined, so that flooding would not interfere with the functional use of a transportation facility needed for emergency vehicles or evacuation. Culverts and bridges in regulatory floodplains would be designed to accommodate a 100-year flood in accordance with FEMA and local floodplain ordinance criteria. Culverts and bridges in other areas would be designed to accommodate a 50-year flood per UDOT's requirements for the facility. These design standards, together with the proper placement of structures and walls, would reduce the risk that the project improvements would exacerbate flooding conditions. Hydraulic structures and walls would also preserve floodplain connectivity and would reduce impacts to natural and beneficial floodplain conveyance values.

Floodplains, water quality, and ecosystems are interrelated; refer to the following chapters for additional discussion: Chapter 12, *Water Resources*, and Chapter 13, *Ecosystem Resources*. With the mitigation measures presented in Section 14.4.8, *Mitigation Measures*, the Enhanced Bus Service Alternative would not result in a significant adverse impact to natural and beneficial floodplain values.

In summary, the Enhanced Bus Service Alternative would result in neither a significant potential for interfering with a transportation facility needed for evacuation or emergency vehicles nor a significant risk of upstream flooding. Furthermore, the impacts to natural and beneficial floodplain values would not be significant because of proposed hydraulic structures and walls. For additional discussion, refer to Section 14.4.8, *Mitigation Measures*.

14.4.4 Enhanced Bus Service in Peak-period Shoulder Lane Alternative

This section describes the floodplain impacts from the Enhanced Bus Service in Peak-period Shoulder Lane Alternative, which includes improvements to the Wasatch Boulevard segment of S.R. 210, improvements to the segment of S.R. 210 from North Little Cottonwood Road to the town of Alta, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

14.4.4.1 S.R. 210 – Wasatch Boulevard

The floodplain impacts from the Imbalanced-lane and Five-lane Alternatives with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as those with the Enhanced Bus Service Alternative.

14.4.4.2 S.R. 210 – North Little Cottonwood Road to Alta

Table 14.4-4 summarizes the impacts to regulatory floodplains from the Enhanced Bus Service in Peak-period Shoulder Lane Alternative from North Little Cottonwood Road to the town of Alta. Impacts are designated by FEMA zone and impact type (transverse or longitudinal) as well as quantified by the number of acres impacted. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

As shown in Table 14.4-4, the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would have longitudinal crossings of regulatory floodplains in Salt Lake County. These impacts account for about 0.88 acre of Zone A floodplains on Little Cottonwood Creek. They would result from widening S.R. 210 from North Little Cottonwood Road to the town of Alta as a result of implementing shoulder lanes for the enhanced bus service.

S.R. 210 from North Little Cottonwood Road to the town of Alta crosses numerous tributary streams that do not have a regulatory floodplain. The current capacity of the existing S.R. 210 crossing culverts for these smaller tributary streams has not been evaluated. As described in Section 14.4.3.7, *Summary of Regulatory Floodplain Impacts*, UDOT would design these culverts to pass 50-year flow rates, which would improve the capacity of some of the culverts. Also see Chapter 12, *Water Resources*, for more information about the water quality effects of deficient culverts and Chapter 13, *Ecosystem Resources*, for additional discussion regarding the riparian values of these smaller tributaries.

Table 14.4-4. Regulatory Floodplain Impacts from the Enhanced Bus Service in Peak-period Shoulder Lane Alternative

Stream	FEMA Zone(s)[a]	Acreage and Type of Floodplain Impacts[b]	
		Type of Impact	Enhanced Bus Service in Peak-period Shoulder Lane Alternative
Big Cottonwood Creek	A / AE / AE Floodway	No impacts	
Little Cottonwood Creek	A	Longitudinal	0.88
Little Cottonwood Creek	AE / AE Floodway	No impacts; floodplain is not in this segment	
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain is not in this segment	
Crossing S.R. 210 near 9000 South	A	No impacts; floodplain is not in this segment	

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.
[b] Determined based on the project footprint.

14.4.4.3 Mobility Hubs Alternative

The floodplain impacts from the mobility hubs with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

14.4.4.4 Avalanche Mitigation Alternatives

The floodplain impacts from the avalanche mitigation alternatives with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

14.4.4.5 Trailhead Parking Alternatives

The floodplain impacts from the trailhead parking alternatives with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

14.4.4.6 No Winter Parking Alternative

The floodplain impacts from the No Winter Parking Alternative with the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would be the same as with the Enhanced Bus Service Alternative.

14.4.4.7 Summary of Regulatory Floodplain Impacts

The floodplain impacts from the Enhanced Bus Service in Peak-period Shoulder Lane Alternative (between about 2.06 and 2.20 total acres) would occur as a result of longitudinal and transverse crossings of regulated floodplain. The majority of these impacts are necessary to widen Wasatch Boulevard (about 1.17 acres) and to widen S.R. 210 between North Little Cottonwood Road and the town of Alta (about 0.88 acres). Therefore, completely avoiding longitudinal floodplain encroachments from this alternative is not feasible. All of the impacted regulatory floodplains are classified as Zone A, meaning that no base flood elevations have been established. Without measures to reduce or mitigate floodplain impacts, this

alternative could reduce the natural and beneficial floodplain values including flood conveyance, storage, and control; groundwater recharge; water quality function; and wildlife habitat and diversity.

Following the appropriate design standards and criteria would avoid floodplain impacts to adjoining properties, adjacent stream segments, and flooding risks to the highway infrastructure and the traveling public. Roadway elevations would continue to be above the adjacent floodplain elevations, where those elevations are defined, so that flooding would not interfere with the use of a transportation facility needed for emergency vehicles or evacuation. Culverts and bridges in regulatory floodplains would be designed to accommodate 100-year flood flows in accordance with FEMA and local floodplain ordinance criteria. Culverts and bridges in other areas would be designed to accommodate a 50-year flood per UDOT's requirements for the facility. These design standards, together with the proper placement of structures and walls, would reduce the risk that the project improvements would exacerbate flooding conditions. Hydraulic structures and walls would also preserve floodplain connectivity and would reduce impacts to natural and beneficial floodplain conveyance values.

Floodplain values, water quality, and ecosystems are interrelated; refer to the following chapters for additional discussion: Chapter 12, *Water Resources*, and Chapter 13, *Ecosystem Resources*. With the mitigation measures presented in Section 14.4.8, *Mitigation Measures*, the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would not result in a significant adverse impact to natural and beneficial floodplain values.

In summary, the Enhanced Bus Service in Peak-period Shoulder Lane Alternative would result in neither a significant potential for interfering with a transportation facility needed for evacuation or emergency vehicles nor a significant risk of upstream flooding. Furthermore, the impacts to natural and beneficial floodplain values would not be significant because of proposed hydraulic structures and walls. For additional discussion, refer to Section 14.4.8, *Mitigation Measures*.

14.4.5 Gondola Alternative A (Starting at Canyon Entrance)

This section describes the floodplain impacts from Gondola Alternative A, which includes a gondola alignment from the entrance to Little Cottonwood Canyon to the Snowbird and Alta ski resorts, improvements to the Wasatch Boulevard segment of S.R. 210, two mobility hubs, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

14.4.5.1 S.R. 210 – Wasatch Boulevard

The floodplain impacts from the Imbalanced-lane and Five-lane Alternatives with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

What are base, angle, and terminal stations?

As used in this chapter, the term *terminal station* refers to the first and last stations on a passenger's gondola trip. Passengers board and disembark the gondola cabins at the terminal stations.

The *base station* is the terminal station at the bottom of the canyon, and a *destination station* is a terminal station at the top of the canyon.

The gondola alternatives also include *angle stations*, which are needed to adjust the horizontal direction of the cabin; passengers remain in the cabin as it passes through an angle station.

A *tower* supports the gondola cable.

14.4.5.2 S.R. 210 – North Little Cottonwood Road to Alta

The floodplain impacts from Gondola Alternative A from North Little Cottonwood Road to the town of Alta would be the same as with the Enhanced Bus Service Alternative.

Table 14.4-5 summarizes the impacts to regulatory floodplains from the gondola towers and stations (base, angle, and destination stations) with Gondola Alternative A. Impacts are identified by FEMA zone and impact type (transverse or longitudinal) as well as quantified by the number of acres impacted. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

Table 14.4-5. Regulatory Floodplain Impacts from the Gondola Towers and Stations with Gondola Alternative A

Stream	FEMA Zone(s)[a]	Acreage and Type of Floodplain Impacts	
		Type of Impact	Gondola Alternative A
Impacts from Gondola Towers and Stations			
Big Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is outside gondola alignment	
Little Cottonwood Creek	A	Longitudinal	0.32
Little Cottonwood Creek	AE / AE Floodway	No impacts	
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain outside gondola alignment	
Crossing S.R. 210 near 9000 South	A	No impacts	

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.
[b] Determined based on the project footprint.

As shown above in Table 14.4-5, the gondola towers and stations with Gondola Alternative A would have longitudinal crossings of regulatory floodplains in Salt Lake County impacting about 0.3 acre of the Little Cottonwood Creek Zone A floodplain.

14.4.5.3 Mobility Hubs Alternative

The floodplain impacts from the mobility hubs with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

14.4.5.4 Avalanche Mitigation Alternatives

The floodplain impacts from the avalanche mitigation alternatives with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

14.4.5.5 Trailhead Parking Alternatives

The floodplain impacts from the trailhead parking alternatives with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

14.4.5.6 No Winter Parking Alternative

The floodplain impacts from the No Winter Parking Alternative with Gondola Alternative A would be the same as with the Enhanced Bus Service Alternative.

14.4.5.7 Summary of Regulatory Floodplain Impacts

The total floodplain impacts from Gondola Alternative A (between about 1.50 and 1.64 total acres) would occur as a result of longitudinal and transverse crossings. The majority of these impacts (about 1.17 acres) are necessary to widen Wasatch Boulevard. An additional about 0.32 acre of longitudinal floodplain impacts are necessary for placing the gondola towers and stations (base, angle, and destination stations). Therefore, completely avoiding floodplain encroachments from this alternative is not feasible. The impacted regulatory floodplains are classified as Zone A, meaning that no base flood elevations have been established. Without measures to reduce or mitigate floodplain impacts, this alternative could reduce the natural and beneficial floodplain values including flood conveyance, storage, and control; groundwater recharge; water quality function; and wildlife habitat and diversity.

Following the appropriate design standards and criteria would reduce floodplain impacts to adjoining properties, adjacent stream segments, and flooding risks to the highway infrastructure and the traveling public. Roadway elevations would continue to be above the adjacent floodplain elevations, where those elevations are defined, so that flooding would not interfere with the functional use of a transportation facility needed for emergency vehicles or evacuation. Culverts and bridges in regulatory floodplains would be designed to accommodate a 100-year flood in accordance with FEMA and local floodplain ordinance criteria. Culverts and bridges in other areas would be designed to accommodate a 50-year flood per UDOT's requirements for the facility. Some of the gondola towers are currently planned to be located in the floodplain. If they cannot be relocated outside the floodplain during final design, the footings would be located outside the floodway, and they would be designed to withstand flood flows if they are located in the floodway fringe. These design standards, together with the proper placement of structures and walls, would reduce the risk that the project improvements would exacerbate flooding conditions. Hydraulic structures and walls would also preserve floodplain connectivity and would reduce impacts to natural and beneficial floodplain conveyance values.

Floodplains, water quality, and ecosystems are interrelated; refer to the following chapters for additional discussion: Chapter 12, *Water Resources*, and Chapter 13, *Ecosystem Resources*. With the mitigation measures presented in Section 14.4.8, *Mitigation Measures*, Gondola Alternative A would not result in a significant adverse impact to natural and beneficial floodplain values.

In summary, Gondola Alternative A would result in neither a significant potential for interfering with a transportation facility needed for evacuation or emergency vehicles nor a significant risk of upstream flooding. Furthermore, the impacts to natural and beneficial floodplain values would not be significant because of proposed hydraulic structures and walls. For additional discussion, refer to Section 14.4.8, *Mitigation Measures*.

14.4.6 Gondola Alternative B (Starting at La Caille)

This section describes the floodplain impacts of Gondola Alternative B, which includes a gondola alignment from La Caille to the Snowbird and Alta ski resorts, improvements to the Wasatch Boulevard segment of S.R. 210, improvements to the segment of S.R. 210 on North Little Cottonwood Road, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

14.4.6.1 S.R. 210 – Wasatch Boulevard

The floodplain impacts from the Imbalanced-lane and Five-lane Alternatives with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

14.4.6.2 S.R. 210 – North Little Cottonwood Road to Alta

Table 14.4-6 summarizes the impacts to regulatory floodplains from the gondola towers and stations (base, angle, and destination stations) and additional travel lanes for Gondola Alternative B. Impacts are identified by FEMA zone and impact type (transverse or longitudinal) as well as quantified by the number of acres impacted. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

Table 14.4-6. Regulatory Floodplain Impacts from the Gondola Towers and Stations and Additional Travel Lanes with Gondola Alternative B

Stream	FEMA Zone(s)[a]	Acreage and Type of Floodplain Impacts	
		Type of Impact	Gondola Alternative B
Impacts from Gondola Towers and Stations			
Big Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is outside gondola alignment	
Little Cottonwood Creek	A	Longitudinal	0.32
Impacts from Additional Travel Lanes at Gondola Base Station at La Caille			
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain is outside gondola alignment	
Crossing S.R. 210 near 9000 South	A	Longitudinal	0.55
Little Cottonwood Creek	AE	Longitudinal	0.02
Little Cottonwood Creek	AE Floodway	Longitudinal	0.05

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.

[b] Determined based on the project impact footprint.

As shown above in Table 14.4-6, Gondola Alternative B would have longitudinal crossings of regulatory floodplains in Salt Lake County impacting about 0.87 acre of Zone A floodplains from the gondola towers and stations and additional travel lanes. In addition, there would be impacts to about 0.02 acre of Zone AE

floodplains on Little Cottonwood Creek and about 0.05 acre of floodway near S.R. 210 as a part of accommodating the additional travel lanes at the gondola base station.

14.4.6.3 Mobility Hubs Alternative

Because the Gondola Alternative B base station at La Caille would include a 2,500-space parking structure, there would be no need for mobility hubs at the gravel pit or at the existing 9400 South and Highland Drive park-and-ride lot. The floodplain impacts to the gravel pit and the existing 9400 South and Highland Drive park-and-ride-lot with Gondola Alternative B would be the same as with the No-Action Alternative.

The analysis of the 2,500-space parking structure at the Gondola Alternative B base station is included in Section 14.4.6.2, *S.R. 210 – North Little Cottonwood Road to Alta*.

14.4.6.4 Avalanche Mitigation Alternatives

The floodplain impacts from the avalanche mitigation alternatives with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

14.4.6.5 Trailhead Parking Alternatives

The floodplain impacts from the trailhead parking alternatives with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

14.4.6.6 No Winter Parking Alternative

The floodplain impacts from the No Winter Parking Alternative with Gondola Alternative B would be the same as with the Enhanced Bus Service Alternative.

14.4.6.7 Summary of Regulatory Floodplain Impacts

The floodplain impacts from Gondola Alternative B (between about 2.12 and 2.26 total acres) would occur as a result of longitudinal and transverse crossings. The majority of these impacts (about 1.17 acres) are necessary to widen Wasatch Boulevard. An additional approximately 0.94 acre of longitudinal floodplain impacts are necessary for the additional travel lanes needed to access the gondola base station and for placing the gondola towers and stations (base, angle, and destination stations). Therefore, completely avoiding floodplain encroachments from this alternative is not feasible. The impacted regulatory floodplains are classified as Zone A, with the exception of 0.07 acre of floodplain impacts that are classified as Zone AE, including 0.05 acre of floodway. Base flood elevations have been established for the Zone AE floodplains only. Final design and hydraulic analysis will determine whether the encroachments into the Zone AE floodplains would change water surface elevations. Without measures to reduce or mitigate floodplain impacts, this alternative could reduce the natural and beneficial floodplain values including flood conveyance, storage, and control; groundwater recharge; water quality function; and wildlife habitat and diversity.

Following the appropriate design standards and criteria would reduce floodplain impacts to adjoining properties and flooding risks to the highway infrastructure and the traveling public. Roadway elevations would continue to be above the adjacent floodplain elevations, where those elevations are defined, so that flooding would not interfere with the functional use of a transportation facility needed for emergency vehicles

or evacuation. Culverts and bridges in regulatory floodplains would be designed to accommodate a 100-year flood in accordance with FEMA and local floodplain ordinance criteria. Culverts and bridges in other areas would be designed to accommodate a 50-year flood per UDOT's requirements for the facility. Some of the gondola towers are currently planned to be located in the floodplain. If they cannot be relocated outside the floodplain during final design, the footings would be located outside the floodway, and they would be designed to withstand flood flows if they are located in the floodway fringe. These design standards, together with the proper placement of structures and walls, would reduce the risk that the project improvements would exacerbate flooding conditions. Hydraulic structures and walls would also preserve floodplain connectivity and would reduce impacts to natural and beneficial floodplain conveyance values.

Floodplains, water quality, and ecosystems are interrelated; refer to the following chapters for additional discussion: Chapter 12, *Water Resources*, and Chapter 13, *Ecosystem Resources*. With the mitigation measures presented in Section 14.4.8, *Mitigation Measures*, Gondola Alternative B would not result in a significant adverse impact to natural and beneficial floodplain values.

In summary, Gondola Alternative B would result in neither a significant potential for interfering with a transportation facility needed for evacuation or emergency vehicles nor a significant risk of upstream flooding. Furthermore, the impacts to natural and beneficial floodplain values would not be significant because of proposed hydraulic structures and walls. For additional discussion, refer to Section 14.4.8, *Mitigation Measures*.

14.4.7 Cog Rail Alternative (Starting at La Caille)

This section describes the impacts to regulatory floodplains from the Cog Rail Alternative, which includes a cog rail alignment from La Caille to the Snowbird and Alta ski resorts, improvements to the Wasatch Boulevard segment of S.R. 210, improvements to the segment of S.R. 210 on North Little Cottonwood Road, avalanche mitigation alternatives, trailhead parking alternatives, and the No Winter Parking Alternative.

What are cog rail base and terminal stations?

As used in this chapter, the term *terminal station* refers to the first and last stations on a passenger's cog rail trip. Passengers board and disembark the cog rail vehicles at the terminal stations.

The *base station* is the terminal station at the bottom of the canyon, and a *destination station* is a terminal station at the top of the canyon.

14.4.7.1 S.R. 210 – Wasatch Boulevard

The floodplain impacts from the Imbalanced-lane and the Five-lane Alternatives with the Cog Rail Alternative would be the same as with the Enhanced Bus Service Alternative.

14.4.7.2 S.R. 210 – North Little Cottonwood Road to Alta

Table 14.4-7 summarizes the impacts to regulatory floodplains from the cog rail tracks and stations for the Cog Rail Alternative. Impacts are designated by FEMA zone and impact type (transverse or longitudinal) as well as quantified by the number of acres impacted. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

Table 14.4-7. Regulatory Floodplain Impacts from the Cog Rail Alternative

Stream	FEMA Zone(s)[a]	Acreage and Type of Floodplain Impacts[b]	
		Type of Impact	Cog Rail Alternative
Impacts from Cog Rail Tracks and Stations at Snowbird and Alta			
Big Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is outside cog rail alignment	
Little Cottonwood Creek	A	Longitudinal	0.07
Little Cottonwood Creek	AE / AE Floodway	No impacts; floodplain is outside cog rail alignment	
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain is outside cog rail alignment	
Crossing S.R. 210 near 9000 South	A	No impacts; floodplain is outside cog rail alignment	
Impacts from Additional Travel Lanes and Cog Rail Station at La Caille			
Big Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is outside cog rail alignment	
Little Cottonwood Creek	A	Longitudinal	0.21
Little Cottonwood Creek	AE	Longitudinal	0.02
Little Cottonwood Creek	AE Floodway	Longitudinal	0.05
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain is outside cog rail alignment	
Crossing S.R. 210 near 9000 South	A	No impacts; floodplain is outside cog rail alignment	

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.
[b] Determined based on the project footprint.

As shown above in Table 14.4-7, the Cog Rail Alternative would have longitudinal crossings of regulatory floodplains in Salt Lake County. These impacts account for about 0.28 acre of Zone A floodplains on Little Cottonwood Creek. In addition, there would be impacts to about 0.02 acre of Zone AE (floodway fringe) and 0.05 acre of Zone AE Floodway floodplains on Little Cottonwood Creek near S.R. 210 as a part of accommodating the additional travel lanes at the cog rail base station.

14.4.7.3 Mobility Hubs Alternative

The floodplain impacts from the mobility hubs with the Cog Rail Alternative would be the same as with Gondola Alternative B.

14.4.7.4 Avalanche Mitigation Alternatives

The Cog Rail Alternative includes two alternatives for avalanche mitigation in the mid-canyon segment: the Snow Sheds with Berms Alternative and the Snow Sheds with Realigned Road Alternative. These snow sheds would cover both the proposed cog rail tracks and the existing roadway. In the upper portions of the canyon, cog rail snow sheds would be needed for some of the higher-risk avalanche paths (East Hellgate, Hilton, Superior, and Little Superior). These snow sheds would cover the cog rail tracks. These upper-canyon snow sheds are all outside the floodplain of Little Cottonwood Creek.

Table 14.4-8 summarizes the impacts to regulatory floodplains from the avalanche mitigation alternatives with the Cog Rail Alternative. Impacts are identified by FEMA zone and impact type (transverse or longitudinal) as well as quantified by the number of acres impacted. For both avalanche mitigation alternatives, there would be an additional snow shed in the upper canyon to protect the cog rail tracks; however, this snow shed would be outside the regulatory floodplain, and no impacts are identified. Regulatory floodplains in the floodplain impact analysis area are shown above in Figure 14.3-1 through Figure 14.3-4, *Floodplains in the Floodplain Impact Analysis Area*.

Table 14.4-8. Regulatory Floodplain Impacts from the Avalanche Mitigation Alternatives with the Cog Rail Alternative

Stream	FEMA Zone(s)[a]	Acreage and Type of Floodplain Impacts[b]		
		Type of Impact	Snow Sheds with Berms Alternative	Snow Sheds with Realigned Road Alternative
Big Cottonwood Creek	A / AE / AE Floodway	No impacts; floodplain is not in this segment		
Little Cottonwood Creek	A	Longitudinal	No impacts	0.05
Little Cottonwood Creek	AE / AE Floodway	No impacts; floodplain is not in this segment		
Adjacent to S.R. 210 near 3500 East	A	No impacts; floodplain is not in this segment		
Crossing S.R. 210 near 9000 South	A	No impacts; floodplain is not in this segment		

[a] FEMA zones:
A = No base flood elevations determined.
AE = Base flood elevations determined. (The area within a Zone AE floodplain that is not within a floodway is referred to as the floodway fringe. See Figure 14.2-1, *FEMA Floodplain Schematic*, above.)
AE Floodway = Base flood elevations and floodway determined.

[b] Determined based on the project impact footprint.

14.4.7.4.1 Snow Sheds with Berms Alternative

There are no floodplain impacts identified from the Snow Sheds with Berms Alternative, which includes both the mid-canyon snow sheds and the upper-canyon, rail-only snow shed.

14.4.7.4.2 Show Sheds with Realigned Road Alternative

The Snow Sheds with Realigned Road Alternative would result in 0.05 acre of longitudinal Zone A floodplain impacts to Little Cottonwood Creek. All these impacts would be from the mid-canyon snow sheds; there would no floodplain impacts as a result of the upper-canyon, rail-only snow shed. These impacts are

classified as longitudinal because the flow in Little Cottonwood Canyon is parallel to S.R. 210 near the proposed snow shed locations. Because the impacts would occur in a Zone A floodplain, no base flood elevations have been determined, and it is unclear whether these impacts would occur below the 100-year water surface elevation.

14.4.7.5 Trailhead Parking Alternatives

14.4.7.5.1 Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative

There are no floodplain impacts identified at the Bridge and White Pine Trailheads from this trailhead parking alternative. Improvements at the Grit Mill, Gate Buttress, and Lisa Falls Trailheads have been included in Section 14.4.7.2, *S.R. 210 – North Little Cottonwood Road to Alta*, since improvements at these trailheads are required to implement the required cog rail tracks and stations as part of the Cog Rail Alternative.

14.4.7.5.2 Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

The floodplain impacts from this trailhead parking alternative would be the same as those from the Trailhead Improvements and No S.R. 210 Roadside Parking within ¼ Mile of Trailheads Alternative.

14.4.7.5.3 No Trailhead Improvements and No Roadside Parking from S.R. 209/S.R. 210 Intersection to Snowbird Entry 1 Alternative

The floodplain impacts from this trailhead parking alternative would be the same as with the Enhanced Bus Service Alternative.

14.4.7.6 No Winter Parking Alternative

The floodplain impacts from the No Winter Parking Alternative with the Cog Rail Alternative would be the same as with the Enhanced Bus Service Alternative.

14.4.7.7 Summary of Regulatory Floodplain Impacts

The floodplain impacts from the Cog Rail Alternative (between about 1.52 and 1.57 total acres) would occur as a result of longitudinal and transverse crossings. The majority of these impacts (about 1.17 acres) are necessary to widen Wasatch Boulevard. An additional approximately 0.35 acre of longitudinal floodplain impacts are necessary for the additional travel lanes needed to access the cog rail base station and for the cog rail alignment and stations at Snowbird and Alta. An additional 0.05 acre of longitudinal floodplain impacts can be avoided by choosing the Snow Sheds with Berms Alternative instead of the Snow Sheds with Realigned Road Alternative for avalanche mitigation. Therefore, completely avoiding floodplain encroachments from the Cog Rail Alternative is not feasible.

The impacted regulatory floodplains are classified as Zone A, with the exception of 0.07 acre of floodplain impacts that are classified as Zone AE, including 0.05 acre of Zone AE Floodway. Base flood elevations have been established for the Zone AE floodplains only. Final design and hydraulic analysis will determine whether the encroachments into the Zone AE floodplains would change water surface elevations. Without measures to reduce or mitigate floodplain impacts, this alternative could reduce the natural and beneficial floodplain values including flood conveyance, storage, and control; groundwater recharge; water quality function; and wildlife habitat and diversity.

Following the appropriate design standards and criteria would reduce floodplain impacts to adjoining properties and flooding risks to the highway infrastructure and the traveling public. Roadway elevations would continue to be above the adjacent floodplain elevations, where those elevations are defined, so that flooding would not interfere with the functional use of a transportation facility needed for emergency vehicles or evacuation. Culverts and bridges in regulatory floodplains would be designed to accommodate a 100-year flood in accordance with FEMA and local floodplain ordinance criteria. Culverts and bridges in other areas would be designed to accommodate a 50-year flood per UDOT's requirements for the facility. These design standards, together with the proper placement of structures and walls, would reduce the risk that the project improvements would exacerbate flooding conditions. Hydraulic structures and walls would also preserve floodplain connectivity and would reduce impacts to natural and beneficial floodplain conveyance values.

Floodplains, water quality, and ecosystems are interrelated; refer to the following chapters for additional discussion: Chapter 12, *Water Resources*, and Chapter 13, *Ecosystem Resources*. With the mitigation measures presented in Section 14.4.8, *Mitigation Measures*, the Cog Rail Alternative would not result in a significant adverse impact to natural and beneficial floodplain values.

In summary, the Cog Rail Alternative would result in neither a significant potential for interfering with a transportation facility needed for evacuation or emergency vehicles nor a significant risk of upstream flooding. Furthermore, the impacts to natural and beneficial floodplain values would not be significant because of proposed hydraulic structures and walls. For additional discussion, refer to Section 14.4.8, *Mitigation Measures*.

14.4.8 Mitigation Measures

UDOT and/or its construction contractor will take measures to reduce floodplain impacts and to ensure that the project complies with all applicable regulations. These mitigation measures will include the following:

- The action alternatives would require a number of stream and floodplain crossings in the same locations where they presently exist. Where new or rehabilitated bridges and culverts are included in the design of an alternative, the design will follow FEMA requirements and the requirements of UDOT's *Drainage Manual of Instruction*, where applicable. Where no regulatory floodplain is defined, culverts and bridges will be designed to accommodate a 50-year (2%-annual-chance) or greater-magnitude flood. Where regulatory floodplains are defined, hydraulic structures will be designed to accommodate a 100-year (1%-annual-chance) flood. Energy-dissipation measures will be included in the alternative's design as applicable.
- Stream alteration permits will be obtained for stream crossings as required by the Utah Division of Water Rights. Note that the stream alteration permitting process is a separate process from the floodplain permitting process. The stream alteration permitting process is required to satisfy state regulations and under certain circumstances may also be used to meet Clean Water Act Section 404 permitting requirements (through use of Army Corps of Engineers Programmatic General Permit 10).
- Floodplain development permits will be obtained for all locations where the proposed roadway embankment or structural elements would encroach on a regulatory floodplain, and structures will be designed to meet the more stringent of FEMA requirements and local floodplain ordinances. FEMA requires that construction within a floodway must not increase the base (100-year) flood elevation. FEMA Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) processes will be executed in compliance with 44 CFR Sections 60.3 and 65.12 as necessary based on hydrologic and hydraulic analyses and the nature of anticipated changes in base flood elevation and/or floodplain limits. The following case applies:
    - For areas of Zone A floodplain impacts, the approach will be to analyze existing and proposed conditions and design project features such that compliance is achieved (that is, such that a CLOMR is not required) as much as possible. In these areas, FEMA performed floodplain mapping based on approximate methods. The absence of a detailed study or floodway delineation places the burden on the project proponent (in this case, UDOT) to perform hydrologic and hydraulic analyses consistent with FEMA standards. These analyses will confirm or refine the FEMA floodplain mapping and could increase or decrease the estimate of affected areas.
- UDOT will obtain flood-control permits from Salt Lake County for actions affecting County-controlled waterways, which include Little Cottonwood Creek and Big Cottonwood Creek. UDOT will obtain flood-control permits from Cottonwood Heights City for Unnamed Creek near 3500 East and Unnamed Creek near 9000 South.
- Roadway elevations will be a minimum of 2 feet above adjacent floodplain elevations, where those elevations are defined, so that flooding will not interfere with a transportation facility needed for emergency vehicles or evacuation.
- Walls will be designed and constructed to minimize longitudinal floodplain impacts.

14.5 References

[FEMA] Federal Emergency Management Agency

2017 National Flood Hazard Layer for Salt Lake County (All Jurisdictions). Obtained via FEMA Map Service Center. https://msc.fema.gov/portal. Updated October 2, 2017.

2018a Zone A Definition/Description. https://www.fema.gov/zone. Accessed May 2, 2018.

2018b Zone AE and A1-30 Definition/Description. https://www.fema.gov/zone-ae-and-a1-30. Accessed May 2, 2018.

2018c Flood Insurance Study. https://www.fema.gov/media-library-data/20130726-1554-20490-6003/dfm_dfft.pdf. Accessed November 14, 2018.

2018d Community Status Book. https://www.fema.gov/cis/UT.pdf. Accessed April 16, 2018. [FEMA's Community Status Book is updated daily.]

2019 Flood Insurance Study for Salt Lake County, Letters of Map Revision, and Letters of Map Amendment. Obtained via search on the FEMA Flood Map Service Center for Effective Products in Salt Lake County (All Jurisdictions). https://msc.fema.gov/portal.

[USGS] U.S. Geological Survey

1998 Draper, Utah, 7.5-minute topographic quadrangle, scale 1:24,000.