

## APPENDICES

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# **Appendix A**

## **FEMA CTP Agreement**

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Cooperating Technical Partners  
Memorandum of Agreement

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**FEDERAL EMERGENCY MANAGEMENT AGENCY**  
and the  
**CARSON WATER SUBCONSERVANCY DISTRICT, NEVADA**

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**AGREEMENT** is made on (date) June 6, 2005, by these parties: Carson Water Subconservancy District and the Federal Emergency Management Agency (FEMA).

**BECAUSE** the National Flood Insurance Program (NFIP) established by the National Flood Insurance Act of 1968 has several purposes, the most significant being

- To better indemnify individuals from losses through the availability of flood insurance;
- To reduce future flood damages through community floodplain management regulations; and
- To reduce costs for disaster assistance and flood control.

**BECAUSE** a critical component of this program is the identification and mapping of the nation's floodplains to create a broad-based awareness of the flood hazard and to provide the data necessary for community floodplain management programs and to actuarially rate flood insurance;

**BECAUSE** the Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP) and is authorized by §1360 of the National Flood Insurance Act of 1968, as amended (42 U.S.C. 4101), to establish and update flood-risk zone data in floodplain areas. Further, in the identification of flood-prone areas, FEMA is authorized to consult with, receive information from, and enter into agreements or other arrangements with the head of any State, regional, or local agency;

**BECAUSE** FEMA encourages strong Federal, State, regional, and local partnerships for the purposes of reducing flood losses and disaster assistance; and FEMA and its State, regional, and local partners have determined that it is advantageous to encourage and formalize greater cooperation in the flood hazard identification and mapping processes; and many communities and the agencies that serve them have developed considerable technical capabilities and resources that provide the opportunity to improve and expand the collection, development, and evaluation of flood hazard data; and

**BECAUSE** the Carson Water Subconservancy District has expressed a desire to perform certain functions in the flood hazard identification process and has provided evidence that it has sufficient technical capability and will dedicate the resources necessary to perform those functions.

**NOW THEREFORE**, it is mutually agreed that the parties enter into this agreement to work together to create and maintain accurate, up-to-date flood hazard data for the counties of Douglas, Carson City, Churchill and Lyon, Nevada and Alpine, California, subject to the terms and conditions recited below.

### 1. CONSULTATIONS

The parties shall collaborate on flood hazard identification activities and shall consult with each other to fully integrate each other's contributions into flood hazard identification efforts.

### 2. EVALUATION AND REPORTING

The parties shall annually review the partnership created by the agreement to determine and document the activities undertaken to maintain accurate flood hazard data.

### 3. RESOURCE COMMITMENT

The parties agree to commit the appropriate human, technical, and available financial resources sufficient to coordinate effectively with all entities impacted by flood hazard identification efforts to implement this agreement.

### 4. STANDARDS

Unless otherwise agreed to by the parties, all flood hazard identification activities will be accomplished in accordance with the standards documented in *Guidelines and Specifications for Flood Hazard Mapping Partners*, dated April 2003, and all subsequent revisions.

### 5. SPECIFIC INITIATIVES

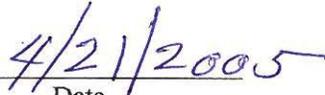
When specific initiatives, projects, or activities are to be performed, they will be forward through and negotiated by the Carson Water Subconservancy District and shall be attached as negotiated Mapping Activity Statement (MAS) items. For this Memorandum of Agreement to go into effect, no MAS items are required.

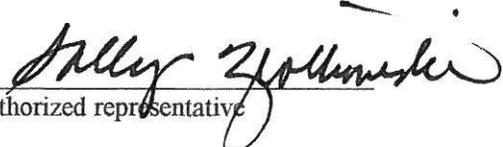
### 6. TERM

The respective duties, responsibilities and commitments of the parties in this agreement shall begin on the date this Agreement is signed by the parties and may be periodically renewed, revised, or terminated at the option of any of the parties. The parties agree that a 60-day notice shall be given prior to the termination of this agreement.

**THEREFORE**, each party has caused this Agreement to be executed by its duly authorized representatives on the date mentioned above.

  
\_\_\_\_\_  
Carson Water Subconservancy, Authorized Representative\*

  
\_\_\_\_\_  
Date

  
\_\_\_\_\_  
FEMA authorized representative

  
\_\_\_\_\_  
Date

\* The Carson Water Subconservancy District is composed of the following entities:

- Carson City, Nevada
- Churchill County, Nevada
- Douglas County, Nevada
- Lyon County, Nevada
- Alpine County, California

## Appendix B

### Links to FEMA County Flood Insurance Rate Maps

<b>JURISDICTION</b>	<b>ONLINE LOCATION</b>
Alpine County, California	<a href="https://msc.fema.gov/portal/availabilitySearch?addcommunity=060632&amp;communityName=ALPINE%20COUNTY%20UNINCORPORATED%20AREAS#searchresultsanchor">https://msc.fema.gov/portal/availabilitySearch?addcommunity=060632&amp;communityName=ALPINE%20COUNTY%20UNINCORPORATED%20AREAS#searchresultsanchor</a>
Carson City, Nevada	<a href="https://msc.fema.gov/portal/availabilitySearch?addcommunity=320001&amp;communityName=CARSON%20CITY,%20CITY%20OF#searchresultsanchor">https://msc.fema.gov/portal/availabilitySearch?addcommunity=320001&amp;communityName=CARSON%20CITY,%20CITY%20OF#searchresultsanchor</a>
Churchill County, Nevada	<a href="https://msc.fema.gov/portal/availabilitySearch?addcommunity=320001&amp;communityName=CARSON%20CITY,%20CITY%20OF#searchresultsanchor">https://msc.fema.gov/portal/availabilitySearch?addcommunity=320001&amp;communityName=CARSON%20CITY,%20CITY%20OF#searchresultsanchor</a>
Douglas County, Nevada	<a href="https://msc.fema.gov/portal/availabilitySearch?addcommunity=320008&amp;communityName=DOUGLAS%20COUNTY%20UNINCORPORATED%20AREAS#searchresultsanchor">https://msc.fema.gov/portal/availabilitySearch?addcommunity=320008&amp;communityName=DOUGLAS%20COUNTY%20UNINCORPORATED%20AREAS#searchresultsanchor</a>
Lyon County, Nevada	<a href="https://msc.fema.gov/portal/availabilitySearch?addcommunity=320001&amp;communityName=CARSON%20CITY,%20CITY%20OF#searchresultsanchor">https://msc.fema.gov/portal/availabilitySearch?addcommunity=320001&amp;communityName=CARSON%20CITY,%20CITY%20OF#searchresultsanchor</a>
Storey County, Nevada	<a href="https://msc.fema.gov/portal/availabilitySearch?addcommunity=320033&amp;communityName=STOREY%20COUNTY%20UNINCORPORATED%20AREAS#searchresultsanchor">https://msc.fema.gov/portal/availabilitySearch?addcommunity=320033&amp;communityName=STOREY%20COUNTY%20UNINCORPORATED%20AREAS#searchresultsanchor</a>

## **Appendix C**

### **Rapid Evaluation of the Carson River**

## **Rapid Evaluation of Carson River System**

In order to assess where the critical floodplain and flood hazard areas are within the basin that are not necessarily shown on FEMA flood insurance maps, the working group conducted a rapid evaluation of the river system using photographs, maps and on-the-ground knowledge. The evaluation was conducted with the primary focus on known flood hazard areas and critical floodplain areas and did not necessarily consider the political or landowner factors.

For the purposes of this document the following definitions apply:

**Critical Floodplain (CF) areas:** Lands adjacent to the river that allow the river to access the floodplain, store floodwaters, dissipate flood velocities and provide critical habitat for wildlife. These lands are highly valued for the public safety and natural resource protection services that they provide.

**Flood Hazard (FH) areas:** Lands adjacent to the river that are at high risk for hazards associated with channel migration due to factors such as excessive bank erosion.

The following subsections are the result of this evaluation. Each area is labeled by County, Number, Critical Floodplain or Flood Hazard with a brief description (e.g. AC1- CF would indicate Alpine County #1, Critical Floodplain). Click link to a google map with points. A shape file can be provided upon request.

### **East and West Fork Drainages in Alpine County (AC), California**

The majority of the watershed in Alpine County is located in wilderness areas with populated areas centered around Markleeville and Woodfords. Over 95% of the land in Alpine County is publicly owned. The floodplain is very narrow throughout the upper river system with canyon walls and wilderness area preventing development in many areas. Flood zones in this area are undetermined by FEMA.

#### **General Recommendations**

- Maintain river system to allow floodwaters to access floodplains in valley and meadow areas.
- Support Markleeville Guard Station Restoration Project.
- Investigate restoration activities in Upper Hope Valley and Hot Springs Creek to enhance floodplain accessibility and potential plus reduce erosion.
- Investigate opportunities for road, culvert and bridge enhancement to accommodate floodwaters better and decrease erosion.

## East Fork Carson River Drainages in Alpine County, California

### AC01-FH: Flood Hazard Area - Wolf Creek Landslide:

The landslide is located downstream of Wolf Creek meadows area on land managed by the USFS. The landslide causes damage to the road that accesses the meadow and the campground when active. This road is the only access to Wolf Creek meadow and the campground area. Documented landslides have occurred since the 1960's with the most recent during the 1997 flood event. Debris from the landslide has come across the channel during flood events causing channel blockage and excessive sediment loading.

### AC02-CF: Critical Floodplain Area – Wolf Creek Meadow:

This meadow is wide and long and provides for good storage of floodwaters. Currently there are 4 homes located in the meadow. Allowing the meadow to act as a sponge for floodwaters would decrease the amount of flood water that enters into the East Fork.

### AC03-FH: Flood Hazard Area - Upper East Fork:

Highway 89 closely follows the East Fork Carson River from the confluence of Silver and Wolf Creeks to Hangman's Bridge. There is a high potential for damage to the road during flooding events.

### AC04 – FH: Flood Hazard Area – Washington Fire Burn Scar:

The burn area of the Washington Fire affects East Fork Carson River drainages along Highway 89 and Highway 4, and Wolf Creek Road. Record snow pack and extended high flows caused multiple landslides in burn scar area during 2017. Large sections of Highway 89 and Highway 4 were closed until late summer 2017. Wolf Creek Road was blocked with debris flows for many months in 2017 and did not open to public traffic until 2018.

### AC05 – FH: Flood Hazard Area - Silver Hill Mine Road:

This dirt road off Highway 4 is closed indefinitely after Washington Fire due to hazards from burned trees, erosion, flooding, and potential debris flows.

### AC06 – FH: Flood Hazard Area - Mountaineer Creek:

Mountaineer Creek subject to potential post-fire flooding to East Fork Carson River and may result also cause debris flows.

### AC07–FH: Flood Hazard Area – Monitor Creek:

Monitor Creek is heavily laden with tailings from historic mining activities. During flood events these tailings could be washed into the East Fork increasing sedimentation and contamination of the river. The USFS currently has a project that is reducing the amount of acid mine drainage entering the stream system. Flood Hazard Area - Markleeville Guard Station: The guard station, which is located in the heart of Markleeville, experiences flooding on a regular basis. Currently there are designs to remove the station and return the area to a more natural state with floodplain. There are flood walls and a bridge at this location that constrains high flows causing flooding to occur in adjacent areas. In addition, drains on the guard station property frequently back up causing flooding during even small events.

### AC08–FH: Flood Hazard Area - Markleeville Guard Station Restoration Site:

The guard station, located in the heart of Markleeville, experienced flooding on a regular basis. The guard station was removed in 2012 and designs to return the floodplain to a more natural state with were created. The flood walls and a bridge at this location constrain high flows and increase flood velocities. Millberry Creek, a tributary of Markleeville Creek, has blown out the road to the pump station and wastewater ponds at its confluence with Markleeville Creek several times. In addition, manhole drains on the guard station property

are not sealed and can take on water during floods. When inundated, the wastewater storage could potentially fail and spill which would create both flood and environmental hazards. FEMA funded a gabion repair project in 2004-2005 at this site and in 2017 FEMA funded the repair of the pump station. Alpine County continues to seek funding to restore this site and mitigate flood and environmental hazards. A repair project completed in 2004-2005 just east of this location (FEMA funded). In 2017, FEMA funded pump station replacement. Potential to apply for PDM funds to move pump station so doesn't have to continue to be replaced.

AC09– FH: Flood Hazard Area – Markleeville Airport:

Post – fire flooding has blocked airport access when flood waters flow across road.

AC10 – FH: Flood Hazard Area - Spratt Creek:

The ditch is used by Water District whose supply is 50% groundwater and 50% surface water source for peak flows in the summer. Water collected in gallery conveyed to pipe then goes across private lands and ends up at Hot Springs Rd. During high flows, turbidity levels are too high for treatment, so this source lost. It has potential to blow out road and flood private land adjacent to this ditch.

AC11 – FH: Flood Hazard Area - Hot Springs Road Bridge:

Hot Springs Road Bridge may not have enough capacity to convey high flows. It may plug or overtop during large floods.

AC12 – FH: Flood Hazard Area – Hot Springs Creek:

The portion of Hot Springs Creek between Markleeville and Grover Hot Springs has high potential for channel migration and excessive erosion. There have been debris flow problems along the road, in particular at the location of the retaining wall.

AC13 – FH: Flood Hazard Area - Old Ditch System:

This Ditch, West of Markleeville, from Pleasant Valley Road to Laramie Street in Markleeville, may flood houses and fire station. It collects all surface runoff and fails regularly. It requires regular maintenance but to prevent failure.

AC14 – FH: Flood Hazard Area - Unnamed Tributaries of Shay Creek:

Culverts need to be upsized to prevent flooding.

AC15 – FH: Flood Hazard Area – Burnside Lake:

Burnside Lake area subject to potential post-fire flooding and debris flows which would impact Burnside Lake Road.

AC16 – FH: Flood Hazard Area - Scossa Cow Camp:

On Highway 4 near Scossa Cow Camp, undersized culverts adjacent to Silver Creek were plugged. As a result, water was diverted and drainages alongside road in these areas became small creeks (approximately 4 feet wide) before eventually flowing over Highway 4 to Silver Creek. This eroded significant portions of the Highway.

AC17– FH: Flood Hazard Area – Dixon Mine Road:

Bridge capacity has been exceeded and needs to be replaced to pass higher flows but it will require mitigation associated with wetlands in the construction area.

AC18 – CF: Critical Floodplain Area – Hot Springs Pools:

In 2017, stakeholders gathered to survey this area was conducted and discuss challenges of this popular site. Many recreational issues at the site, including unregulated boat camps, off road travel, private access, river crossing, road maintenance and erosion.

AC19 – FH: Flood Hazard Area – Leviathan Mine Superfund Site:

The holding ponds at this superfund site effectively contained record snow and precipitation in 2017. However, communication between stakeholders is critical during floods and fires.

### **West Fork Carson River Drainages in Alpine County, California**

AC20 – CF: Critical Floodplain Area – Hope Valley:

The meadow provides for storage of floodwaters. The area is used for recreational primarily and there is little or no development upstream.

AC21 – FH: Flood Hazard Area – Pickett’s Junction:

This junction of Highway 88 and Highway 89 junction has closed in the past during major floods because water flows over them. Highway 88 is a trans- Sierra highway and serves as an important corridor within California.

AC22 – FH: Flood Hazard Area – Indian Creek Bridge at Dresslerville Road:

During high water events clogging occurs at the bridge and floods tribal property.

AC23– FH: Flood Hazard Area – Woodfords Bridge at Highway 89 / Highway 88 :

There bridge may need to be resized to handle larger flow events such as 1997 flood.

AC24-FH: Flood Hazard Area - Irrigation infrastructure affects roadway, and this problem is exacerbated in high water. However, there are not tail water problems because it goes back into creek.

AC25-FH: Flood Hazard Area: Ditch supplies water for treatment by water company.

AC26 - FH: Flood Hazard Area - Bridge

AC27-CF: Heenan Lake - Critical Fishery for Lahontan cutthroat trout

AC28-CF: Critical Floodplain Area - Stream bank stabilization on West Fork of the Carson. Undersized highway bridge leading to increased erosion on down stream banks.

AC29-CF: Critical Floodplain Area - Prevent meander bend cut off on West Fork of Carson. Needs to be maintained until stabilized.

AC30-CF: Critical Floodplain Area - Restoration of Charity Valley Creek and Meadow

AC31-CF: Critical Floodplain Area - Restoration of head cuts, along with removal of dewatering-trails and barriers in Grover Meadow.

AC32-CF: Critical Floodplain Area - Abandoned road segments allow for off road travel, and along with erosion and siltation along river.

### **East Fork Carson River: Stateline to Cradlebaugh Bridge, Douglas County (DC), Nevada**

From the Nevada/California Stateline the river travels through a canyon until it reaches the Carson Valley. Carson Valley is situated between the eastern face of the Sierra Nevada and the Pine Nut Mountains. The wide valley floor is the floodplain for both the East and West Forks of the Carson River, and is a natural floodwater storage area. Old river channels, also called sloughs, interlace the valley's floor between the East and West Forks and the Brockliss Slough (which carries the West Fork's water). The USGS published the 2013 Carson Valley Groundwater Model in 2013 which confirms interaction of surface and groundwater in the 2D Hydraulic Model of the Carson River the high-water table and tendency to flood. There is very limited water storage available in the upper watershed, and the drainages are composed of highly erosive materials. During flood events, sedimentation and debris deposition often result in rapid channel obstruction and channel migration.

General Recommendations for this reach:

1. Retain agricultural lands west of Highway 395 as floodplain and floodwater storage areas where possible but still provide infrastructure protection where necessary.
2. Investigate opportunities for using existing infrastructure to move floodwater.
3. Utilize the irrigation ditches for stormwater retention not for river release during flooding events.
4. Investigate opportunities to remove portions of berms to allow floodwaters to access floodplain.
5. Support conservation easement as a means to protect critical floodplain areas
6. Properly manage and control future development in flood hazard and critical floodplain areas.
7. Update floodplain ordinances to new Flood Insurance Rate Maps and to incorporate use of the Hydraulic Model
8. Design future bridges and roads to protect the floodplain, accommodate and not restrict the changing course of the river and not create additional levees.
9. Address inadequate FEMA flood zone designations and inconsistent floodway delineation.
10. Evaluate existing bridges more thoroughly for safety and flow constraint concerns.

### **California/Nevada Stateline to the Old Power Dam, Douglas County, Nevada**

From the Nevada/California line to the site of the Old Power Dam, also known as the Broken Dam, the river is largely confined through a canyon consisting of a relatively steep, bedrock, boulder and cobble bed stream. The Old Power Dam was removed after the 1997 flood event. Longtime residents attribute the increase of sediment loading to the river to the removal of the dam.

DC01-CF: Critical Floodplain Area - Bryant Creek - legacy mining problem, previous contaminated discharge from Leviathan Mine.

DC02-CF: Critical Floodplain Area - Banks of the East Fork infested with noxious weeds (Perennial Pepper Weed) from Bryant Creek to Ruhestroth Dam.

DC03-CF: Flood Hazard - Ruhestroth Dam. Dam was blown up during the 1997 flood. Remnants of the dam may still hazard.

### **Old Power Dam to Riverview Drive, Douglas County, Nevada**

Throughout much of this section, spoils from a 1965 project were turned into berms or unintended levees when the tops of the spoils were compacted. The effort was intended to create capacity, not to protect homes and other infrastructure. Since the creation of the berms the area has had to be defended from high water. In 1997 over 300 homes got wet and many of the homes have been raised using funding from FEMA. The berms run from the Allerman Canal to Riverview Drive Bridge. Locations where there may be potential to remove portions of the berm to allow floodwaters to access the floodplain are noted below.

DC04-FH: Flood Hazard - Tribal RV and Campground Area: The Tribe would like to reestablish campground, but are prone to flooding.

DC05-CF: Critical Floodplain Area - Douglas County purchased parcel for future park/open space with Q1 funds.

DC06-FH: Flood Hazard - Allerman Diversion and Canal: Taken floodwater in the past and floodwater has been diverted onto the adjacent agricultural lands during flood events.

DC07-FH: Flood Hazard Area - Tribal property in this area typically floods when Indian Creek overflows its banks. Culvert clogs also lead to further flooding.

DC08-FH: Flood Hazard - Berm Removal - Investigate opportunities to remove portions of the berm near Brunell ponds to allow floodwaters to access floodplain; result in divert floodwaters away from development.

DC09-FH: Critical Flood Area - Undeveloped Land east of the river could provide storage during flood events.

DC10-FH: Flood hazard area - During the 1997 flood event the river went out of bank by the Dresslerville Community levee and returned to the river further downstream.

DC11-FH: Flood Hazard Area - Berm placed on Tribal property in 2016 using fill has the potential to force water east toward 395. Potential flood hazard.

DC12-CF: Critical floodplain Area - Berm prevents river from accessing its floodplain, provides false sense of security to residents. Berm breached in 1997; 2005/2006 water backed up onto Tribal land.

DC13-FH: Flood Hazard - High flows have eroded property away; restoration project to alter river to west side during high flows.

DC14-FH: Flood Hazard - Gravel bars: The gravel bars with willow growth in this section may have a significant influence of river behavior. Clearing and snagging funds may be able to be used to remove the vegetation from stream bottom and allow the sediment load to continue downstream.

DC15–FH: Flood Hazard Area – Riverview Bridge: The river overflowed below Riverview Bridge during the 1997 flood event to the east towards Highway 395. There is a large culvert that runs under the highway by the medical center which needs to be protected and could possibly be used to help route floodwaters.

DC18 - CF: Critical floodplain area - Tribal Headquarters Ranch: The berm through this reach is preventing the river from accessing its floodplain and provides a false sense of security to local residents. Water breached the berm in 1997. During the 2005/06 event the berm backed water up onto Tribal land. The berm on this property may need to be investigated further to see if there is a potential to remove portions to allow floodwaters to access the floodplain, while still protecting the Tribal headquarters infrastructure.

### **Riverview Drive to Centerville Lane**

The river is incised (up to 15 feet) on both sides from the Riverview Drive Bridge to the Cottonwood Diversion, significantly limiting the river's ability to meander. From the Cottonwood Diversion to the Lutheran Bridge the river is able to meander. The emergency manager created a County Emergency Access plan for this reach of the river to identify property which would be inaccessible in during a flood.

– CF: Critical Floodplain Area: This ranch property should be protected in order to conserve the floodplain and its benefits. It is in an area that historically floods. The buildings on the ranch were constructed after the 1997 flood so it is unknown what the extent of the inundation would be during a large flood event (100 year). The buildings did not flood during the 2005/06 event. This property is a good candidate for a conservation easement.

- CF: Critical Floodplain Area – Hussman Ranch: The ranch has been in the Hussman family since the 1800's and the family's management approach to the river is "hands off". They report that channel migration occurs on the regular basis throughout this area. There is the potential to utilize the property for storage of floodwaters. This property is under a conservation easement.

CF: Critical Floodplain Area – Hussman Ranch: This ranch, which has a large portion on the east side of the river (#18) and a smaller portion on the west side (#19), is now under a conservation easement. There is a cottonwood gallery adjacent to the river and the Hussman's have seen the river migrate all throughout this area. Some of the area appears to serve as a sediment sink.

FH: Lutheran Bridge: The river is dramatically incised at this location and may be causing a backwater effect. It is owed by NDOT; Needs to be evaluated (if it hasn't been done recently) to pass 100 yr. flow. Find out status of NDOT and/or county priority list or Douglas County Transportation Master Plan.

### **Centerville Lane (Lutheran Bridge) to Highway 88**

This entire reach of the East Fork is prone to flooding and is an aggrading reach. Aggrading reaches are typically unstable; tend to shift their course frequently because significant deposits of sediment in the channel divert the flow, leading to bank erosion and lateral shifting of the channel. There are berms on both sides of the river except by the ranch on the south side of the river between Hwy 88 and Waterloo Lane, where the berm is less apparent. Head cuts have resulted in 20 – 25 feet of incised banks from the Cottonwood Diversion up to the mining site (#25). Conservation easements and other protection methods should be supported and encouraged. This area is critical for the storage of floodwaters.

– FH: Flood Hazard Area: The river changed its path during the 1997 flood event and headed to the west.

- FH: Flood Hazard Area: This area is the continuation of the changed river path area identified on Figure 5, #20.
- CF: Critical Floodplain Area - Potential area for berm removal: Investigate opportunities to remove portions of the berm through this area to allow floodwaters to access floodplain. This could relieve pressure and divert waters away from residential development.
- HF: Flood Hazard Area - Infrastructure Protection: Residential area needs to be protected from flooding. Removal of portions of berm upstream of area may help protect homes by allowing floodwaters to access floodplain on opposite side of river.
- FH: Flood Hazard Area – Aspen Mobile Home Park:  
The park had to be evacuated in January and February of 2017. Water flooded crawl spaces but did not flood any homes. Emergency Access were unable to access this Aspen Mobile Home Park during this flood.
- CF & FH: Critical floodplain area & flood hazard area: This property is regularly inundated during flooding events. There is a berm on the left side of the river but not on the right so considerable sediment deposition occurs here. Landowner may be interested in a conservation easement or other protective measures.
- CF: Critical Floodplain Area: If the family chooses to build close to river channel there may be infrastructure protection issues associated with this property.
- CF or FH: Alluvial Gravel Mining Site: This area was mined in the 1970's. There was a cement plant where the High School is today and they used material from this area. The sand bars through this area keep changing and the landowner believes that the reach functioned better when the material from this area was mined.
- CF: Critical floodplain area: Landowner may be interested in conservation measures that improve river bank stability.
- CF: Critical floodplain area: This ranch has one-acre zoning. This property has been nominated for a conservation easement. Property would provide excellent storage for floodwaters.
- FH: Highway 88 Bridge. The bridge is heavily scoured underneath. This bridge tends to act as an obstruction during high water events because it wasn't designed to accommodate the flood flows - both width & height may be insufficient. The next large flood event could result in significant damage to this bridge. Upstream of the bridge the river is not as incised as it is at the Lutheran Bridge.

#### **Highway 88 to Muller Lane, Douglas County, Nevada**

There are old levees along the river on the right side from projects implemented in the 1960's. This reach has been the site of numerous conservation projects including river workdays, grazing management, fencing, and a \$1 million restoration project. The river tends to move to the west in this area during high water events. Douglas County is currently conducting a culvert expansion project under this bridge.

- FH: Flood Hazard Area - New Housing Development: This property is targeted for 32 townhomes. The rancher that historically owned this property deeded it to the County because it flooded so frequently. Later the County brought in 4 feet of fill to build the high school. Development of the area has continued since. Wetlands are located on the east and west sides of Highway 88 near this area. The permit expired and there is no longer a proposed development at this site.

– FH: Flood Hazard Area - Westwood Subdivision: Residents are very interested in protecting structures through this reach. When the river breaches its bank, it tends to move left towards the Cottonwood and Home Sloughs. Historic maps show that the East Fork used to flow through this area. Some homes are very close to the river and have flooded during recent events.

– CF: Critical floodplain area and flood hazard area: The property on the west side of river frequently floods and provides an excellent area for storage of floodwaters. Currently the area is not designated by FEMA as an “A” (100 year) floodplain but should be. The current management approach by Park Cattle is to let the area flood. A conservation easement or other floodplain protection measure would be highly desirable for this area.

- FH: Flood Hazard Area - Muller Lane Bridge: This Bridge has the smallest capacity of any of the East Fork bridges, acts as dam during high flows and tends to capture considerable sediment. There are effluent and power lines running under it that could be damaged during a flood event. The 1996 Interfluv Assessment suggests that the river is unpredictable in this area, possibly resulting in further pier and abutment scour and threats to the overall stability of the bridge. The west side of this area is a good storage area for floodwaters despite the poor conveyance capacity of the bridge. In 2018, NDOT replaced the bridge and did extensive work on Muller Lane to address access and flood hazards.

#### **Muller Lane to Genoa Lane, Douglas County, Nevada**

This entire area is prone to flooding and should be considered critical floodplain area.

DC35 – CF: Critical Floodplain

Area: Question 1 Project Starting Point: 2018 - This project was not implemented because it was deemed infeasible. This large-scale restoration project that runs from the Muller Lane Bridge to the Genoa Lane Bridge will address multiple issues including floodplain protection. Restoration approaches will include installation of stream deflectors, instream weirs, and low-flow channel meanders.

– CF: Critical Floodplain Areas: Below the Muller Lane bridge, floodwaters tend to flow east and west onto adjacent fields. Park Cattle is the landowner and is interested in allowing the fields to flood. However, effluent is used for irrigation and some infrastructure defense may be necessary in order to maintain permits.

– FH: Flood Hazard Area - Effluent Storage Basins: Two storage basins are located in close proximity to the river. The basins will require protection and/or best management practices to prevent the treated effluent from contaminating the river during a flood event.

– CF: Critical Floodplain Area - River Fork Ranch: This area is where the East and West Forks of the Carson River merge to form the mainstem Carson River. It is a critical area for floodplain and wetlands management. The Nature Conservancy has removed the berm on the ranch that was at the confluence of the West and East Forks. This may be a good area for floodwater storage even during modest events. This area is under fee title with floodplain protection as one of the main goals.

CF: Critical Floodplain Area – Wetlands: This area is part of the River Fork Ranch. It is the desire of The Nature Conservancy to increase the capacity of the wetland area. This creates a good opportunity for storage of floodwaters.

– FH: Floodplain Hazard Area - Genoa Lane Bridges: Bridges cross the mainstem Carson River just after the confluence of the East and West Forks, and the Brockliss Slough (upper and lower). According to the Interfluve report (1996), the bridges are undersized and given the large in-channel sediment supply from upstream, there could be problems with local aggradation and abutment scour during large flood events. All the Genoa Lane bridges are at risk in the event of significant channel shifts above the bridge locations.

### **Genoa Lane to Cradlebaugh Bridge, Douglas County, Nevada**

– FH: Flood Hazard Area – Willowbend Subdivision: FEMA repetitive loss area. Homes are built close to river in floodplain and are very prone to flooding. The potential for channel shifts and backwater problems may also affect this area. CVCD is currently working on a restoration/stabilization project in this area. A repetitive loss property was acquired in this subdivision.

– FH: Flood Hazard Area - Genoa Golf Course: The golf course was built to allow for flooding and does not have houses adjacent to the river but some homes flooded in 1997. The Interfluve report states banks were already incised up to 12 feet from Genoa to Cradlebaugh. The river further incised dramatically through this reach during the 1997 Flood resulting in vertical banks of approximately 20 feet. There are three bridges through the golf course and a golf path along the riverbanks so there is a need to protect infrastructure.

– CF: Critical Floodplain Area: All of the areas east of the river to Highway 395 should be considered critical floodplain and flood storage areas. It is obvious from the aerial photos that the river has shifted course through this area on numerous occasions. Conservation easements and other methods of protection should be encouraged and implemented. Western Pond Turtles have been identified in this reach of the river.

– CF: Critical Floodplain Area: There is a proposal for a conservation easement on this ranch property just downstream of Genoa Lakes Golf Course on the north side of the river. The owner wants to work the ranch and has given no indication that they will sell or subdivide.

– CF: Critical Floodplain Area - Old River Channel: The old channel has willow growth and water. The channel could support wildlife and serve as a flood channel.

– CF: Critical Floodplain Area - Stewart Ranch: The Washoe Tribe of Nevada and California owns this property. The Tribe has constructed fencing 100 to 300 feet from the river on 2.5 miles each side of river. The purpose of the fencing is to reduce grazing pressure and protect the floodplain.

### **West Fork Carson River and the Brockliss Slough, Douglas County, Nevada**

In addition to areas covered in the previous section the following observations were noted.

#### **General Recommendations:**

- Maintain critical floodplain areas for storage of floodwaters.
- Investigate opportunities to enhance road and bridge construction to allow for flooding and protection of floodplain areas
- Investigate the use of the West Fork as a flood storage channel
- Investigate opportunity to utilize existing infrastructure to move floodwaters.

– CF: Critical Floodplain Area – All areas north of Mottsville Lane: This area is critical for flood water attenuation and storage. Development in these areas may significantly alter downstream flow patterns. Property previously unaffected may be flooded if urbanization increases in the floodplain.

– FH: Flood Hazard Area - Big Ditch: The ditch runs through the Mottsville Development. It has no defined source and is a collection of tail waters including waters from the Carson Range. It flows into the Brockliss Slough.

– FH: Flood Hazard Area – Mottsville Development: The development is in the floodplain of the West Fork and Brockliss Slough. The homes are elevated and are on septic systems engineered above ground. The cumulative impacts from this development during a flood event will need to be watched. Homes that may not have flooded previously may now have increased risk due to the changes in the floodplain in this area.

– CF: Critical Floodplain Area – Wally’s Hot Springs: The area around Wally’s Hot Springs has wetlands and is critical for floodwater retention and storage.

– CF and FH: Critical Floodplain & Flood Hazard Area - Centerville to Mottsville: The water table rises significantly in this area during high water events. Mottsville Road acts as a dam, even though it is at ground level, and can cause flooding even when the buildings in the area have been elevated. This flooding along Mottsville Lane blocks emergency access.

### **Main Carson River from Cradlebaugh Bridge to Deer Run Bridge, Douglas County to Carson City (CC) , Nevada**

This section of the river system is in very good shape with regards to flooding and floodplain management. The Nature Conservancy successfully worked with the landowner to secure a large area of the floodplain with a conservation easement (Kirman Field). The Carson City Open Space Program has been very active in acquiring lands along the river corridor and securing conservation easements. The Silver Saddle Ranch (BLM) and the Ambrose Natural Area (Carson City) also provide floodplain protection. Most of the damage caused by flooding in the Carson City is the result of alluvial fan flooding. A study was recently conducted by RCI to look at this issue and present potential solutions.

#### **General Recommendations for Carson City – Main Carson River**

- Support Carson City’s Open Space Program and other organizations, with their ongoing acquisition and protection of critical floodplain lands along the river corridor
- Stay abreast of issues with the State Land prison property
- Investigate opportunity to enhance grade control structures, including Mexican dam. The Anderson diversion was removed in 2016.
- Consider bridge designs that do not create a barrier in the floodplain or obstruct flood flows in the river channel.

– FH: Flood Hazard Area - Cradlebaugh Bridge: According to Interfluve (1996) the base level is lowering and pier footings are exposed. An inspection might determine if structural fortifications are feasible to improve bridge stability, allow greater flow capacity and reduce scour.

– CF: Critical Floodplain Area - Kirman Field Conservation Easement: The Nature Conservancy and landowner were successful in protecting this critical floodplain area.

– CF: Critical Floodplain Area: Potential Site for Railroad ROW Bridge crossing from Carson City to Douglas County: There is the possibility that a railroad bridge may be needed in this area to accommodate the revived V&T Railroad. Investigate the opportunity to design and construct bridges that do not obstruct floodplain and allow greater flow capacity.

CC1– CF: Critical Floodplain Area – Prison Farms: This property is owned by the State of Nevada for the purpose of providing a State prison and associated prison farms. The area provides for good storage of flood waters and should remain in open space. A fluvial geomorphic assessment may need to be conducted at this bend; this road has over washed previously; potential bank stabilization project.

CC2 - CF: Critical Floodplain: Carson River Canyon has many steep banks between the Prison Farm and Lyon County line which erode and add sediment to the river.

CC3– FH: Flood Hazard Area - Golden Eagle Lane: There are several homes very close to the river and in the immediate floodplain in this area. This is the only road to about 7 houses and if the road washes out, access to these homes is cut off. Above the road is high potential for erosion with very steep topography and gullies coming off Prison Hill. A potential project to terrace the bank, slope; take shear stress off bank. One of the homes in this area is on the FEMA Repetitive Loss List and base elevation for one of the homes is above the garage door.

CC4 – CF: Critical Floodplain Area – MCTarnahan Bridge to Mexican Gage: This area provides excellent storage of floodwaters.

CC5 – FH: Flood Hazard Area – Mexican Gage to Lloyd’s Bridge: There are areas that are highly erosive as evidenced by gully washers and sediment deposits. Mexican gage – Carson City working with Lumos to identify boating portage solution.

CC 6– CF: Critical Floodplain Area: There is one parcel for sale and the CC Open Space Program is investigating acquiring the property. As of 2018, this Golden Eagle property has been acquired by Carson City as open space.

CC7 –FH: Flood Hazard - Mexican Dam: The dam is very old and in disrepair. It should be investigated for repair or possible replacement. There are 10-12 owners in the ditch company.

CC8 – FH: Anderson Diversion Structure – The structure was removed.

CC9 – CF: Critical Floodplain Area: This property, formerly Buzzy’s Ranch, has been acquired by Carson City’s Open Space Program. This is a critical area for flood water attenuation. Reuse water will be used for irrigation which may represent additional challenges.

CC10 – CF: Critical Floodplain Area – potential land purchase: There is a small piece of the Anderson Ranch on the right side of the river that may be included in the Anderson Ranch acquisition. The Carson City Open Space program is investigating this property which is located by the Ambrose Natural Area.

CC11 – CF: Critical Floodplain Area – Ambrose Natural Area: This area has been provided protection through the Carson City Open Space Program and is managed to accommodate flood flows.

CC12 – CF: Critical Floodplain Area - Empire Golf Course: The golf course is managed to allow for flooding and is crucial for storage and attenuation of floodwaters in the area. The golf course is in the floodway or floodplain.

CC13 – CF: Critical Floodplain Area – Morgan Mill: Morgan Mill Trailhead: Carson City has developed this area which includes an aquatic trail ramp, picnic tables, restroom, and access to the hiking / biking trail just west of the parking lot. This area was closed January and February 2017 because of extensive flooding.

## **Carson River: Deer Run Road, Carson City, Nevada to Lahontan Reservoir, Lyon County (LC), Nevada**

Portions of this reach have been under tremendous development pressure for the last decade and this pressure is expected to continue. The prospect of future floods and associated impacts are of concern to landowners and natural resource managers. Controlling noxious weeds, such as tall whitetop, has also become a huge issue on floodplain lands from the Carson River Estates downstream to the reservoir.

This reach has high potential for channel migration and excess sediment deposition. During the 1997 event floodwaters spread from ¼ to ½ mile wide and between 2 and 4 feet deep in places through this reach. Extensive volumes of sand deposited on many fields and ranch lands were attributed to channel migration and bank erosion.

### **Recommendations for Deer Run Road to Lahontan Reservoir**

- Manage development in special flood hazard areas and other flood hazard areas (those known hazard areas that are not documented on FEMA flood maps) to provide public safety and protect the natural functions and benefits of floodplain lands;
- Incorporate principles of low impact development in subdivision designs to limit impervious surface and retain stormwater runoff onsite;
- Support conservation easements, and other methods for protecting critical floodplain lands and channel migration hazard areas, that consider long-term management of the lands;
- Monitor and treat for noxious weeds;
- Support river restoration projects that incorporate principles of bio-engineering and utilize non-structural designs to the extent possible with hard points where necessary;
- Provide public education regarding the importance of riparian vegetation, floodplain protection and noxious weeds such as TWT.
- Design future bridges and roads to protect floodplain, accommodate and not restrict the changing course of the river and not create additional levees.
- Address inadequate FEMA flood zone designations and inconsistent floodway delineation.

### **CC14 to LC1 – CF: Critical Floodplain Area - Deer Run Road to Santa Maria Ranch:**

The river travels from Deer Run Road through the Carson Canyon for about five air miles until it reaches the Santa Maria Ranch area upstream of Dayton. The canyon is a deep, narrow, twisting canyon with steep and rugged terrain. There is no development in the canyon; however, there is an aggregate mine at the site of the historic bridge. Carson City has acquired this property and installed a gate and its park ranger patrols this area daily. This reach is part of the Carson River Aquatic Trail and of the revitalization project for the Truckee-Virginia Railway.

CC15 – FH: Flood Hazard: Brunswick Dam outlet: Carson City is permitted to release water into the Carson River. Significant damage to infrastructure in 2017.

CC 16 – CF: Critical Floodplain: Carson City looking to purchase this 106-acre parcel from Erickson

## **Santa Maria Ranch to Dayton Bridge, Lyon County, Nevada**

There has been numerous bank stabilization, restoration and flood repair projects constructed on this reach of the Carson River. These projects are well documented in the Stewardship Plan. The lands along this segment of the river flood on a regular basis. There is a fair amount of unknown risk and uncertainty associated with some of the development that has occurred along the river channel in recent years.

LC2 – FH: Flood Hazard Area - – Santa Maria Ranch Subdivision:

Upon emerging from the Carson Canyon, the Carson River used to be able to access its floodplain and spread the floodwaters out over a ¼ to ½ mile wide alluvial fan area. This area has been developed in recent years. The Santa Maria Ranch subdivision was developed on the old Winters Ranch that flooded on a regular basis. Portions of the land where the subdivision is located were underwater during the 1997 flood. The mobile home park, neighborhoods and agricultural lands downstream of the Santa Maria Ranch flooded in 1997 including about 30 homes and the Dayton State Park. This subdivision is also within the Carson River Mercury Superfund site. A tremendous amount of fill was brought in for the development; however, flood velocities downstream have increased and downstream properties have experienced flooding in varying degrees since its construction (most notably in 2006 and 2017).

LC3 – CF: Critical Floodplain: Santa Maria Park: This area provides aquatic trail ramp, parking, restrooms and picnic area. It is closed during floods to attenuate flood waters.

LC4 – CF: Critical Floodplain and Flood Hazard Area :

These fields flood on a regular basis and provide critical storage of floodwaters during flooding events. Damage to downstream properties may increase significantly without the storage volume that these fields provide. Lands across the river from the fields have been developed and did flood during the 1997 event. During the 1997 event over 150 feet of bank was lost from this area due to channel migration and erosive action.

#### **Dayton Bridge to the River Park Estates, Lyon County, Nevada**

LC5 – FH: Flood Hazard Area

Encroachment on both sides of the river increases the potential flood risk. The blue line outlines the FEMA Zone A floodplain.

LC6: CF: Critical Floodplain Area

The ranch lands and open space along this reach of the river are ideal for allowing the river to access its floodplain, storage of flood waters, dissipation of flood velocities, and critical habitat for wildlife. The river has changed its course numerous times in this area as evidenced by the old river channels and oxbows that can be seen in Figure 13.

LC7 CF & FH: Critical Floodplain and Flood Hazard Area Rolling A Ranch:

Lyon County was successful in acquiring the Rolling A Ranch. Portions of this ranch were sold and developed into the River Park Subdivision. Approximately 276 acres of the property adjacent to the river was retained and is part of a large Question 1 funded project that involves river restoration, developing a trail system, floodplain protection, weed abatement and public education opportunities. Lyon County and the Dayton Valley Conservation District are working together along with other stakeholders to implement this project.

An extensive infestation of Perennial Pepperweed (Also known as Tall White Top) is found in this reach. Of the 276 acres of floodplain land mentioned above 50-75% of the lands are infested with Perennial Pepperweed. Lyon County and the DVCD are actively pursuing treatment options.

The lands adjacent to the river are considered critical flood storage areas and serve as a buffer to the adjacent development. However, it is uncertain how safe the subdivision and associated infrastructure will be during a 100-year event like in 1997 when river flows exceed 20,000 cfs. In addition, the raised subdivision may act as a levee and push floodwaters to other properties that previously were not prone to flooding.

LC8 – CF: Critical Floodplain Areas – Rolling A Ranch to Weeks Bridge: (shown on Figure 14)

These lands provide areas for the river to access its floodplain and provide habitat for wildlife. This area includes Fort Churchill State Park and follows historic Fort Churchill Road along the river. There is very little development in this area and a physical map revision which maps floodplain and floodways in this reach became effective in 2016.

### **River Park Estates to Lahontan Reservoir**

The river leaves the Dayton area and flows northeastward across the broad alluvial valley of the Carson Plains. During the 1997 event this area was inundated with 2 to 4 feet of water and approximately ½ mile wide. Extensive blankets of sand were deposited on many of the fields and ranch in the area.

From the Carson Plains the river flows through a relatively confined bedrock channel through the northern Pine Nut Mountains for about 12 air miles before reaching the area by Fort Churchill Historic State Park. There is little to no development within this reach. During the 1997 flood event the automobile test track property was totally inundated. Portions of the Fort Churchill road (unpaved) and part of the old Carson River Route of the California Emigrant Trail were washed away and flooded in many places.

By Fort Churchill there is an approximately 25' vertical bank that is approximately 1,100' long that is within 20 feet of the Buckland Ditch and within 35 yards of the Fort Churchill Road. A flood event could easily erode this bank to the point that it impacts the ditch and road. Nevada State Parks, Dayton Valley Conservation District and others are currently investigating options for addressing this issue. A considerable amount of sediment was deposited throughout this area during the 1997 and 2005/06 flood events.

Tall white top is a huge problem within the floodplain next to the Buckland Station off of U.S. 95 Alternate. Flood waters can easily carry seed to downstream properties.

Week's Bridge crosses the Carson River at U.S. 95 Alternate and was fully surrounded by the flood waters in 1997. Flood debris was trapped by the bridge foundation.

The river flows from the Week's Bridge area into the Lahontan Reservoir system.

### **Lahontan Reservoir to Carson Sink**

Lahontan Reservoir was not built as a flood control facility; it was designed as part of an irrigation system. It can provide some storage of floodwaters if there is storage capacity available in the reservoir.

The river system below Lahontan Dam is very different than the reaches above Lahontan Reservoir due to the Newlands Irrigation Project and associated irrigation canals. During the 1997 flood the area did not experience flooding of homes or other structures but did have bank erosion problems. Much of the flooding problems in this area is the result of alluvial fan flooding and storm water drainage issues.

Bafford Bridge has been identified by Churchill County as a flood hazard due to low capacity and sediment clogging. The County is in the process of addressing this issue.

The river corridor is highly urbanized. Approximately 50% of the property along the river has homes in close proximity to the channel. The Lahontan Valley Environmental Alliance is working on behalf of the Churchill County and other stakeholders to investigate opportunities for protecting the river corridor and other areas

through conservation easements and other tools. The Frey and Bell Ranch conservation easements are great examples of river corridor protection.

### **2017 Lahontan Reservoir to Carson Sink**

Lahontan Reservoir was not built as a flood control facility; it was designed as part of an irrigation system. It can provide some storage of floodwaters if there is storage capacity available in the reservoir. The river system below Lahontan Dam is very different than the reaches above Lahontan Reservoir due to the Newlands Irrigation Project and associated irrigation canals. During the 1997 flood the area did not experience flooding of homes or other structures but did have bank erosion problems. Much of the flooding problems in this area is the result of alluvial fan flooding and storm water drainage issues.

Bafford Bridge has been identified by Churchill County as a flood hazard due to low capacity and sediment clogging. In 2017, Churchill County and TCID received permission to clear and snag much of the Carson River below diversion dam and beyond Bafford Bridge. This increased the river's capacity and reduced flooding concerns.

The river corridor is highly urbanized. Approximately 50% of the property along the river have homes in close proximity to the channel. The Lahontan Valley Environmental Alliance is working on behalf of the Churchill County and other stakeholders to investigate opportunities for protecting the river corridor and other areas through conservation easements and other tools. The Frey and Bell Ranch conservation easements are great examples of river corridor protection.

#### Recommendations for Lahontan Reservoir to Carson Sink

- Support conservation easements and other methods of protecting river corridor lands;
- Investigate opportunities to utilize existing infrastructure for moving flood waters;
- Continued public outreach about flooding hazards and river corridor protection.
- Investigate ways to minimize the flood hazard impacts of excess sediment and vegetation

CH1 – FH: Flood Hazard Area: Potential sloughing and cutting of banks (can lead to excess sediment in the river). Potential for Bank stabilization projects. Something to investigate.

CH2 – FH: Flood Hazard Area - Carson Diversion:

CH3 – FH Flood Hazard Area – V-line Ditch: The V-line ditch extends to the south, carrying approximately 2,000 cfs. In 2017, a weir was built off this ditch to accommodate the approximately 912,000 acre-feet of water which had to be moved from Lahontan Reservoir to the Carson Sink.

CH 4 – FH: Flood Hazard Area - T-line Ditch: The T-line is diverted to the north, carrying approximately 150 cfs.

CH5 – CF : The river itself continues between these diversions. Immediately downstream from the diversions is a road crossing of the river (Pioneer Way) that has a severely undersized culvert; the

river flows over the road frequently, preventing primary access by some residents (there is a secondary way to get to these properties).

CH6 – FH: Flood Hazard Area : Bridge over V-line downstream from diversion.

CH7 – FH: Flood Hazard Area - 26-foot drop: this is the original drain to Sheckler. Water has to be at approximately 900 cfs before it gets here.

CH8 – FH: Flood Hazard Area - Casey Road: This is the road that follows the ditch from the Sheckler drain all the way to Walmart. Consideration by the County on a potential study to evaluate the different potential flood flows (e.g., 3,000 cfs, 5,000 cfs) and needs for mitigation or emergency management operations in the event of overtopping flows, as the canal is not part of the River and therefore not in the FEMA floodplain.

Ch9 – FH: Flood Hazard Area -Lewis Breach: This was the location of a breach (2008-2010), but is also a way to get water out of the canal and collect it downstream later.

CH10 – FH: Flood Hazard Area - Potential flooding from both River and V-Line ditch to trailer park and Walmart (mapped in the AE zone).

CH11 – FH: Flood Hazard Area – Highway 50 Carson River Bridge: This bridge spans the Carson River at Highway 50 can cause flooding upstream due to backup of flows behind the bridge.

CH13 FH: Flood Hazard Area – Bridge US 95 Alternate: In 2017, NDOT installed four box culverts to move water from the T-Line to Carson Lake.

CH14 – FH: Flood Hazard Area - The county owns most of the open space and the golf course in this area; should be left open for floodplain access to waters. An undeveloped subdivision north of Coleman Road is in the floodplain and several lots are in the mapped floodway. It is also bounded by the ? Canal to the South.

CH15 – FH: Flood Hazard Area – Old River Channel: Old river channel flows through this area, as shown in floodplain maps with AE zones.

CH16 – FH: Flood Hazard Area - Milk Plant: While the floodplain boundary (1977) stops at the original City of Fallon line (a jurisdictional boundary, not a river boundary itself), the River continues, and if modeled, this area could result in being assessed as a floodplain area.

CH17 – FH: Flood Hazard Area - Bafford Lane Bridge: The Bafford Lane Bridge may need to be rebuilt. Has to do with Sagousbie Dam, and the bridge may be rebuilt.

CH18– FH: Sagousbie Dam. Does not have the capacity to flood downstream properties

CH19 – FH: Flood Hazard Area - D-Line diversion or t-line: Flows from the Carson adjacent to the Sagousbie Dam.

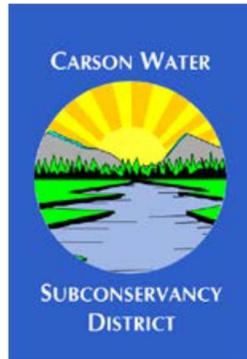
CH20 – Bridge at Highway 50 East: In 2017, NDOT installed four box culverts to move water from Carson Lake toward Stillwater National Wildlife Refuge.

CH21 - Big Dig Big Dig is a 17-mile ditch, there are currently no funds or plans to maintain the ditch; other than it being available in the event there are future high flows such that were seen in 2017.

CH22 – CF: Critical Floodplain – Stillwater National Wildlife Refuge: End of the line for all ditches and drainage on the Carson River. It did not experience flooding, as the water was ‘managed’ by the USFWS by controlling flows as they entered the property, and huge flows were already reduced by the time they crossed the desert.

**Appendix D**

**2016 Floodplain Ordinance Draft Report and Mitigation  
Plan Table**

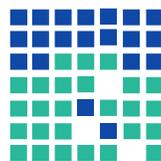


**FLOODPLAIN ORDINANCE REVIEW AND IMPROVEMENT  
FOR  
ALPINE COUNTY, DOUGLAS COUNTY, CARSON CITY AND LYON COUNTY**

***JURISDICTION INTERVIEW SUMMARIES  
AND  
HYDRAULIC MODEL IMPLEMENTATION ORDINANCES***

CARSON WATER SUBCONSERVANCY DISTRICT

DECEMBER 2016



**Robert G. Loveberg**  
Planning ■ Consulting Services

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## INTRODUCTION

This Floodplain Ordinance Review and Improvement project is a multi-jurisdictional effort led by the Carson Water Subconservancy District (CWSD) to prepare for the adoption of new Flood Insurance Rate Maps (FIRMs), implementation of the Carson River Hydraulic Model and improvement of floodplain management programs and regulations. Alpine County, California, and Carson City, Douglas County and Lyon County, Nevada, will be directly affected by the improved FIRMs. These jurisdictions have varying needs and opportunities related to the implementation of new FIRMs and the use of the Carson River Hydraulic Model.

This project is one part of an ongoing, multi-phase effort by the CWSD to assist Alpine County, Douglas County, Carson City and Lyon County in improving Carson River floodplain management. The project has assisted each jurisdiction in the review and future amendment of their floodplain ordinances to incorporate the Carson River Hydraulic Model developed by HDR to accommodate the new regional floodplain mapping and flood insurance rate maps (FIRMs). Each county/city floodplain ordinance has been reviewed, the jurisdictions interviewed, and consistent ordinance language has been developed to incorporate the Carson River Hydraulic Model and its Model Management, Distribution, and Update Guide. New ordinance language has been developed for those jurisdictions that desiring to incorporate enabling language for the use of the Carson River Hydraulic Model.

## Needs and Opportunities

Each jurisdiction was visited to discuss and document their specific needs, unique circumstances, programs and opportunities in regards to floodplain management and development of ordinance revisions. Additionally, the CWSD staff was provided the chance to discuss general and specific jurisdictional needs and opportunities as viewed by the CWSD.

A summary of each jurisdiction's needs and opportunities and the CWSD staff's perspectives are provided below.

### Alpine County

- Alpine County does not currently have any FEMA floodplain mapping.
- It is the only California jurisdiction within the CWSD.
- It has unique flooding hazards (e.g., flooding due to ice dams).
- Lacks defined floodplains which will create a challenge with educating the public and local government officials (i.e., does not have a history of known floodplains or administering a floodplain management program).
- Lacks staffing and training to administer a floodplain management program and regulations.

- Needs to prepare a floodplain management ordinance that meets state and federal requirements.
- Needs technical assistance with implementing and administering a floodplain management program.
- Greatest strengths are that they are familiar with the locations where flooding occurs and there are limited locations that will be identified as a floodplain.
- This is an opportunity to revise/update/create a modern floodplain management ordinance and program.
- It will be easier to create and implement a new floodplain management program because there are limited areas and populations (i.e., specific neighborhoods) involved/affected.
- Shortcomings of the existing floodplain management program include:
  - Outdated and incomplete;
  - Does not meet minimum state and federal requirements; and
  - Does not include FEMA mapping and requirements since the County has not had any FEMA designated floodplains.
- Since the County does not currently have a floodplain management program, it is an opportunity to create a program and train the staff.
- The mitigation measures identified in the Carson Flood Mitigation Plan are generally correct.
- Low impact development (LID) standards should be implemented by resolution as part of existing development standards. Some language in County Code may be necessary to authorize the LID standards.
- The County may need to differentiate between increasing the required freeboard and protecting improvements in certain areas of the county (e.g., between steeper upper river areas and flatter lower valley areas).
- The rankings/priorities for the Carson Flood Mitigation Plan mitigation measures are accurate.
- LID should probably be included in the floodplain management ordinance/code.
- Training for County staff, the public, and civil engineers will be necessary to implement the Carson River Hydraulic Model.
- Revision of the County Code to create new, compliant floodplain management regulations which include the requirement for the use of the model in the newly identified floodplain of the West Fork of the Carson River.
- Requirements for use of the Carson River Hydraulic Model should be included in the new floodplain management ordinance. The County staff did not feel that the requirements would be appropriate for the existing provisions in County Code.
- County staff felt that further discussion was needed regarding the use of the Carson River Hydraulic Model to assess impacts of land use changes and development within the 1-percent (1%) chance and 0.2-percent (0.2%) chance floodplains. However, the staff felt that it would likely be a good idea to use the model to assess all impacts (e.g., cumulative, project specific, etc.).

- Further research and discussions with the County Building Official are needed to determine if the County's floodplain management provisions are coordinated with the County's adopted building codes.
- The County staff felt that it was likely that the County would want to coordinate the new floodplain management ordinance with the County's building codes.
- The County does not have unique requirements for revisions to County Code. However, the County must go through the CEQA process to adopt revisions to the County Code.

## Carson City

- Carson City revised its Municipal Code to be in line with the Nevada model floodplain management ordinance in 2010-2011.
- Further possible floodplain management code revisions include:
  - Increase freeboard requirement in certain cases;
  - Increase volume ratio above 1:1;
  - Utilities;
  - Lower floodway rise allowance from 1-foot to 6-inches; and
  - Adopt Carson River Hydraulic Model protocols and procedures by reference.
- Carson City has been proactive.
- The City has made a concerted effort to educate its population on floodplains and flood insurance.
- The City has implemented a stormwater hotline and the City is quick to respond to correct problems.
- The Public Works Department assists property owners with property evaluations regarding flood risk, drainage, and potential solutions.
- Consistency among departments, keeping up to date with FEMA regulations/requirements, and continuous education of the public are considered program needs or challenges.
- Communication among City departments, and with the public and professionals are considered program strengths.
- The City has a goal to become a CRS Class 4 community.
- In addition to the needs and challenges cited above, shortcomings of the existing floodplain management program include:
  - Regulations could be clearer, and there could be a closer relationship between drainage standards and floodplain requirements.
  - There could be better standards for erosion and landslides/mud flows.
  - There needs to be a better relationship between CRS points and the effort it takes to achieve the point value.
  - FEMA changing the CRS pre-requisites.
- In addition to the further possible revisions identified above, potential changes to the existing floodplain management program include:

- One person dedicated to floodplain management (This would permit improved interaction with and assistance to the community, and better understanding by the public);
  - Provide more one-on-one assistance to the public;
  - Continue open space purchases; and
  - Create a corridor for water to be conveyed from west to east through the City.
- Continued collaboration with other jurisdictions is important for making improvements in the floodplain management program.
- The mitigation measures identified in the Carson Flood Mitigation Plan are generally correct. However, transfer of developments rights should not be included as a mitigation measure for the City; the City has an effective open space program.
- Some revisions are needed to the Carson Flood Mitigation Plan ranking/priorities for Carson City.
- The Carson River Hydraulic Model protocols and procedures need to be referenced in the Municipal Code and in Division 14 of the Development Standards.
- The Carson River Hydraulic Model needs to be referenced in the Municipal Code as the means to study the Caron River floodplain.
- Carson City will need to determine how it wants to use the Carson River Hydraulic Model to assess cumulative impacts within the 1-percent chance and 0.2-percent chance floodplains.
- The City would like to use the Carson River Hydraulic Model to assess project specific impacts of land use changes on adjacent, surrounding and other properties.
- The City would initially consider using the Carson River Hydraulic Model to assess project specific impacts as a means of mitigating the following impacts:
  - Flood hazards to downstream properties and communities.  
However, it would have to be determined how far downstream analysis would be required. It also needs to be determined who is going to keep track of the downstream impacts.
  - Loss of floodplain function.
- The City is unsure about using the Carson River Hydraulic Model to assess project specific impacts as a means of mitigating the following impacts:
  - Loss of riparian habitat.  
The City has not considered this in the past and is unsure how they might use the Model for this purpose.
  - Degradation of water quality.
- The City's floodplain management ordinance/code is coordinated with the City's building codes.
- Some improvement of the floodplain management program may be possible and coordination of regulation implementation enhanced by further clarifying enforcement responsibilities among City departments (e.g., Public Works Department, Building Department, etc.).
- The City does not have unique requirements for revisions to its Municipal Code.

## Douglas County

- Douglas County is unique among the four jurisdictions due to its expansive floodplain.
- The County's floodplain management program's biggest needs or challenges are:
  - Tracking cumulative impacts (This will depend on the size of the development, and a process is needed to track the impacts and supply the information to the CWSD for updating the model.);
  - Flooding in non-mapped areas (e.g., flash flooding); and
  - Revising County Code to require agricultural structures to comply with requirements in a floodway (Although, agricultural structures within a floodway still must meet the rise in BFE standard.).
- The County's floodplain management program's greatest strengths are:
  - The GIS Department;
  - The program complies with FEMA requirements;
  - The program has a dedicated staff member to oversee the CRS program;
  - No parceling is allowed within the floodplain; and
  - Consistent application of the Code.
- Opportunities to improve the County's program are:
  - Adding compensatory storage requirements for filling in the floodplain;
  - Establishing BFEs in all identified floodplains;
  - Making the floodplain ordinance more user-friendly; and
  - Possibly removing the one-foot elevation requirement for the X-shaded flood hazard zone or adding substantial improvement standards.
- In addition to the needs and challenges cited above, shortcomings of the existing floodplain management program include:
  - Lack of compensatory storage requirements in the AO or AH flood hazard zones;
  - The Code exceptions for agriculture that currently exist; and
  - Pertaining to the CRS program:
    - Coordination with towns, agencies, special districts, etc.
    - Consolidated information from other entities (i.e., a single point data repository with the County).
- County staff would like to improve the existing floodplain management program by getting it funded, and getting an administration fee adopted as a funding mechanism.
- The mitigation measures identified in the Carson Flood Mitigation Plan are correct and County staff would like to see them included in the County's floodplain management ordinance.
- Steps need to implement the Carson River Hydraulic Model protocols and procedures include:
  - Coordination with other counties;
  - Use of the Model for all development impact analysis within the Carson River floodplain;
  - A public information and education effort on when the Model will become required;

- Revision of all application and information forms; and
  - Dissemination of information to civil engineering firms.
- Douglas County staff does not believe that it is necessary to revise the existing County Code language to implement the use of the Carson River Hydraulic Model or the Carson River Hydraulic Model protocols and procedures. County staff believes the Model's use and its procedures can be required as the best technical information available.
- The County would use the model to assess the cumulative and project specific impacts of land use changes in the one-percent chance and 0.2-percent chance floodplains.
- County staff believes it would use the Carson River Hydraulic Model to assess project specific impacts as a means of mitigating the following impacts:
  - Flood hazards to downstream properties and communities.
  - Loss of floodplain function (i.e., storage capacity).
- The County does not believe it would use the Carson River Hydraulic Model to assess project specific impacts as a means of mitigating the following impacts:
  - Loss of riparian habitat.
  - Degradation of water quality, unless the MS4 program requirements expand.
- Further discussion with the County's Building Official is needed to determine if the County's floodplain management regulations are coordinated with the adopted building codes and if revisions are needed.
- The County does not have unique requirements for revisions to County Code.

## Lyon County

- Lyon County is unique among the four jurisdictions since it has three different watersheds within the County and significant mercury pollution of the Carson River.
- The County's floodplain management program's biggest needs or challenges are the education of the public and landowners within the floodplain. This need/challenge ties in with the Nevada Division of Environmental Protection's education efforts regarding the Carson River's mercury contamination.
- The County's floodplain management program's greatest strength is its GIS mapping.
- Needs for improving and/or shortcomings of the County's program include:
  - Need for staff and staff training;
  - Need for additional public outreach; and
  - Need to make sure that the new Title 15, Consolidated Development Code, has floodplain regulations identified in all its parts where needed.
- Lyon County does not participate in the Community Rating System.
- In addition to the possible revisions identified above, potential changes to the existing floodplain management program include:
  - Better streamlining of the process; and
  - Informational materials created in a bullet print format.
- County staff would like to improve the existing floodplain management program by creating:
  - More readable and understandable information, and

- Making GIS floodplain/FIRM information readily available to the public.
- The mitigation measures identified in the Carson Flood Mitigation Plan are correct.
- The Carson Flood Mitigation Plan ranking/priorities for Lyon County are accurate.
- County staff would like to see the following mitigation measures included in the County's floodplain management ordinance:
  - Density bonuses for not developing within the floodplain;
  - Density bonuses for clustering;
  - Incentives for the use of low impact development techniques;
  - Transfer of development rights; and
  - Real estate transaction notification requirements.
- The Carson River Hydraulic Model and Carson River Hydraulic Model protocols and procedures need to be added to County Code, probably by reference.
- For the County to implement the Carson River Hydraulic Model and its procedures, it will be necessary to educate County staff, professionals and the public.
- The County would use the Model to assess the cumulative and project specific impacts of land use changes in the one-percent chance and 0.2-percent chance floodplains.
- The County would like to use the Carson River Hydraulic Model to assess project specific impacts of land use changes on adjacent, surrounding and other properties.
- The County would use the Carson River Hydraulic Model to assess project specific impacts as a means of mitigating the following impacts:
  - Flood hazards to downstream properties and communities;
  - Loss of riparian habitat;
  - Loss of floodplain function; and
  - Degradation of water quality.
- Further research is needed to determine if the County's floodplain management regulations are coordinated with the adopted building codes and if revisions are needed.
- The County does not have unique requirements for revisions to County Code.

## Carson Water Subconservancy District

The Carson Water Subconservancy District staff was interviewed to obtain a watershed perspective on the needs and opportunities of the four jurisdictions.

- CWSD staff believes that each jurisdiction has characteristics that make it unique:
  - Alpine County – The County contains the headwaters Carson River, so what happens there is critical to all of the downstream jurisdictions.
  - Carson City – The City has acquired much of the Carson River floodplain within the City's boundaries and holds it in public ownership.
  - Douglas County – The County has the primary and most extensive flood storage area. It is particularly important to the management of floods on the River. The middle section of the River through the Carson Valley will not have a floodway designated so it will need greater management. Driveways, raised road sections, and similar development features in the floodplain will require special attention

and management to perpetuate drainage and the ability of the floodplain to function. Additionally, agriculture's needs for construction within the floodplain will need to be addressed.

- Lyon County – The County has experienced development within the floodplain that has impacted floodplain function and the delineation of floodplain element boundaries. The County has flood storage areas critical to the management of floods within its portion of the River. The new FIRMs will include existing homes within the designated floodway. The approximate flood zones east of Dayton will need to be studied/modeled and new special flood hazard zones identified (i.e., base flood elevations). Additionally, a new bridge across the River will need to be constructed in the future. The bridge location, impacts, and mitigation are important considerations, and they will affect the floodplain.
- The biggest needs or challenges for floodplain management programs include:
  - Educating elected officials, planning commissions, and staff about the program and its importance is a challenge for all programs.
  - Alpine County – The County needs a new compliant floodplain management ordinance and a floodplain management program.
  - Carson City – CWSD staff did not identify needs or challenges for Carson City.
  - Douglas County – The County has challenges regarding its agricultural community, maintaining the function and storage capacity of the floodplain, and development pressure on the agricultural lands within the floodplain that would result in a reduction of storage capacity.
  - Lyon County – The County has challenges regarding development pressure on agricultural and undeveloped lands within the floodplain that would result in a reduction of storage capacity.
- The greatest strengths of the floodplain management programs include:
  - Alpine County – The small amount of floodplain within the County and landowners who are actively applying agricultural water quality improvements on their lands.
  - Carson City – The protection and public management of most of the City's Carson River floodplain, and active participation in the CRS program.
  - Douglas County – The County's long-standing implementation of a transfer of development rights program and interest in conservation easements; the existence of the County's current floodplain management program with a dedicated staff person (However, the County has a challenge in finding funding for the program); and active participation in the CRS program.
- Opportunities to improve the floodplain management programs include:
  - The development of new and revised/improved floodplain management ordinances;
  - New FIRMs with better and more realistic definition of the floodplains;
  - The ability of the jurisdictions to benefit from a regional approach that allows them to discuss, coordinate and cooperate with, and learn from each other;
  - The addition of incentives and mitigation measures to updated ordinances that reduce flood risks and maintain floodplain storage capacity; and

- Improvements to CRS ratings in participating Counties.
- The shortcomings of the existing floodplain management systems include:
  - The lack of cumulative impact analysis (A strength is that the new hydraulic model will aid in accomplishing this.);
  - Many discontinuous floodways; and
  - A lack of or limited incentives specified in floodplain ordinances to protect the floodplain from development.
- Recommended changes to the existing floodplain management programs would include:
  - Embracing the new Carson River Hydraulic Model and new FIRMs;
  - Implementing the identified mitigation measures for each jurisdiction; and
  - Each jurisdiction continuing to embrace the CWSD Floodplain Management Plan.
- The CWSD staff believes that the mitigation measures identified in the Carson River Mitigation Plan are accurate and the staff would see some of the measures as being higher in priority from a watershed perspective.
- The CWSD staff would see low impact development standards, transfer of development rights programs and conservation easement programs as mitigation measures applicable to each of the jurisdictions, and measures to be included in each jurisdiction's floodplain management ordinance.
- The CWSD staff believes that implementation of the Carson River Hydraulic Model and its protocols and procedures requires:
  - Each jurisdiction to pass enabling language in their City/County Codes; and
  - Training for city/county staff, planning commissioners, and others.

## Needs and Opportunities Conclusions

Additional support is needed for Alpine County, Carson City, Douglas County and Lyon County to implement the use of the Carson River Hydraulic Model, achieve their identified mitigation measures, and continue to improve their floodplain management programs. Some entities have more mature programs and can continue to make modest advances over an extended period. However, none of the jurisdictions have the staff or financial resources necessary to independently complete their identified improvements and mitigation measures in a timely manner.

An overarching need is the training of city/county staff, elected officials, planning commissioners, professionals and the public regarding the new FIRMs and the Carson River Hydraulic Model. All of the jurisdictions require assistance for this training.

Technical and staff support are necessary to assist the jurisdictions in developing, preparing and adopting ordinances to implement identified mitigation measures. Additional technical and staff support may be needed to develop the identified plan and program mitigation measures.

Continuing regional support by the CWSD will be necessary to oversee, coordinate, maintain, and manage the Carson River Hydraulic Model. This is also true for maintaining and updating the

regional Floodplain Management Plan. Additionally, the regional approach to management of the Carson River empowered by the CWSD must be continued to allow the jurisdictions to discuss, coordinate and cooperate with, and learn from each other.

Alpine County will need extensive support to develop, adopt and implement a floodplain management program and ordinance. The County has the greatest need of any of the four jurisdictions for assistance with preparing a floodplain ordinance since it has not previously had FIRMs and does not have a conforming ordinance to modify. It will need additional assistance to develop and implement its other identified mitigation measures.

Carson City, Douglas County, and Lyon County each have differing floodplain management program strengths and improvement opportunities. Their needs for facilitating implementation of their identified mitigation measures also vary. However, each will require some support and assistance to make timely progress.

## Preliminary Draft Floodplain Management Ordinance Language

Prepare preliminary draft floodplain management ordinance language for use by each jurisdiction incorporating the previously identified mitigation measures, and Carson River Model Protocol and Procedures, as applicable.

### Generic Language

Preliminary draft generic floodplain management ordinance language is provided in Appendix 2 for the use of any jurisdiction.

### Alpine County

Alpine County staff believes that it needs to incorporate the use of the Carson River Hydraulic Model, the Carson River Hydraulic Model Procedures/Guidance and identified mitigation measures into a new, complete floodplain management ordinance. The staff does not believe that adding provisions into the existing code language would be appropriate.

### Carson City

Carson City staff believes that use of the Carson River Hydraulic Model and the Carson River Hydraulic Model Guide should be adopted by means of a revision to the existing Municipal Code. They believe that adoption by reference is appropriate.

Specific preliminary draft floodplain management revision language is provided in Appendix 3 for the revision of the Carson City Municipal Code

## Douglas County

Douglas County staff believes that its current code language is sufficient to incorporate the use of the Carson River Hydraulic Model, and the Carson River Hydraulic Model Procedures/Guidance. The staff does not believe that adding enabling provisions into the existing code language is necessary.

## Lyon County

Lyon County staff believes that use of the Carson River Hydraulic Model and the Carson River Hydraulic Model Guide should be adopted by means of a revision to its County Code. They believe that adoption by reference is appropriate.

Specific preliminary draft floodplain management revision language is provided in Appendix 4 for the revision of the Lyon County Code

## Appendix 1 – Jurisdiction Specific Needs and Opportunities

### Interview Questions

Purpose: To discuss and document each jurisdiction's specific needs, unique circumstances, programs, and opportunities in regards to floodplain management and development of ordinance revisions.

Questions:

1. What makes your jurisdiction unique from others in regards to floodplain management?
2. What are your biggest needs or challenges regarding your jurisdiction's floodplain management program?
3. What do you see as your floodplain management program's greatest strengths?
4. What opportunities do you see to improve your floodplain management program?
5. What are the shortcomings of the existing floodplain management system?
  - a. Floodplain management ordinance/code?
  - b. Regulations/requirements?
  - c. Standards?
  - d. Community Rating System?
6. What would you change in the existing floodplain management program? How would you change it?
7. What improvements would you make in the existing floodplain management program?
8. Are the Carson Flood Mitigation Plan mitigation measures still accurate for your jurisdiction? If not, what changes or additions would you make?
9. Are the rankings/priorities for the Carson Flood Mitigation Plan mitigation measures still accurate for your jurisdiction? If not, what changes or additions would you make?
10. What mitigation measures do you want to see included in your jurisdiction's floodplain management ordinance/code?
11. For your jurisdiction specifically, what do you see as being necessary to implement the Carson River Hydraulic Model protocols and procedures?
12. How would you recommend that requirements for the Carson River Hydraulic Model protocols and procedures be inserted into your jurisdiction's floodplain management ordinance? Where in the ordinance/code?
13. How does your jurisdiction want to regulate the use of the Carson River Hydraulic Model to assess cumulative impacts of land use changes within the 1% and 0.2% chance floodplains?

14. Does your jurisdiction want to use the Carson River Hydraulic Model to assess project specific impacts of land use changes on adjacent, surrounding or other properties?
15. Does your jurisdiction want to use the Carson River Hydraulic Model to assess project specific impacts of land use changes as a means of mitigating any of the following items?
  - a. Flood hazards to downstream properties and communities
  - b. Loss of riparian habitat
  - c. Loss of floodplain function
  - d. Degradation of water quality
  - e. Other
16. Is your jurisdiction's floodplain management ordinance/code coordinated with the jurisdiction's adopted building codes?
17. Would your jurisdiction want to revise its floodplain management ordinance/code to be coordinated with the jurisdiction's adopted building codes?
18. What unique requirements does your jurisdiction have for revising its code, regulations, and standards?

## Appendix 2 – Generic Preliminary Draft Floodplain Management Ordinance Revision Language

### CARSON RIVER FLOODPLAIN HYDRAULIC MODELING:

#### A. Purpose:

It is the purpose of the Carson River Floodplain Hydraulic Modeling provisions to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions within the Carson River floodplain by requiring the use of the Carson River Hydraulic Model and procedures designed to:

1. Provide a consistent and complete tool to assess cumulative impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;
2. Provide a consistent and complete tool to assess project specific impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;
3. Provide a consistent and complete tool for mitigating flood hazards to downstream communities, loss of riparian habitat and floodplain function, and degradation of water quality due to impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;
4. Provide consistent protocols, procedures, and guidance necessary to use the Carson River Hydraulic Model to evaluate impacts to floodplain extents, peak flow, peak flow timing, and flood volumes.

#### B. Definitions

1. “Carson River Hydraulic Model (Model)” is a single unified HEC-RAS model encompassing portions of the Carson River within Alpine County, California, Carson City, Nevada, Douglas County, Nevada and Lyon County, Nevada. The Model has its downstream terminus at Lahontan Reservoir, its upstream extent for the West Fork of the Carson River at approximately the USGS stream gage (10310000), West Fork Carson River At Woodfords, California, and its upstream extent for the East Fork of the Carson River at approximately the USGS stream gage (10309000), East Fork Carson River Near Gardnerville, Nevada.
2. “Carson River Hydraulic Model – Model Management, Distribution, and Update Guide (Guide)” is the document that provides guidance and procedures regarding the use, management, distribution, modification, submission, and review of the Model.

#### C. General Provisions.

1. The Model is hereby adopted as the hydraulic modeling/mapping tool to assess impacts of land use changes and development within the Carson River floodplain.
2. The Guide is hereby adopted as the required procedures and guidance for the use of the Model, including management, distribution, modification, submission and review.

3. Lands to which this Section Applies. This section shall apply to all areas of special flood hazards within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains of the Carson River within the jurisdiction of \_\_\_\_\_.

4. The most current version of the model shall be used to assess cumulative and project specific impacts of land use changes and development where a detailed hydrologic and hydraulic analyses and/or demonstration of the cumulative effect of the proposed land use changes or development are required by this code. The Model shall be used for the following:

- a. Technical analysis as set forth in subsection \_\_\_\_ of this chapter.
- b. When there is no base flood elevation data available as set forth in subsection \_\_\_\_ of this chapter.
- c. Additional technical analysis as set forth in subsection \_\_\_\_\_, of this chapter.
- d. Use of other base data as set forth in subsection \_\_\_\_ of this chapter.
- e. Interpretation of Flood Insurance Rate Map (FIRM) Boundaries as set forth in subsection \_\_\_\_ of this chapter.
- f. For reviewing all proposals for new development as set forth in subsection \_\_\_\_ of this chapter.
- g. For compliance with the provisions of subsection \_\_\_\_\_, "Specific Standards For Flood Hazard Reduction" "Standards for Subdivisions."
- h. For compliance with the provisions of subsection \_\_\_\_\_ "Specific Standards For Flood Hazard Reduction" "Floodways."
- i. For compliance with the provisions of and providing information for subsection \_\_\_\_\_, "Variances procedures."
- j. For compliance with the provisions of and providing information for subsection \_\_\_\_\_, "Map revision/amendment procedures."

5. All subdivision proposals and other proposed developments shall assess the cumulative and project specific impacts of land use changes and development through a detailed hydrologic and hydraulic analyses and/or demonstration of the cumulative effect of the proposed land use changes or development.

6. Use of the model shall be in conformance with the procedures and guidelines set forth in the most current version of the guide.

## Appendix 3 – Carson City Preliminary Draft Floodplain Management Ordinance Revision Language

Bill No. \_\_\_\_\_

Ordinance No. \_\_\_\_\_

**SUMMARY:** AN ORDINANCE AMENDING CARSON CITY MUNICIPAL CODE TITLE 12 – WATER, SEWERAGE AND DRAINAGE; BY AMENDING: CHAPTER 9 – FLOOD DAMAGE PREVENTION, REVISING SECTION 12.09.020 – DEFINITIONS, REVISING SECTION 12.09.040 – DECLARATION OF PURPOSE, REVISING SECTION 12.09.060 – GENERAL PROVISIONS, REVISING SECTION 12.09.080 – PROVISIONS FOR FLOOD HAZARD REDUCTION; ADDING PROVISIONS PERTAINING TO CARSON RIVER FLOODPLAIN HYDRAULIC MODELING; TO ESTABLISH THE HYDRAULIC MODELING/MAPPING TOOL, AND PROTOCOLS AND PROCEDURES TO BE USED TO ASSESS PROJECT AND CUMULATIVE IMPACTS OF LAND USE CHANGES WITHIN THE 1-PERCENT CHANCE (100-YEAR) AND 0.2-PERCENT CHANCE (500-YEAR) FLOODPLAIN OF THE CARSON RIVER; AND OTHER MATTERS PROPERLY RELATED THERETO.

**TITLE:** AN ORDINANCE AMENDING CARSON CITY MUNICIPAL CODE TITLE 12 – WATER, SEWERAGE AND DRAINAGE; BY AMENDING: CHAPTER 9 – FLOOD DAMAGE PREVENTION; AND OTHER MATTERS PROPERLY RELATED THERETO.

EXPLANATION – Matter in underlined bolded *italics* is new; matter with strikethrough text [~~omitted material~~] is to be omitted.

THE BOARD OF SUPERVISORS OF CARSON CITY, NEVADA DOES HEREBY ORDAIN:

**Section 1.** Carson City Municipal Code; Title 12 – Water, Sewerage And Drainage, Chapter 9 – Flood Damage Prevention, is hereby amended to revise the following sections:

Chapter 12.09 - FLOOD DAMAGE PREVENTION

Sections:

12.09.010 - Short title.

This chapter of the Carson City Municipal Code shall be shown and cited as the Carson City Flood Damage Prevention Ordinance.

12.09.020 - Definitions.

As used in this chapter:

1. "Accessory use" means a use which is incidental and subordinate to the principal use of the parcel of land on which it is located.
2. "Alluvial fan" is an area subject to flooding when the floodplain is comprised of low flow channels where sediment accompanies the shallow flooding and the unstable soils scour and erode during a flooding event.

3. "Alluvial fan flooding" means flooding occurring on the surface of an alluvial fan or similar land form which originates at the apex and is characterized by high-velocity flows: active processes of erosion, sediment transport, deposition, and unpredictable flow paths.
4. "Anchoring" means a series of methods used to secure a structure to its footings or foundation wall so that it will not be displaced by flood or wind forces.
5. "Apex" means the highest point on an alluvial fan or similar landform below which the flow path of the major stream that formed the fan becomes unpredictable and alluvial fan flooding can occur.
6. "Appeal" is a request for a review of the Local Floodplain Administrator's interpretation of any provision of this chapter or a request for a variance.
7. "Area of shallow flooding" is a designated AO Zone on the Flood Insurance Rate Map. The base flood depths range from one (1) to three (3) feet; a clearly defined map channel indeterminate; and, velocity flow may be evident. AO is characterized as sheet flow and AH indicates ponding.
8. "Base flood" is the flood having a one percent (1%) chance of being equaled or exceeded in any given year, also referred to as the "one hundred-year flood."
9. "Base flood elevation" (BFE) means the height in relation to mean sea level expected to be reached by the waters of the base flood at pertinent points in the floodplain of riverine areas.
10. "Basement" means any area of the building having its floor subgrade (below ground level) on all sides. A sub grade crawlspace is considered a basement unless it meets the minimum technical requirements defined in FEMA Technical Bulletin 11-01 (Crawlspace Construction for Buildings Located in Special Flood Hazard Areas, 2001).
11. "Building" - See structure.
- 12. "Carson River Hydraulic Model (Model)" means a single unified HEC-RAS model encompassing portions of the Carson River within Alpine County, California, Carson City, Nevada, Douglas County, Nevada and Lyon County, Nevada. The Model has its downstream terminus at Lahontan Reservoir, its upstream extent for the West Fork of the Carson River at approximately the USGS stream gage (10310000), West Fork Carson River At Woodfords, California, and its upstream extent for the East Fork of the Carson River at approximately the USGS stream gage (10309000), East Fork Carson River Near Gardnerville, Nevada.**
- 13. "Carson River Hydraulic Model – Model Management, Distribution, And Update Guide (Guide)" means the document that provides guidance and procedures regarding the use, management, distribution, modification, submission and review of the Model.**
- ~~14~~14. "Community" means any state or area or political subdivision thereof, or any Indian tribe or authorized tribal organization, or authorized native organization, which has authority to adopt and enforce flood plain management regulations for the areas within its jurisdiction.
- ~~13~~15. "Community rating system" (CRS) means a program developed by FIA to provide incentives for those communities in the Regular Program that have gone beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding.
- ~~14~~16. "Conditional letter of map amendment" (CLOMA) means a letter from FEMA stating that a proposed structure that is not to be elevated by fill would not be inundated by the base flood if built as proposed.
- ~~15~~17. "Conditional letter of map revision" (CLOMR) means procedures by which contractors, developers and communities can request review and determination by the Federal Insurance Administrator of scientific and technical data for a proposed project, when complete and functioning effectively would modify the elevation of individual structures and parcels of land, stream channels, and floodplains on the FIRM.
- ~~16~~18. "Conditional letter of map revision (based on fill)" (CLOMR-F) means a letter from FEMA stating that a parcel of land or proposed structure that is to be elevated by fill would not be inundated by the base flood if fill is placed on the parcel as proposed or the structure is built as proposed.

- 1719.** "Critical structures" means any structure for which even a slight chance of flooding would reduce or eliminate its designed function of supporting a community in an emergency. Fire stations, hospitals, municipal airports, police stations, communication antennas or towers, elder care facilities (retirement homes) fuel storage facilities, schools designated as emergency shelters, fresh water and sewage treatment facilities are some examples of critical structures.
- 1820.** "Date of construction" means the date that the building permit was issued provided the actual start of construction, repair, reconstruction, or improvement was within one hundred eighty (180) days of the permit date.
- 1921.** "Designated floodway" means the channel of a stream and the portion of the adjoining floodplain designated by a regulatory agency to be kept free of further development to provide for unobstructed passage of flood flows.
- 2022.** "Development" means any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials located within special flood hazard area.
- 2123.** "Digital flood insurance rate map" (DFIRM) means the official map, in digital format, on which the Federal Emergency Management Agency or Federal Insurance Administration has delineated both the areas of special flood hazards and the risk premium zones applicable to the community. The DFIRM is the legal equivalent of the FIRM in communities where a DFIRM is available (See Flood Insurance Rate Map).
- 2224.** "Dry floodproofing" means a floodproofing method used to design and construct buildings so as to prevent the entrance of floodwaters.
- 2325.** "Elevation certificate" means the elevation certificate is required in order to properly rate post-FIRM buildings, which are buildings constructed after publication of the Flood Insurance Rate Map (FIRM), for flood insurance Zones A1—A30, AE, AH, A (with BFE), VE, V1—V30, V (with BFE), AR, AR/A, AR/AE, AR/A1—A30, AR/AH, and AR/AO. The elevation certificate is not required for pre-FIRM buildings unless the building is being rated under the optional post-FIRM Flood insurance rules.
- 2426.** "Enclosure" means that portion of an elevated building below the lowest elevated floor that is either partially or fully shut-in by rigid walls.
- 2527.** "Encroachment" means the advance or infringement of uses, plant growth, excavation, fill, buildings, permanent structures or development, storage of equipment and materials, or any other physical object placed in the floodplain, that hinders the passage of water or otherwise affects flood flows.
- 2628.** "Existing manufactured home park or manufactured home subdivision" means a manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including, at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads) is completed before the effective date of the ordinance codified in this chapter.
- 2729.** "Expansion to an existing manufactured home park or manufactured home subdivision" is the preparation of additional sites by the construction of facilities for serving the lots on which the manufactured homes are to be affixed (including the installation of utilities, either final site grading or pouring of concrete pads, or the construction of streets).
- 2830.** "Federal Emergency Management Agency" (FEMA) is the federal agency under which the National Flood Insurance Program (NFIP) is administered.
- 2931.** "Federal Insurance Administration" (FIA) is the government unit, a part of Federal Emergency Management Agency (FEMA), that administers the National Flood Insurance Program (NFIP).
- 3032.** "Flash flood" means a flood that crests in a short period of time and is often characterized by high velocity flows. It is often the result of heavy rainfall in a localized area.

- 3133.** "Flood, flooding or flood waters" means a general and temporary condition of partial or complete inundation of normally dry land areas from the overflow of floodwaters; the unusual and rapid accumulation or runoff of surface waters from any source and mudslides (i.e., mudflows) and the condition resulting from flood-related erosion.
- 3234.** "Flood control" means keeping flood waters away from specific developments or populated areas, areas by the construction of flood storage reservoirs, channel alterations, dikes and levees, bypass channels, or other engineering works.
- 3335.** "Flood Hazard Boundary Map" (FHBM) is an official map of a community, issued by the Administrator, where the boundaries of the flood, mudslide (i.e., mudflow) related erosion areas having special hazards have been designated as Zones A, M, and/or E.
- 3436.** "Flood Insurance Rate Map" (FIRM) is the official map on which the Federal Emergency Management Agency or Federal Insurance Administration has delineated both the areas of special flood hazards and the risk premium zones applicable to the community. Includes Digital Flood Insurance Rate Map (DFIRM) in communities where a DFIRM is available (See Digital Flood Insurance Rate Map).
- 3537.** "Flood Insurance Study" is the official report provided by the Federal Emergency Management Agency that includes flood profiles, the Flood Insurance Rate Map (FIRM), the Flood Boundary Floodway Map, and the water surface elevation of the base flood.
- 3638.** "Floodplain and flood-prone area" means any land area susceptible to being inundated by waters from any source. (also See Flood, flooding or flood waters).
- 3739.** "Floodplain management" is the operation of an overall program of corrective and preventive measures for reducing flood damage and preserving and enhancing, where possible, natural resources in the floodplain, including but not limited to emergency preparedness plans, flood control works and floodplain management plans, regulations and ordinances.
- 3840.** "Floodplain management regulations" means this chapter, and any federal, state or local regulations plus community zoning ordinances, subdivision regulations, building codes, health regulations, special purpose ordinances (such as a grading and erosion control) and other applications of police power which control development in flood-prone areas to prevent and reduce flood loss and damage.
- 3941.** "Floodproofing" means any combination of structural and nonstructural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved property, water and sanitary facilities, structures and their contents. Refer to FEMA Technical Bulletins TB-1 (Openings in Foundation Walls and Walls of Enclosures, 2008), TB-3 (Non-residential Floodproofing - Requirements and Certification, 1993), and TB-7(Wet Floodproofing Requirements, 1993) for Guidelines on dry and wet floodproofing.
- 4042.** "Flood-related erosion" is a condition that exists in conjunction with a flooding event that alters the composition of the shoreline or bank of a watercourse. It is a condition that increases the possibility of loss due to the erosion of the land area adjacent to the shoreline or watercourse.
- 4143.** "Floodway" means the channel or a river or other watercourse and the adjacent land area that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than 0.99 foot.
- 4244.** "Flood Insurance Risk Zone Designations" are the zone designations indicating the magnitude of the flood hazard in specific areas of a community. See Special Flood Hazard Area.
- 4345.** "Zone A" means Special Flood Hazard Areas inundated by the one hundred-year flood; base flood elevations are not determined.
- 4446.** "Zone A1—30 and Zone AE" means Special Flood Hazard Areas inundated by the one hundred-year flood; base flood elevations are determined.

- 4547.** "Zone AO" means Special Flood Hazard Areas inundated by the one hundred-year flood; with flood depths of one (1) to three (3) feet (usually sheet flow on sloping terrain); average depths are determined. For areas of alluvial fan flooding, velocities are also determined.
- 4648.** "Zone AH" means Special Flood Hazard Areas inundated by the one hundred-year flood; flood depths of one (1) to three (3) feet (usually areas of ponding); base flood elevations are determined.
- 4749.** "Zone AR" means Special Flood Hazard Areas that result from the decertification of a previously accredited flood protection system that is in the process of being restored to provide a one hundred-year or greater level of flood protection.
- 4850.** "Zones AR/A1—30, AR/AE, AR/AH, AR/AO, and AR/A" means Special Flood Hazard Areas that result from the decertification of a previously accredited flood protection system that is in the process of being restored to provide a one hundred-year or greater level of flood protection. After restoration is complete, these areas will still experience residual flooding from other flooding sources.
- 4951.** "Zone A99" means Special Flood Hazard Areas inundated by the one hundred-year flood to be protected from the one hundred-year flood by a Federal flood protection system under construction; no base flood elevations determined.
- 5052.** "Zone B and Zone X (shaded)" means Areas of 500-year flood; areas subject to the one hundred-year flood with average depths of less than one (1) foot or with contributing drainage area less than one (1) square mile; and areas protected by levees from the base flood.
- 5153.** "Zone C and Zone X (unshaded)" means Areas determined to be outside the 500-year floodplain.
- 5254.** "Zone D" means Areas in which flood hazards are undetermined.
- 5355.** "Footing" means the enlarged base of a foundation wall, pier, or column, designed to spread the load of the structure so that it does not exceed the soil bearing capacity.
- 5456.** "Foundation" means the underlying structure of a building usually constructed of concrete that supports the foundation walls, piers, or columns.
- 5557.** "Foundation walls" means a support structure that connects the foundation to the main portion of the building or superstructure.
- 5658.** "Freeboard" means a margin of safety usually expressed in feet above a flood level for purposes of flood plain management. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed.
- 5759.** "Functionally dependent use" means a use which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only marina facilities, port facilities that are necessary for the loading and unloading of cargo or passengers, and boat building and boat repair facilities, but does not include long-term storage or related manufacturing facilities.
- 5860.** "Governing body" means the local governing unit, county or municipality that is empowered to adopt and implement regulations to provide for public health, safety and general welfare of its citizenry.
- 5961.** "Hardship" is related to Variances of this chapter. The exceptional hardship would result from a failure to grant the requested variance. The Board of Supervisors requires the variance be exceptional, unusual, and pertain only to the property involved. Mere economic or financial hardship alone is not exceptional. Inconvenience, aesthetic considerations, physical handicaps, personal preferences, or the disapproval of one's neighbors likewise cannot, as a rule, qualify as an exceptional hardship. All of these problems can be resolved through other means without granting a variance, even if the alternative is more expensive, or requires the property owner to build elsewhere or put the parcel to a different use than originally intended.
- 6062.** "Highest adjacent grade" means the highest natural elevation of ground surface prior to construction next to the proposed walls of a structure or the highest ground surface next to the structure.

- ~~6163~~. "Historic structure" means any structure that is:
- Listed individually in the National Register of Historic Places (a listing maintained by the Department of Interior) or preliminarily determined by the Secretary of the Interior as meeting the requirements for individual listing on the National Register;
  - Certified or preliminarily determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;
  - Individually listed on a State inventory of historic places in states with historic preservation programs which have been approved by the Secretary of Interior; or
  - Individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either by an approved State program as determined by the Secretary of the Interior or directly by the Secretary of the Interior in states without approved programs.
- ~~6264~~. "Hydrodynamic loads" are forces imposed on structures by floodwaters due to the impact of moving water on the upstream side of the structure, drag along its sides, and eddies or negative pressures on its downstream side.
- ~~6365~~. "Hydrostatic loads" are forces imposed on a flooded structure due to the weight of the water.
- ~~6466~~. "Letter of map amendment" (LOMA) is the procedure by which any owner or lessee of property who believes his property has been inadvertently included in a Special Flood Hazard Area can submit scientific and technical information to the Federal Insurance Administrator for review to remove the property from said area. The Administrator will not consider a LOMA if the information submitted is based on alteration of topography or new hydrologic or hydraulic conditions since the effective date of the FIRM.
- ~~6567~~. "Letter of map revision" (LOMR) is an official revision to a currently effective FIRM. A LOMR officially changes flood zone, floodplain and floodway designations, flood elevations and planimetric features.
- ~~6668~~. "Letter of map revision (based on fill)" (LOMR-F) is a letter from FEMA stating that an existing structure or parcel of land that has been elevated by fill would not be inundated by the base flood.
- ~~6769~~. "Levee" means a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control or divert the flow of water so as to provide protection from temporary flooding.
- ~~6870~~. "Lowest floor" means the lowest floor of the lowest enclosed area (including basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access or storage, in an area other than a basement area, is not considered a building's lowest floor, provided that such enclosure does not violate applicable non-elevation design requirements.
- ~~6971~~. "Hazard mitigation plan" is a plan that incorporates a process whereby the potential of future loss due to flooding can be minimized by planning and implementing alternatives to floodplain management community-wide.
- ~~7072~~. "Manufactured home" (mobile home) means a structure, transportable in one (1) or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when attached to the required utilities. The term "manufactured home" does not include "recreational vehicles".
- ~~7173~~. "Manufactured home park or subdivision" means a parcel or contiguous parcels of land divided into two (2) or more manufactured home lots for rent or sale.
- ~~7274~~. "Market value" is for the purposes of determining substantial improvement, market value pertains only to the structure in question. It does not pertain to the land, landscaping or detached accessory structures on the property. For determining improvement, the value of the land must always be subtracted.

Acceptable estimates of market value can be obtained from the following sources:

- a. Independent appraisals by a professional appraiser; or
- b. Detailed estimates of the structure's Actual Cash Value (used as a substitute for market value based on the preference of the community); or
- c. Property appraisals used for tax assessment purposes (Adjusted Assessed Value: used as a screening tool); or
- d. The value of buildings taken from NFIP claims data (used as a screening tool); or.
- e. "Qualified estimates" based on sound professional judgment made by staff of the local building department or local or State tax assessor's office.

As indicated above, some market value estimates should only be used as screening tools to identify those structures where the substantial improvement ratios are obviously less than or greater than fifty percent (50%) (e.g., less than forty percent (40%) or greater than sixty percent (60%)). For structures that fall between the forty percent (40%) and sixty percent (60%) range, more precise market value estimates should be used.

~~7375~~. "Mobile home" has the same meaning as manufactured home.

~~7476~~. "Natural grade" means the grade unaffected by construction techniques such as fill, landscaping, or berming.

~~7577~~. "New construction" means structures for which the "start of construction" commenced on or after the effective date of the ordinance codified in this chapter.

~~7678~~. "New manufactured home (mobile home) subdivision" means a manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed including at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads is completed on or after the effective date of these floodplain management regulation adopted by the Board of Supervisors.

~~7779~~. "Non-residential" includes, but is not limited to: small business concerns, churches, schools, farm buildings (including grain bins and silos), poolhouses, clubhouses, recreational buildings, mercantile structures, agricultural and industrial structures, warehouses, and hotels or motels with normal room rentals for less than six (6) months duration.

~~7880~~. "Obstruction" includes, but is not limited to, any dam, wall, wharf, embankment, levee, dike, pile, abutment, protection, excavation, channelization, bridge, conduit, culvert, building, wire, fence, rock, gravel refuse, fill, structure, vegetation or other material in, along, across or projecting into any watercourse which may alter, impede, retard or change the direction and or velocity of the flow of water, or due to its location, its propensity to snare or collect debris carried by the flow of water, or its likelihood of being carried downstream.

~~7981~~. "One-hundred year-flood" has the same meaning as base flood.

~~8082~~. "Physical map revisions" (PMR) is a reprinted NFIP map incorporating changes to floodplains, floodways, or flood elevations. Because of the time and cost involved to change, reprint, and redistribute an NFIP map, a PMR is usually processed when a revision reflects large scope changes.

~~8183~~. "Ponding hazard" is a flood hazard that occurs in flat areas when there are depressions in the ground that collect "ponds" of water. The ponding hazard is represented by the zone designation AH on the FIRM.

~~8284~~. "Post-FIRM construction" means construction or substantial improvement that started on or after the effective date of the initial Flood Insurance Rate Map (FIRM) of the community or after December 31, 1974, whichever is later.

~~8385~~. "Pre-FIRM construction" means construction or substantial improvement which started on or before December 31, 1974 or before the effective date of the initial Flood Insurance Rate Map (FIRM) of the community, whichever is later.

- 8486.** "Principal residence" is a single family dwelling in which at the time of loss, the named insured or the named insured's spouse has lived for either (1) eighty percent (80) percent of the calendar year, or (2) eighty percent (80) percent of the period of ownership, if less than one (1) year.
- 8587.** "Proper openings for enclosures"(Applicable to Zones A, A1-A30, AE, AO, AH, AR, and AR Dual) relates to all enclosures below the lowest floor must be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. A minimum of two (2) openings, with positioning on at least two (2) walls, having a total net area of not less than one (1) square inch for every square foot of enclosed area subject to flooding must be provided.
- 8688.** "Public safety" relates to granting of a variance, the variance must not result in anything which is injurious to safety or to health of people, neighborhoods or community.
- 8789.** "Public nuisance" relates to any person that unlawfully obstructs the free passage or use, in the customary manner, of any navigable lake, or river, above or below ground channel, swale, stream, canal, or basin.
- 8890.** "Recreational vehicle" means a vehicle built on a single chassis, four hundred (400) square feet or less when measured at the largest horizontal projection, designed to be self-propelled or permanently towable by a light-duty track, and designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel, or seasonal use.
- 8991.** "Special Flood Hazard Area"(SFHA) is Darkly shaded area on a Flood Hazard Boundary Map (FHBM) or a Flood Insurance Rate Map (FIRM) that identifies an area that has a one percent (1%) chance of being flooded in any given year (one hundred-year floodplain). Over a thirty-year period, the life of most mortgages, there is at least a twenty-six percent (26%) chance that this area will be flooded. The FIRM identifies these shaded areas as FIRM Zones A, AO, AH, A1—A30, AE, A99, AR, AR/A, AR/AE, AR/A1—A30, AR/AH, AR/AO, V, V1—V30, and VE. See Flood Insurance Risk Zone Designations
- 9092.** "Start of construction" includes substantial improvement and other proposed new development and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, rehabilitation, addition, placement, or other improvement was within one hundred eighty (180) days from the date of the permit. The actual start means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation, or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading, and filling; nor does it include the installation of streets and or walkways; nor does it include excavation for a basement, footings, piers, or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure. For a substantial improvement, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of a building, whether or not that alteration affects the external dimensions of the building.
- 9193.** "Structure" is a walled and roofed building or manufactured home that is principally above ground. A structure may be a gas or a liquid storage tank.
- 9294.** "Substantial damage" means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damage condition would equal or exceed fifty percent (50%) of the market value of the structure before the damage occurred.
- 9395.** "Substantial improvement" means any reconstruction, rehabilitation, addition, or other proposed new development of a structure, the cost of which equals or exceeds fifty percent (50%) of the market value of the structure before the "start of construction" of the improvement. This term includes structures which have incurred "substantial damage," regardless of the actual repair work performed. The term does not, however, include either;

- a. Any project for improvement of a structure to correct existing violations of state or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure a safe living conditions, or
- b. Any alteration of a "historic structure" provided that the alteration will not preclude the structure's continued designation as a "historic structure."

**9496.** "Variance" means a grant of relief from the requirements of this chapter which permits construction in a manner that would otherwise be prohibited by this chapter.

**9597.** "Violation" means the failure of a structure (new or substantially improved/damaged) or other development to be fully compliant with this chapter. A structure or other development in a special flood hazard area, without an elevation certificate, other certifications or other evidence of compliance required in this chapter is presumed to be in violation until such time as that documentation is provided.

**9698.** "Water surface elevation" means the height, in relation to the North American Vertical Datum (NAVD) of 1988, or (other datum, where specified) of floods of various magnitudes and frequencies in the floodplains of coastal or riverine areas.

**9799.** "Watercourse" means a lake, river, creek, stream, wash, arroyo, channel or other topographic feature on or over which waters flow at least periodically. Watercourse includes specifically designated areas in which substantial flood damage may occur.

**98100.** "2010 Carson City Control Network" means the record of survey map recorded on August 11, 2010, as map number 2749, document number 403435 in the office of Recorder, Carson City, Nevada.

**99101.** "Appeal Board" means the Board of Supervisors of Carson City.

#### 12.09.025 - Statutory authorization.

The legislature of the State of Nevada in Nevada Revised Statutes 278.020, 244A.057, and 543.020 confers upon local government units authority to adopt regulations designed to promote the public health, safety, and general welfare of its citizenry. Therefore, the Board of Supervisors of Carson City does hereby adopt the following floodplain management regulations.

#### 12.09.030 - Findings of fact.

1. That the flood hazard areas of Carson City are subject to periodic inundation which results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety and general welfare.
2. That these flood losses are caused by the cumulative effect of obstructions in areas of special flood hazards which increase flood heights and velocities, and when inadequately anchored, damage uses in other areas. Uses that are inadequately floodproofed, elevated or otherwise protected from flood damage also contribute to the flood loss.

#### 12.09.040 - Declaration of purpose.

It is the purpose of this chapter to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas by provisions designed:

1. To protect human life and health;
2. To minimize expenditure of public money for costly flood-control projects;

3. To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
4. To minimize prolonged business interruptions;
5. To minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets and bridges located in areas of special flood hazard;
6. To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future blight areas;
7. To ensure that potential buyers are notified that property is in an area of special flood hazard; and
8. To ensure that those who occupy the areas of special flood hazard assume responsibility for their actions; and
9. To maintain qualifying standards for participation in the National Flood Insurance Program.

**10. To minimize public and private losses due to flood conditions within the Carson River floodplain by requiring the use of the Carson River Hydraulic Model and procedures designed to:**

- a. Provide a consistent and complete tool to assess cumulative impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;**
- b. Provide a consistent and complete tool to assess project specific impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;**
- c. Provide a consistent and complete tool for mitigating flood hazards to downstream communities, loss of riparian habitat and floodplain function, and degradation of water quality due to impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;**
- d. Provide consistent protocols, procedures, and guidance necessary to use the Carson River Hydraulic Model to evaluate impacts to floodplain extents, peak flow, peak flow timing, and flood volumes.**

12.09.050 - Methods of reducing flood losses.

In order to accomplish its purposes, this chapter includes methods and provisions for:

1. Restricting or prohibiting uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities;
2. Requiring that land uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;
3. Controlling the alteration of natural floodplains, stream channels and natural protective barriers, which help accommodate or channel floodwaters;
4. Controlling, filling, grading, dredging, and other development which may increase flood damage; and
5. Preventing or regulating the construction of flood barriers which will unnaturally divert floodwaters or which may increase flood hazards in other areas.

12.09.060 - General provisions.

The general provisions of this chapter are as follows:

1. Lands to which this Chapter Applies. This chapter shall apply to all areas of special flood hazards within the jurisdiction of Carson City.

2. Basis for Establishing the Areas of Special Flood Hazard. The areas of special flood hazard identified by the Federal Insurance Administration, through the Federal Emergency Management Agency in the Flood Insurance Study (FIS), with the accompanying Flood Insurance Rate Maps (FIRM), dated March 4, 1986 and all subsequent amendments and/or revisions, are hereby adopted by reference and declared to be a part of this chapter. The Flood Insurance Study is on file at the Development Services - Engineering for Carson City in its offices of record for public reference and review.
3. Compliance. No structure or land shall hereafter be constructed, located, extended, converted or altered without full compliance with the terms of this chapter and other applicable regulations. Violations of the provisions of this chapter by failure to comply with any of its requirements (including violations of conditions and safeguards established in connection with conditions) shall constitute a misdemeanor. Any person who violates this chapter or fails to comply with any of its requirements shall upon conviction be guilty of a misdemeanor of each violation, and in addition shall pay all costs and expenses involved in the case. Nothing herein contained shall prevent Carson City from taking such other lawful actions as is necessary to prevent or remedy any violation.
4. Abrogation and Greater Restrictions. This chapter is not intended to repeal, abrogate or impair any existing easements, covenants or deed restrictions. However, where the ordinance codified in this chapter and another chapter, easement, covenant or deed restriction conflict or overlap, whichever imposes the more stringent restrictions shall prevail.
5. Interpretation. In the interpretation and application of this chapter, all provisions shall be:
  - a. Considered as minimum requirements;
  - b. Liberally construed in favor of the governing body; and
  - c. Deemed neither to limit nor repeal any other powers granted under state statutes.
6. Warning and Disclaimer of Liability. The degree of flood protection required by this chapter is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Larger floods can and will occur on rare occasions. Flood heights may be increased by man—made or natural causes. This chapter does not imply that land outside the areas of special flood hazards or uses permitted within such area will be free from flooding or flood damages. This chapter shall not create liability on the part of Carson City, any officer or employee thereof, or the Federal Insurance Administration, for any flood damages that result reliant on this chapter or any administrative decision lawfully made hereunder.
7. Declaration of Public Nuisance. Every new structure, building, fill, excavation or development located or maintained within any area of special flood hazard after March 4, 1986 is in violation of this chapter and considered a public nuisance per se and may be abated, prevented or restrained by action of this political subdivision.
8. Unlawful Acts. It is unlawful for any person to divert, retard or obstruct the flow of waters in any watercourse whenever it creates a hazard to life or property without securing the appropriate local, state and/or Federal permit(s). Any person violating the provisions of this section shall be guilty of a misdemeanor.
9. Severability. This chapter and the various parts thereof are hereby declared to be severable. Should any section of this ordinance be declared by the courts to be unconstitutional or invalid, such decisions shall not affect the validity of the chapter as a whole, or any portion thereof other than the section so declared to be unconstitutional or invalid.

**10. Carson River Floodplain Hydraulic Modeling.**

**a. The Carson River Floodplain Hydraulic Model (Model) is hereby adopted as the hydraulic modeling/mapping tool to assess impacts of land use changes and development within the Carson River floodplain.**

- b. The Carson River Hydraulic Model – Model Management, Distribution, And Update Guide (Guide) is hereby adopted as the required procedures and guidance for the use of the model, including management, distribution, modification, submission and review.*
- c. Lands to which the Carson River Floodplain Hydraulic Modeling Applies. The Carson River Floodplain Hydraulic Modeling shall apply to all areas of special flood hazards within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains of the Carson River within the jurisdiction of Carson City.*
- d. The most current version of the Model shall be used for the following:*
- (1) Technical analysis as set forth in subsection 12.09.070 1f of this chapter.*
  - (2) When there is no base flood elevation data available as set forth in subsection 12.09.070 1g of this chapter.*
  - (3) Additional technical analysis as set forth in subsection 12.09.070 3a3, of this chapter.*
  - (4) Use of other base data as set forth in subsection 12.09.070 3b1 and 3b2 of this chapter.*
  - (5) Interpretation of Flood Insurance Rate Map (FIRM) Boundaries as set forth in subsection 12.09.070 e of this chapter.*
  - (6) For reviewing all proposals for new development as set forth in subsection 12.09.070 g of this chapter.*
  - (7) For compliance with the provisions of subsection 12.09.080 4f and 4g, “Specific Standards For Flood Hazard Reduction” “Standards for Subdivisions.”*
  - (8) For compliance with the provisions of subsection 12.09.080 6a and 6b “Specific Standards For Flood Hazard Reduction” “Floodways.”*
  - (9) For compliance with the provisions of and providing information for subsection 12.09.090, “Variances procedures.”*
  - (10) For compliance with the provisions of and providing information for subsection 12.09.100, “Map revision/amendment procedures.”*
- e. Use of the Model shall be in conformance with the procedures and guidelines set forth in the most current version of the Guide.*

#### 12.09.070 - Administration.

This chapter shall be administered as follows:

1. Establishment of Development Permit. A development permit shall be obtained before construction or development begins within any area of special flood hazard established pursuant to this chapter. The permit shall be for all structures including manufactured homes, and for all development including fill and other activities.

Application for a development permit shall be made on forms furnished by the Permit Center and may include, but not be limited to: plans in duplicate scale showing the nature, location, dimensions, and elevation of the area in question; existing or proposed structures, fill, storage of materials, drainage facilities; and the location of the foregoing. Specifically, the following information is required:

- a. Proposed elevation in relation to mean sea level, of the lowest floor (including basement) of all residential and non-residential structures whether new or substantially improved to be located in Zones A, A1—A30, AE, and AH, if base flood elevations data are available;
- b. Proposed elevation in relation to mean sea level to which any new or substantially improved non-residential structure will be floodproofed;

- c. Certification by a registered professional engineer or architect that the floodproofing methods for any nonresidential structure and/or any utility meets the floodproofing criteria;
  - d. Description of the extent to which any watercourse will be altered or relocated as a result of proposed development. When a watercourse will be altered or relocated as a result of the proposed development, the applicant must submit the maps, computations, and other materials required by the Federal Emergency Management Agency (FEMA) to process a Letter of Map Revision (LOMR) and pay any fees or other costs assessed by FEMA for processing the revision;
  - e. In Zone AO the proposed elevation in relation to mean sea level, of the lowest floor (including basement) and the elevation of the highest adjacent grade of all residential and non-residential structures whether new or substantially improved;
  - f. A technical analysis, by a professional engineer licensed in the State of Nevada, showing the proposed development located in the special flood hazard area will not cause physical damage to any other property; and
  - g. When there is no base flood elevation data available for Zone A from any source, the base flood elevation data will be provided by the permit applicant for all proposed development of subdivisions, manufactured home and recreational vehicle parks in the special flood hazard areas, for all developments of fifty (50) lots or five (5) acres, whichever is less.
  - h. Basis of elevation for floodplain analysis and certificates shall use the 2010 Carson City Control Network vertical data.
2. Designation of the Local Floodplain Administrator. The City Engineer or his designee is hereby appointed to administer and implement this chapter by granting or denying development applications in accordance with its provisions.
  3. Duties and Responsibilities of the Administrator. The duties and responsibilities of the administrator shall include, but not be limited to:
    - a. Permit Review.
      - (1) Review of development applications to determine that the requirements of this chapter have been satisfied;
      - (2) Review of all applications to determine that the site is reasonably safe from flooding;
      - (3) Review of all development applications to determine if the proposed development in the Special Flood Hazard Area may result in physical damage to any other property to include stream bank erosion and any increase in velocities or that it does not adversely affects the flood-carrying capacity of the area where base flood elevations have been determined but a floodway has not been designated. For purposes of this chapter, "adversely affected" means that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than 0.99 foot at any point. To assist the Local Floodplain Administrator in making this determination, the permit applicant may be required to submit additional technical analyses;
      - (4) Review of all proposals for the development of five (5) parcels or more to assure that the flood discharge exiting the development after construction is equal to or less than the flood discharge at the location prior to development;
      - (5) Review all development applications to determine that all necessary permits have been obtained from those federal, state, or local governmental agencies from which prior approval is required; and
      - (6) Verify that vertical elevations used for any analysis or certificate is from the 2010 Carson City Control Network vertical data.

- b. Use of Other Base Flood Data.
  - (1) When base flood elevation data has not been provided, the Local Floodplain Administrator shall obtain, review, and reasonably utilize the best base flood data available from any source: federal, state, or other; such as high water marks(s), floods of record, or private engineering reports, in order to administer this chapter and provide the developer with an estimated base flood elevation.
  - (2) Multiple parcels (five (5) or more) will be required to have all proposals establish the one hundred-year base flood elevation before consideration of the tentative plan for development. The Local Floodplain Administrator may, at his/her discretion, require standards exceeding those identified in this chapter. Any higher standards above those in this chapter shall be adopted by the Board of Supervisors.
- c. Information to be Obtained and Maintained. The Local Floodplain Administrator shall obtain and retain for public inspection and have available for the National Flood Insurance Program coordinator or the Federal Emergency Management Agency representative conducting a Community Assistance Visit, the following:
  - (1) Floodplain development permits and certificates of compliance.
  - (2) Elevation Certificates with record of certification required by for Lowest Floor Certification.
  - (3) Certifications required for Nonresidential Floodproofing.
  - (4) Elevation Certificates with record of certification required for Areas Below the Lowest Floor.
  - (5) Elevation Certificates with record of certification of elevation required for Subdivisions.
  - (6) Certification required for Floodways.
  - (7) Variances issued pursuant to Variance Procedures.
  - (8) Notices required under Alteration of Watercourses.
- d. Alteration of Watercourse. Prior to issuing a permit for any alteration or relocation of watercourse the Local Floodplain Administrator must:
  - (1) Notify all adjacent communities, Nevada's National Flood Insurance Program Coordinator, and submittal of evidence of such notification to the Federal Insurance Administration, and the Federal Emergency Management Agency;
  - (2) Determine that the potential permit recipient has provided for maintenance within the altered or relocated portion of said watercourse so that the flood carrying capacity is not diminished; and
  - (3) Have received a Conditional Letter of Map Revision (CLOMR) determination from FEMA.
  - (4) Provide funds from the Developer to the City for processing the Letter of Map Revision (LOMR).
- a. Funds shall be in United States currency.
- b. The amount of the funds shall be determined by an independent professional firm and shall include data collection, modeling, document research and preparation, FEMA processing fees, and filing of FEMA forms. The cost of the estimate will be split by the City and the Developer.
- c. Once the funds are agreed upon and collected by the City, there will be no further obligation from the Developer for the LOMR.
- e. Interpretation of Flood Insurance Rate Map (FIRM) Boundaries. The Local Floodplain Administrator or his designee may provide interpretations, where needed, as to the exact location of the boundaries of the areas of special flood hazards (for example, where there appears to be a conflict between a mapped boundary and actual field conditions).
- f. Maintenance of Flood Protection Measures. The maintenance of any and all flood protection measures (levees, dikes, dams, or reservoirs) will be required of the jurisdiction where such measures provide protection. If these measures are privately owned, an operation or maintenance plan will be required of

the owner to be on file with Development Services. Carson City is required to acknowledge all maintenance plans by the adoption of such plans by ordinance.

- g. Hazard Mitigation Plan. The planning commission and board of supervisors shall be responsible for reviewing all proposals for new development and shall weigh all requests for future floodplain development against the city's master plan. Consideration of the following elements is required before approval:
  - (1) Determination of whether or not a proposed development is in or affects a known floodplain.
  - (2) Inform the public of the proposed activity.
  - (3) Determine if there is a practicable alternative or site for the proposed activity.
  - (4) Identify impact of the activity on the floodplain.
  - (5) Provide a plan to mitigate the impact of the activity.
- h. Submission of New Technical Data to FEMA. When Carson City base flood elevations either increase or decrease resulting from physical changes affecting flooding conditions, as soon as practicable, but not later than six (6) months after the date such information becomes available, Carson City will submit the technical or scientific data to FEMA. Such submissions are necessary so that upon confirmation of the physical changes affecting flooding conditions, risk premium rates and flood plain management requirements will be based upon current data.

#### 12.09.080 - Provisions for flood hazard reduction.

- 1. Standards for Construction. In all areas of special flood hazard, the following standards are required:
  - a. Anchoring.
    - (1) All new construction and substantial improvements shall be anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy; and
    - (2) All manufactured homes shall meet the anchoring standards for Manufactured Homes.
  - b. Construction Materials and Methods.
    - (1) All new construction and substantial improvements shall be constructed with materials and utility equipment resistant to flood damage.
    - (2) All new construction and substantial improvements shall use methods and practices that minimize flood damage.
    - (3) All elements that function as a part of the structure, such as electrical, heating, ventilation, plumbing, air conditioning equipment and other service facilities shall be located so as to prevent water from entering or accumulating within the components during conditions of flooding.
    - (4) Within Zones AH or AO, improvements shall provide adequate drainage paths around structures on slopes to guide flood waters around and away from proposed structures.
  - c. Elevation Requirements for Lowest Floor
    - (1) In Zone AO, elevated above the highest adjacent grade to a height two (2) feet above the depth number specified in feet on the FIRM, or elevated at least three (3) feet above the highest adjacent grade if no depth number is specified.
    - (2) In Zone A, elevated two (2) feet above the base flood elevation, as determined by Local Floodplain Administrator.
    - (3) In all other zones, elevated at least two (2) feet above the base flood elevation.

- d. Lowest Floor Certification Requirements. Upon completion of the structure, the elevation of the lowest floor including basement shall be certified by a registered professional engineer or surveyor and verified by the community building inspector to be properly elevated. The certification shall be provided to the Floodplain Administrator using the current FEMA Elevation Certificate.
- e. Nonresidential Floodproofing Requirements. Nonresidential construction shall either be elevated to conform with Elevation Requirements for Lowest Floor or together with attendant utility and sanitary facilities;
  - (1) Will be floodproofed below the elevation recommended under Elevation Requirements for Lowest Floor so that the structure is watertight with walls substantially impermeable to the passage of water;
  - (2) Will have the structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy; and
  - (3) Will be certified by a registered professional engineer or architect that the standards of Elevation Requirements for Lowest Floor are satisfied. The certification shall be provided to the Local Floodplain Administrator.
- f. Requirements for Areas Below the Lowest Floor. All new construction and substantial improvements with fully enclosed areas below the lowest floor (excluding basements) that are usable solely for parking of vehicles, building access or storage, and which are subject to flooding, shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement shall follow the guidelines in FEMA Technical Bulletins TB-1 (Openings in Foundation Walls and Walls of Enclosures, 2008) and TB-7 (Wet Floodproofing Requirements, 1993) and must either be certified by a licensed professional engineer or architect to meet or exceed the following minimum criteria;
  - (1) Must have a minimum of two (2) openings having a total net area of not less than one (1) square inch for every square foot of enclosed area subject to flooding; and
  - (2) The bottom of all such openings will be no higher than one (1) foot above the lowest adjacent finished grade.

Openings may be equipped with louvers, valves, screens or other coverings or devices provided they permit the automatic entry and exit of floodwaters.

2. Standards for Alluvial Fans. Areas subject to alluvial-fan flooding have irregular flow paths that result in erosion of existing channels and the undermining of fill material. Those areas are identified on the Flood Insurance Rate Map (FIRM) as AO Zones with velocities.
  - a. All structures must be securely anchored to minimize the impact of the flood and sediment damage.
  - b. All new construction and substantial improvements must be elevated on pilings, columns, or armoured fill so that the bottom lowest floor beam is elevated at or above the depth number.
  - c. Use of all fill materials must be armoured to protect the material from the velocity of the flood flow.
  - d. All proposals for subdivision development must provide a mitigation plan that identifies the engineering methods used to:
    - (1) Protect structures from erosion and scour caused by the velocity of the flood flow;
    - (2) Capture or transport flood and sediment flow through the subdivision to a safe point of disposition.
  - e. All manufactured homes shall be prohibited within the identified hazard area except within existing manufactured home parks or subdivisions.
  - f. Approval by the director of public works is required.

3. Standards for Utilities.
  - a. All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the system.
  - b. on-site waste disposal system shall be located to avoid impairment to them or contamination from them during flooding.
  - c. All new and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters or discharge from the systems into flood waters. Sanitary sewer and storm drainage systems for buildings that have openings below the base flood elevation shall be provided with automatic backflow valves or other automatic backflow devices that are installed in each discharge line passing through a building's exterior wall
4. Standards for Subdivisions.
  - a. All preliminary subdivision proposals shall identify the flood hazard area and the elevation of the base flood.
  - b. All final subdivision plans will provide the elevation of proposed structure(s), pads, and adjacent grade. If the site is filled above the base flood, the final pad elevation shall be certified by a registered professional or surveyor and provided to the official as set forth in this chapter.
  - c. All subdivision proposals shall be consistent with the need to minimize flood damage.
  - d. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize flood damage.
  - e. All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage as set forth in this chapter. Certification of compliance shall be required of the developer and the project's engineer.
  - f. Additionally all subdivision proposals will demonstrate, by providing a detailed hydrologic and hydraulic analyses that the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one (1) foot at any point within the Special Flood Hazard Area-
  - g. All subdivision proposals and other proposed developments shall assess the project specific impacts of land use changes and development through a detailed hydrologic and hydraulic analyses and/or demonstration of the effect of the proposed land use changes or development on other properties.**
5. Standards for Manufactured Homes.
  - a. All manufactured homes that are placed or substantially improved, within Zones A, AH, AE, and on the community's Flood Insurance Rate Map, on sites located:
    - (1) Outside of a manufactured home park or subdivision;
    - (2) In a new manufactured home park or subdivision;
    - (3) In an expansion to an existing manufactured home park or subdivision; or
    - (4) In an existing manufactured home park or subdivision on a site upon which a manufactured home has incurred "substantial damage" as a result of a flood:
      - a. Shall be elevated on a permanent foundation so that the lowest floor will be elevated to or above the base flood elevation and be securely anchored to an adequately anchored foundation system to resist flotation, collapse and lateral movement. Methods of anchoring may include, but are not to be limited to, use of over-the-top or frame ties to ground anchors. This requirement is in addition to applicable State and local anchoring requirements for resisting wind forces.

- b. All manufactured homes to be placed or substantially improved on sites in an existing manufactured home park or subdivision within Zones A, AH, and AE on the community's Flood Insurance Rate Map that are not subject to the provisions for the Standards for Critical Structures will be elevated so that either the:
            - (1) The bottom of structural frame or the lowest point of the manufactured home is at least two (2) feet above the base flood elevation; or
            - (2) The manufactured home chassis is supported by reinforced piers or other foundation elements of at least equivalent strength that are no less than thirty-six (36) inches in height above grade plus freeboard and securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.
          - c. Within Zone A, when no base flood elevation data is available, new and substantially improved manufactured homes shall have the floor elevated at least three (3) feet above the highest adjacent grade.
          - d. Within Zone AO, the floor for all new and substantially improved manufactured homes will be elevated above the highest adjacent grade at least as high as the depth number specified on the Flood Insurance Rate Map, or at least two (2) feet if no depth number is specified. Upon the completion of the structure, the elevation of the lowest floor including basement shall be certified by a registered professional.
6. Floodways. Since the floodway is an extremely hazardous area due to the velocity of floodwaters, which carry debris, potential projectiles, and erosion potential, the following provisions apply.
  - a. If a floodway has not been designated within the special flood hazard areas established in Basis for Establishing Areas of Special Flood Hazard, no new construction, substantial improvement, or other development (including fill) shall be permitted within Zones A1—30 and AE, unless it has been demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than 0.99 foot at any point within the community.
  - b. In designated floodways located within the special flood hazard areas established in Basis for Establishing Areas of Special Flood Hazard encroachment shall be prohibited, including fill, new construction, substantial improvements, storage of equipment or supplies, and any other development within the adopted regulatory floodway; unless it has been demonstrated through hydrologic and hydraulic analyses, performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge, and the Federal Emergency Management Agency has issued a Conditional Letter of Map Revision (CLOMR).
  - c. If the above "a and b" in Floodways have been satisfied; all proposed new development and substantial improvements will comply with all other applicable flood hazard reduction provisions of Provisions for Flood Hazard Reduction.
  - d. No manufactured homes shall be placed in a floodway except in existing manufactured home parks or existing manufactured home subdivisions.
7. Standards for Recreational Vehicles. All recreational vehicles placed on sites within the floodplain on the community's Flood Insurance Rate Map will either;
  - a. Be on the site for fewer than one hundred eighty (180) consecutive days;
  - b. Be fully licensed and ready for highway use. A recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to the site only by quick disconnect type utilities and security devices, and has no permanently attached additions, or:
  - c. Will meet the permit requirements for Permit Application and the elevation and anchoring requirements for manufactured homes for Standards for Manufactured Homes.

8. Standards for Critical Structures. Critical structures are not authorized in a Special Flood Hazard Area, unless:
  - a. All alternative locations in Flood Zone X have been considered and rejected.
  - b. All alternative locations in Flood Zone Shaded X have been considered and rejected.

If the Local Floodplain Manager determines the only practical alternative location for the development of a new or substantially improved critical structure is in a Special Flood Hazard Area he must:

- a. Give public notice of the decision and reasons for the elimination of all alternative locations.
9. Protection of Floodplain Storage Capacity. Whenever any portion of a floodplain is authorized for use, the space occupied by the authorized fill or structure below the base flood elevation shall be compensated for and balanced by a hydraulically equivalent volume of excavation taken from below the base flood elevation. All such excavations shall be constructed to drain freely to the watercourse.

#### 12.09.090 - Variance procedures.

The variance procedures are as follows:

1. Nature of Variances. The variance criteria set forth in this chapter of the ordinance are based on the general principal of zoning law that variances pertain to a piece of property and are not personal in nature. A variance may be granted for a parcel of property with physical characteristics so unusual that complying with the requirements of this ordinance would create an exceptional hardship to the applicant or the surrounding property owners. The characteristics must be unique to the property and not be shared by adjacent parcels. The unique characteristic must pertain to the land itself, not to the structure, its inhabitants, or the property owners.

It is the duty of the Board of Supervisors to help protect its citizens from flooding. This need is so compelling and the implications of the cost of insuring a structure built below flood level are so serious that variances from the flood elevation or from other requirements in the flood ordinance are quite rare. The long-term goal of preventing and reducing flood loss and damage can only be met if variances are strictly limited. Therefore, the variance guidelines provided in this ordinance are more detailed and contain multiple provisions that must be met before a variance can be properly granted. The criteria are designed to screen out those situations in which alternatives other than a variance are more appropriate.

If, upon review, the Administrator of FEMA determines that community practices indicate a pattern of issuing variances that is inconsistent with the objectives of sound flood plain management, the community may be suspended from the National Flood Insurance Program.

2. Appeal Board.
  - a. The Board of Supervisors, as established by Title 18 of this code, shall hear and decide appeals and requests for variances from the requirements of this chapter.
  - b. The Board of Supervisors shall hear and decide appeals, if filed within thirty (30) days from any decision or determination, when it is alleged there is an error in any requirement, decision or determination made by the administrator of this chapter.
  - c. Those aggrieved by the decision of the Board of Supervisors may appeal such decision to the appropriate court as provided in the Nevada Revised Statutes.
  - d. In passing upon such applications, the Board of Supervisors shall consider all technical evaluations, all relevant factors, standards, etc., specified in other sections of this chapter, and:
    - (1) The danger that materials may be swept onto other lands to the injury of others;
    - (2) The danger to life and property due to flooding or erosion damage;

- (3) The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner;
  - (4) The importance of the services provided by the proposed facility to the community;
  - (5) The necessity to the facility of a riverfront location, where applicable;
  - (6) The availability of alternative locations for the proposed uses that are not subject to flooding or erosion damage;
  - (7) The compatibility of the proposed use with existing and anticipated development;
  - (8) The relationship of the proposed use to the city's master plan and floodplain management program for that area;
  - (9) The safety of access to the property in times of flood for ordinary and emergency vehicles;
  - (10) The expected heights, velocity, duration, rate of rise and sediment transport of the floodwaters and the effects of wave action, if applicable, expected at the site;
  - (11) The costs of providing governmental services during and after flood conditions, including maintenance and repair of public utilities and facilities such as sewer, gas, electrical and water system, and streets and bridges.
- e. Any applicant to whom a variance is granted shall be given written notice over the signature of a community official that;
- (1) The issuance of a variance to construct a structure below the base flood level will result in increased premium rates;
  - (2) Such construction below the base flood level increases risks to life and property. It is recommended that a copy of the notice shall be recorded by the Local Floodplain Administrator in the Office of the Carson City Recorder and shall be recorded in a manner so that it appears as an exception on the title of the affected parcel of land.
- f. The Local Floodplain Administrator will maintain a record of all variance actions, including justification for their issuance, and report such variances issued in its biennial report submitted to the Federal Insurance Administration, Federal Emergency Management Agency.
2. Conditions for Variances.
- a. Generally, variances may be issued for new construction, substantial improvements, and other proposed new development to be erected on a lot of one-half ( $\frac{1}{2}$ ) acre or less in size contiguous to and surrounded by lots with existing structures constructed below the base flood level, providing that the procedures of Administration and Provisions for Flood Hazard Reduction of the ordinance have been fully considered. As the lot size increases beyond one-half ( $\frac{1}{2}$ ) acre, the technical justification required for issuing the variance increases.
  - b. Variances may be issued for the repair or rehabilitation of "historic structures," as defined in Definitions, upon a determination that the proposed repair or rehabilitation will not preclude the structure's continued designation as an historic structure and the variance is the minimum necessary to preserve the historic character and design of the structure.
  - c. Variances shall not be issued within any mapped regulatory floodway if any increase in flood levels during the base flood discharge would result.
  - d. Variances shall only be issued upon a determination that the variance is the "minimum necessary" considering the flood hazard, to afford relief. "Minimum necessary" means to afford relief with a minimum of deviation from the requirements of this ordinance. For example, in the case of variances to an elevation requirement, this means the Board of Supervisors need not grant permission for the applicant to build at grade, or even to whatever elevation the applicant proposed, but only to that elevation which the Board of Supervisors believes will both provide relief and preserve the integrity of the local ordinance.

- e. Variances shall only be issued upon:
  - (1) Showing of good and sufficient cause;
  - (2) A determination that failure to grant the variance would result in exceptional "hardship," as defined in Definitions, to the applicant;
  - (3) A determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, or extraordinary public expense, create a nuisance, as defined in Definitions, "Public Safety/Nuisance"), cause fraud or victimization, as defined in Definitions of the public, or conflict with existing local laws or ordinances.
- f. Variances may be issued for new construction, substantial improvement, and other proposed new development necessary for the conduct of a functionally dependent use provided that the provisions of Conditions for Variances Sub-sections a through e are satisfied and that the structure or other development is protected by methods that minimize flood damages during the base flood and does not result in additional threats to public safety and does not create a public nuisance.
- g. Upon consideration of all the factors of Appeal Board and the purposes of this ordinance, the Board of Supervisors may attach such conditions to the granting of, variances as it deems necessary to further the purposes of this ordinance.

#### 12.09.100 - Map revision/amendment procedures.

1. Letter of Map Revision/Amendment. National Flood Insurance Program regulations provide procedures to remove property from the one hundred-year floodplain or from a Special Flood Hazard Area. Amendments and revisions to community Flood Insurance Rate Maps can not adversely impact the floodplain or floodway delineation's of the level of the one hundred-year flood.

There are several procedures provided whereby the Federal Insurance Administrator will review information from the community, an owner, or a lessee of property where it is believed the property should not be included in a Special Flood Hazard Area.

Submissions to FEMA for revisions to effective Flood Insurance Studies (FISs) by individual and community requesters will require the signing of application/certification forms. These forms will provide FEMA with assurance that all pertinent data relating to the revision is included in the submittal. They will also assure that: (a) the data and methodology are based on current conditions; (b) qualified professional have assembled data and performed all necessary computations; and (c) all individuals and organizations impacted by proposed changes are aware of the changes and will have an opportunity to comment on them. FEMA procedures permit the following types of request:

A request for a revision to the effective FIS information (FIRM, FBFM, and/or FIS report) is usually a request that FEMA replace the effective floodplain boundaries, flood profiles, floodway boundaries, etc., with those determined by the requester. Before FEMA will replace the effective FIS information with the revised information, the requester must: (a) provide all of the data used in determining the revised floodplain boundaries, flood profiles, floodway boundaries, etc.; (b) provide all data necessary to demonstrate that the physical modifications to the floodplain have been adequately designed to withstand the impacts of the one percent (1%) annual chance flood event and facilities will be adequately maintained; (c) demonstrate that the revised information (e.g., hydrologic and hydraulic analyses and the resulting floodplain and floodway boundaries) are consistent with the effective FIS information.

Requests for amendments or revisions to FEMA maps must be reviewed and submitted to FEMA by Carson City with the applicant for a map amendment or revision required to prepare all the supporting information and appropriate FEMA forms.

The scientific or technical information to be submitted with these requests may include, but is not limited to the following:

- a. An actual copy of the recorded plat map bearing the seal of the appropriate recordation official County Clerk or Recorder of Deeds indicating the official recordation and proper citation, Deed or Plat Book Volume

and Page Number, or an equivalent identification where annotation of the deed or plat book is not the practice.

- b. A topographical map showing;
  - (1) Ground elevation contours in relation to the NGVD (National Geodetic Vertical Datum).
  - (2) The total area of the property in question.
  - (3) The location of the structure or structures located on the property in question.
  - (4) The elevation of the lowest adjacent grade to a structure or structures.
  - (5) An indication of the curvilinear line which represents the area subject to inundation by a base flood. The curvilinear line should be based upon information provided by an appropriate authoritative source, such as a Federal Agency, Department of Water Resources, a County Water Control District, a County or City Engineer, a Federal Emergency Management Agency Flood Insurance Study, or a determination by a Registered Professional Engineer.
- c. A copy of the FHBM or FIRM indicating the location of the property in question.
- d. A certification by a Registered Professional Engineer or Licensed Land Surveyor that the lowest grade adjacent to the structure is above the base flood elevation.
- e. The completion of the appropriate forms in the Federal Emergency Management Agency's Packets, Amendments and Revisions To National Flood Insurance Program Maps (MT-1 FEMA FORM 81-87 Series and MT-2 FEMA FORM 81-89 Series).

**Section 2.** If any section of this ordinance or portion thereof is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such holding shall not invalidate the remaining parts of this ordinance.

**Section 3.** All ordinances, parts of ordinances, chapters, sections, subsections, clauses, phrases or sentences contained in the Carson City Municipal Code in conflict herewith are hereby repealed.

**Section 4.** This ordinance shall be in full force and effect from and after its passage, approval, and publication as required by law.

THIS RESOLUTION was proposed on the \_\_\_\_ day of \_\_\_\_\_, 201\_ by the following City Supervisor(s):

\_\_\_\_\_.

THIS RESOLUTION has been PASSED, ADOPTED and APPROVED this \_\_\_\_ day of \_\_\_\_\_, 201\_ by the following vote of the Board of Supervisors, Carson City:

- AYES: \_\_\_\_\_
- NAYS: \_\_\_\_\_
- ABSENT: \_\_\_\_\_
- ABSTENTIONS: \_\_\_\_\_

Board of Supervisors  
Carson City

\_\_\_\_\_  
By: Chairman

Attest:

\_\_\_\_\_  
City Clerk

## Appendix 4 – Lyon County Preliminary Draft Floodplain Management Ordinance Revision Language

Bill No. \_\_\_\_\_

Ordinance No. \_\_\_\_\_

**SUMMARY:** AN ORDINANCE AMENDING LYON COUNTY CODE TITLE 12 – FLOOD CONTROL; BY AMENDING: CHAPTER 1 – FLOOD DAMAGE PREVENTION, REVISING SECTION 12.01.03 – PURPOSE, REVISING SECTION 5 – DEFINITIONS, REVISING SECTION 12.01.07 – BASIS FOR ESTABLISHING AREAS OF SPECIAL FLOOD HAZARD, INFORMATION MAINTAINED, REVISING SECTION 12.01.12 – GENERAL STANDARDS FOR FLOOD HAZARD REDUCTION; ADDING PROVISIONS PERTAINING TO CARSON RIVER FLOODPLAIN HYDRAULIC MODELING; TO ESTABLISH THE HYDRAULIC MODELING/MAPPING TOOL, AND PROTOCOLS AND PROCEDURES TO BE USED TO ASSESS PROJECT AND CUMULATIVE IMPACTS OF LAND USE CHANGES WITHIN THE 1-PERCENT CHANCE (100-YEAR) AND 0.2-PERCENT CHANCE (500-YEAR) FLOODPLAIN OF THE CARSON RIVER; AND OTHER MATTERS PROPERLY RELATED THERETO.

**TITLE:** AN ORDINANCE AMENDING LYON COUNTY CODE TITLE 12 – FLOOD CONTROL; BY AMENDING: CHAPTER 1 – FLOOD DAMAGE PREVENTION; AND OTHER MATTERS PROPERLY RELATED THERETO.

EXPLANATION – Matter in underlined bolded *italics* is new; matter with strikethrough text [~~omitted material~~] is to be omitted.

THE BOARD OF COUNTY COMMISSIONERS OF LYON COUNTY, NEVADA DOES HEREBY ORDAIN:

**Section 1.** Lyon County Code; Title 12 – Flood Control, Chapter 1 – Flood Damage Prevention, is hereby amended to revise the following sections:

12.01.03: Purpose:

It is the purpose of this chapter to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed:

- A. To protect human life and health;
- B. To minimize expenditure of public money for costly flood control projects;
- C. To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;
- D. To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas;
- E. To ensure that potential buyers are notified that property is in an area of special flood hazard;
- F. To ensure that those who occupy the areas of special flood hazard assume responsibility for their actions; and
- G. To maintain eligibility for state and federal disaster relief.

H. To minimize public and private losses due to flood conditions within the Carson River floodplain by requiring the use of the Carson River Hydraulic Model and procedures designed to:

1. Provide a consistent and complete tool to assess cumulative impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;
2. Provide a consistent and complete tool to assess project specific impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;
3. Provide a consistent and complete tool for mitigating flood hazards to downstream communities, loss of riparian habitat and floodplain function, and degradation of water quality due to impacts of land use changes within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains;
4. Provide consistent protocols, procedures, and guidance necessary to use the Carson River Hydraulic Model to evaluate impacts to floodplain extents, peak flow, peak flow timing, and flood volumes.

12.01.05: DEFINITIONS:

Certain words and terms used herein are defined, for the purpose of this chapter, as provided in this section.

Unless specifically defined in this section, words or phrases used in this chapter shall be interpreted so as to give them the meanings they have in common usage and to give its most reasonable application.

ALLUVIAL FAN FLOODING: Flooding occurring on the surface of an alluvial fan or similar landform which originates at the apex and is characterized by high velocity flows; active processes of erosion, sediment transport, deposition, and unpredictable flow paths.

APPEAL: A request for a review of an administrative determination or department interpretation of any provision of this chapter or a request for a variance.

AREA OF SHALLOW FLOODING: A designated A, AO or AH zone on the flood insurance rate map (FIRM). The base flood depths range from one foot (1') to three feet (3'); a clearly defined channel does not exist, the path of flooding is unpredictable and indeterminate and velocity flow may be evident.

AREA OF SPECIAL FLOOD HAZARD: The land in the floodplain within a community subject to a one percent (1%) or greater chance of flooding in any given year.

BASE FLOOD: The flood having a one percent (1%) chance of being equaled or exceeded in any given year. Also referred to as the "100-year flood". Designation on maps always includes the letters A or V.

BASEMENT: Any area of the building having its floor subgrade (below ground surface) on all sides.

CARSON RIVER HYDRAULIC MODEL (Model) is a single unified HEC-RAS model encompassing portions of the Carson River within Alpine County, California, Carson City, Nevada, Douglas County, Nevada and Lyon County, Nevada. The Model has its downstream terminus at Lahontan Reservoir, its upstream extent for the West Fork of the Carson River at approximately the USGS stream gage (10310000), West Fork Carson River At Woodfords, California, and its upstream extent for the East Fork of the Carson River at approximately the USGS stream gage (10309000), East Fork Carson River Near Gardnerville, Nevada.

CARSON RIVER HYDRAULIC MODEL – MODEL MANAGEMENT, DISTRIBUTION, AND UPDATE GUIDE (Guide) is the document that provides guidance and procedures regarding the use, management, distribution, modification, submission, and review of the model.

**CRAWL SPACE:** Unfinished accessible area below the first floor of a structure. Height ranges from approximately one foot six inches (1'6") to four feet zero inches (4'0"). Commonly used for components such as ductwork and piping.

**DEVELOPMENT:** Any manmade change to improved or unimproved real estate including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, or storage or equipment or materials located within the area of special flood hazard.

**FLOOD INSURANCE RATE MAP (FIRM):** The official map on which the federal insurance administration has delineated both the areas of special flood hazards and the risk premium zones applicable to the community.

**FLOOD INSURANCE RISK ZONE DESIGNATIONS:** The zone designations indicate the magnitude of the flood hazard in specific areas of a community.

Zone A: Special flood hazard areas with a one percent (1%) annual chance of flooding and a twenty six percent (26%) chance of flooding over the life of a thirty (30) year mortgage; base flood elevations are not determined.

Zone A1-30 And Zone AE: Special flood hazard areas with a one percent (1%) annual chance of flooding and a twenty six percent (26%) chance of flooding over the life of a thirty (30) year mortgage; base flood elevations are determined.

Zone A99: Special flood hazard areas with a one percent (1%) or greater chance of flooding each year to be protected by a federal flood protection system under construction; no base flood elevations are determined.

Zone AH: Special flood hazard areas with a one percent (1%) or greater chance of shallow flooding each year, flood depths of one to three feet (3') (usually areas of ponding); base flood elevations are determined.

Zone AO: Special flood hazard areas with a one percent (1%) or greater chance of shallow flooding each year, with flood depths of one to three feet (3') (usually sheet flow on sloping terrain); average depths are determined. For areas of alluvial fan flooding, velocities are also determined.

Zone AR: Special flood hazard areas that result from the decertification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection.

Zone B And Zone X (Shaded): Areas of one percent (1%) annual chance sheet flow flooding where average depths are less than one foot (1'), areas of one percent (1%) annual chance flooding where the contributing drainage is less than one square mile, or areas protected from the one percent (1%) annual chance flood by levees.

Zones AR/A1-30, AR/AE, AR/AH, AR/AO, And AR/A: Special flood hazard areas that result from the decertification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection. After restoration is complete, these areas will still experience residual flooding from other flooding sources.

Zones C And X (Unshaded): Areas determined to be outside the 500-year floodplain.

**FLOOD INSURANCE STUDY:** The official report provided by the federal insurance administration that includes flood profiles, the flood boundary-floodway map and the water surface elevation of the base flood.

**FLOOD OR FLOODING:** A general and temporary condition of partial or complete inundation of normally dry land areas from:

- A. The overflow of inland or tidal waters; and/or

- B. The unusual and rapid accumulation of runoff or surface waters from any source.

**FLOOD RELATED EROSION:** A condition that exists in conjunction with a flooding event that alters the composition of the shoreline or bank of a watercourse; one that increases the possibility of loss due to the erosion of the land area adjacent to the shoreline or watercourse.

**FLOODPLAIN ADMINISTRATOR:** The individual given specific authority and responsibilities to enforce this chapter, specifically the planning director.

**FLOODPROOFING:** Any combination of structural and nonstructural additions, changes or adjustments to nonresidential structures which reduce or eliminate flood damage to real estate or improved property.

**FLOODWAY:** The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot (1').

**HARDSHIP:** The exceptional hardship that would result from a failure to grant the requested variance. The board of county commissioners requires that the variance be exceptional, unusual, and peculiar to the property involved. Mere economic or financial hardship alone is not considered exceptional. Inconvenience, aesthetic considerations, physical handicaps, personal preferences, or the disapproval of one's neighbors likewise cannot, as a rule, qualify as an exceptional hardship. All of these problems can be resolved through other means without granting a variance, even if the alternative is more expensive, or requires the property owner to build elsewhere or put the parcel to a different use than originally intended.

**HAZARD MITIGATION PLAN:** A plan that incorporates a process whereby the potential of future loss due to flooding can be minimized by planning and implementing alternatives to floodplain development community wide.

**HIGHEST GRADE:** The highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

**LETTER OF MAP AMENDMENT (LOMA):** The procedure by which any owner or lessee of property who believes his property has been inadvertently included in a special flood hazard area can submit scientific and technical information to the federal insurance administrator for review to remove the property from said area. The administrator will not consider a LOMA if the information submitted is based on alteration of topography or new hydrologic or hydraulic conditions since the effective date of the FIRM.

**LETTER OF MAP REVISION (BASED ON FILL) (LOMR-F):** A letter from FEMA stating that an existing structure or parcel of land that has been elevated by fill would not be inundated by the base flood.

**LETTER OF MAP REVISION (LOMR):** An official revision to a currently effective FIRM. ~~A An~~ LOMR officially changes flood zone, floodplain and floodway designations, flood elevations and planimetric features.

**LEVEE:** A manmade structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control or divert the flow of water so as to provide protection from temporary flooding.

**LOWEST FLOOR:** The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided, it conforms to the applicable nonelevation design requirements of this chapter found at section 12.01.13 of this chapter, including, but not limited to:

The wet floodproofing standard in subsection 12.01.13A of this chapter;

The anchoring standards in subsection 12.01.12B of this chapter;

The construction materials and methods standards in subsections 12.01.12C1 and C2 of this chapter; and

The utilities standards in subsection 12.01.12C3 of this chapter.

**MANUFACTURED HOME:** A structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For floodplain management purposes, the term "manufactured home" also includes park trailers, travel trailers and other similar vehicles placed on a site for greater than one hundred eighty (180) consecutive days. For insurance purposes, the term "manufactured home" does not include park trailers, travel trailers and other similar vehicles.

**MANUFACTURED HOME PARK OR SUBDIVISION:** A parcel (or contiguous parcels) of land divided into two (2) or more manufactured home lots for rent or sale.

**NEW CONSTRUCTION:** Structures for which the "start of construction" commenced on or after November 5, 1987, the effective date of floodplain management regulations adopted by the county.

**RECREATIONAL VEHICLE:** A vehicle which is built on a single chassis; four hundred (400) square feet or less when measured at the largest horizontal projection; designed to be self-propelled or permanently towable by a light duty truck; designed to be used as temporary living quarters for recreational, camping, travel or seasonal use.

**SAND DUNES:** Naturally occurring accumulations of sand in ridges or mounds landward of the beach.

**SPECIAL FLOOD HAZARD AREA:** An area in the floodplain subject to a one percent (1%) or greater chance of flooding in any given year. It is shown on the FIRM as zone A, AO, A1-30, AE, A99, AH or AR.

**START OF CONSTRUCTION:** Includes substantial improvement and means the date the building permit was issued; provided, the actual start of construction, repair, reconstruction, placement or other improvement was within one hundred eighty (180) days of the permit date. The "actual start" means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns or any work beyond the stage of excavation, or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading and filling nor does it include the installation of streets and/or walkways nor does it include the installation on the property of accessory buildings such as garages or sheds not occupied as dwelling units or not part of the main structure.

**STRUCTURE:** A walled and roofed building, including a gas or liquid storage tank, that is principally aboveground.

**SUBSTANTIAL DAMAGE:** Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed fifty percent (50%) of the market value of the structure before the damage occurred.

**SUBSTANTIAL IMPROVEMENT:** A. Any repair, reconstruction, rehabilitation, addition or other proposed new development of a structure, the cost of which equals or exceeds fifty percent (50%) of the market value of the structure either:

1. Before the improvement or repair is started, or
2. If the structure has been damaged and is being restored, before the damage occurred. For the purposes of this definition, "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure.

- B. "Substantial improvement" does not, however, include either:
1. Any project for improvement of a structure to comply with existing state or local health, sanitary or safety code specifications which are solely necessary to assure safe living conditions, or
  2. Any alteration of a structure listed on the national register of historic places or a state inventory of historic places.

VARIANCE: A grant of relief from the requirements of this chapter which permits construction in a manner that would otherwise be prohibited hereof.

VIOLATION: Failure of a structure or other development to be fully compliant with the county floodplain management regulation. A structure or other development without an elevation certificate or other certifications, or other evidence of compliance as required in this chapter is presumed in violation until such time as that documentation is provided.

WATERCOURSE: A lake, river, creek, stream, wash, arroyo, channel, irrigation canal or other topographic feature on or over which waters flow at least periodically. Watercourse includes specifically designated areas in which substantial flood damage may occur.

#### 12.01.06: INTERPRETATION, APPLICATION AND COMPLIANCE:

- A. This chapter shall apply to all areas of special flood hazards within the jurisdiction of the county.
- B. In the interpretation and application of this chapter, all provisions shall be:
1. Considered as minimum requirements;
  2. Construed in favor of the governing body to promote public health, safety and welfare; and
  3. Deemed neither to limit nor repeal any other powers granted under state statutes or local ordinance.
- C. This chapter is not intended to repeal, abrogate or impair any existing easements, covenants or deed restrictions. However, where this chapter and another ordinance, easement, covenant or deed restriction conflict or overlap, whichever imposes the more stringent restrictions shall prevail.
- D. No structure or land shall hereafter be constructed, located, extended, converted or altered without full compliance with the terms of this chapter and other applicable regulations. Violations of this requirement (including violations of conditions and safeguards established in connection with conditions) shall constitute a misdemeanor.
- E. After discovery of a violation or alleged violation of this chapter, the floodplain administrator shall take action to verify the existence of a violation(s) and remedy the violation(s) through administrative means including stop work orders or other provisions of this code or applicable laws. If a property owner fails to remedy any violation of this chapter, the administrator may submit a report to the governing body which shall include all information available to the floodplain administrator which is pertinent to said violation, and request that the governing body:
1. Take any necessary action to effect the abatement of such violation; or
  2. Issue a variance to this chapter in accordance with the provisions of section 12.01.14 of this chapter; or
  3. Submit to the administrator of federal insurance administration a declaration for denial of insurance, stating that the property is in violation of a cited statute or local law, regulation or ordinance, pursuant to section 1316 of the national flood insurance act of 1968, as amended.

## 12.01.07: BASIS FOR ESTABLISHING AREAS OF SPECIAL FLOOD HAZARD; INFORMATION MAINTAINED:

- A. Flood Insurance Study And Maps: The areas of special flood hazard identified by the federal insurance administration in a scientific and engineering report entitled "The Flood Insurance Study For Lyon County", dated January 19, 1982, with accompanying flood insurance maps, and all subsequent revisions is hereby adopted by reference and declared to be a part of this chapter. The flood insurance study is on file at the Lyon County planning department, 27 South Main Street, Yerington, NV 89447.

Interpretations, where needed, as to location of the boundaries of the areas of special flood hazards (for example, where there appears to be a conflict between a mapped boundary and actual field conditions) shall be made by the floodplain administrator. The person contesting the location of the boundary shall be given a reasonable opportunity to appeal the interpretation as provided in section 12.01.14 of this chapter.

- B. Use Of Other Base Flood Data: When base flood elevation data has not been provided in accordance with subsection A of this section, the floodplain administrator shall obtain, review and reasonably utilize any base flood elevation and floodway data available from a federal, state or other source in order to administer sections 12.01.12 and 12.01.13 of this chapter.

- C. Information Obtained And Maintained:

1. Where base flood elevation data is provided through the flood insurance study or acquired as in subsection B of this section, the actual elevation (in relation to mean sea level) of the lowest floor (including basement) of all new or substantially improved structures and whether or not the structure contains a basement shall be obtained and recorded.
2. For all new or substantially improved floodproofed structures:
  - a. The actual elevation (in relation to mean sea level) shall be verified and recorded; and
  - b. The floodproofing certifications required in subsection 12.01.08B of this chapter shall be maintained.
3. All records pertaining to the provisions of this chapter shall be maintained for public inspection.

*D. Carson River Floodplain Hydraulic Modeling.*

- 1. The Carson River Floodplain Hydraulic Model (Model) is hereby adopted as the hydraulic modeling/mapping tool to assess impacts of land use changes and development within the Carson River floodplain.*
- 2. The Carson River Hydraulic Model – Model Management, Distribution, And Update Guide (Guide) is hereby adopted as the required procedures and guidance for the use of the model, including management, distribution, modification, submission and review.*
- 3. Lands to which the Carson River Floodplain Hydraulic Modeling Applies. The Carson River Floodplain Hydraulic Modeling shall apply to all areas of special flood hazards within the 1-percent chance (100-year) and 0.2-percent chance (500-year) floodplains of the Carson River within the jurisdiction of Lyon County.*
- 4. The most current version of the Model shall be used for the following:*
  - a. Interpretations as set forth in subsection 12.01.07A of this chapter.*
  - b. Use Of Other Base Data as set forth in subsection 12.01.07B of this chapter.*

- c. For information for the application of a development permit as required in subsections 12.01.08B6, B7 and B8 of this chapter.*
  - d. For the issuing of a permit for any alteration of a watercourse as set forth in subsection 12.01.09 of this chapter.*
  - e. For compliance with the provisions of subsection 12.01.12A of this chapter.*
  - f. For compliance with the provisions of subsection 12.01.13D1, "Specific Standards For Flood Hazard Reduction."*
  - g. For compliance with the provisions of and providing information for subsection 12.01.14C, "Variances and Appeals."*
  - h. For compliance with the provisions of and providing information for subsection 12.01.15, "Letters Of Map Revision/Amendment."*
- 5. Use of the Model shall be in conformance with the procedures and guidelines set forth in the most current version of the Guide.*

12.01.08: DEVELOPMENT PERMIT:

- A. Permit Required: A development permit shall be obtained before construction or development begins within any area of special flood hazard established in subsection 12.01.07A of this chapter. The permit shall be for all structures, including manufactured homes as defined in section 12.01.05 of this chapter, and for all development, including fill and other activities, also as defined in section 12.01.05 of this chapter.
- B. Application For Permit: The applicant shall provide at least the following information, where applicable. Additional information may be required as determined by the floodplain administrator.
1. The proposed elevation in relation to mean sea level, of the lowest floor (including basement) of all residential and nonresidential structures whether new or substantially improved to be located in zones A, A1-A30, AE, and AH, if base flood elevations data are available.
  2. In zone AO the proposed elevation in relation to the elevation of the highest adjacent grade of all residential and nonresidential structures whether new or substantially improved.
  3. The proposed elevation in relation to mean sea level, to which any new or substantially improved nonresidential structure will be floodproofed.
  4. A certificate from a licensed professional engineer or architect in the state of Nevada that any utility floodproofing meets the criteria in subsection 12.01.12D, "Utilities", of this chapter.
  5. A certificate from a licensed professional engineer or architect in the state of Nevada that any nonresidential floodproofed structures meet the criteria in sections 12.01.12 and 12.01.13 of this chapter.
  6. When a watercourse will be altered or relocated as a result of the proposed development, the applicant must submit the maps, computations, and other materials required by the federal emergency management agency (FEMA) to process a letter of map revision (LOMR) and pay any fees or other costs assessed by FEMA for processing the revision.
  7. A technical analysis, by a professional engineer licensed in the state of Nevada, showing the proposed development located in the special flood hazard area will not cause physical damage to any other property.

8. When there is no base flood elevation data available for zone A from any source, the base flood elevation data will be provided by the permit applicant for all proposed development of subdivisions, manufactured home and recreational vehicle parks in the special flood hazard areas, for all developments of fifty (50) lots or five (5) acres, whichever is less.

C. Permit Review And Approval: The planning administrator is appointed floodplain administrator to administer and implement this chapter by granting or denying development permit applications in accordance with its provisions.

Duties and responsibilities of the floodplain administrator shall include, but not be limited to:

1. Review all development permits to determine that the permit requirements of this chapter have been satisfied.
2. Review all development permits to determine that all necessary permits have been obtained from those federal, state or local governmental agencies from which prior approval is required.
3. Review all permits to determine that the structure(s) is reasonably safe from flooding.

#### 12.01.09: ALTERATION OF WATERCOURSES:

Prior to issuing a permit for any alteration or relocation of watercourse the floodplain administrator must:

- A. Have processed and received a letter of map revision (LOMR).
- B. Notify all adjacent communities, Nevada's national flood insurance program coordinator, and submittal of evidence of such notification to the federal insurance administration, and the federal emergency management agency.
- C. Determine that the potential permit recipient has provided for maintenance within the altered or relocated portion of said watercourse so that the flood carrying capacity is not diminished.

#### 12.01.10: RETAINING FLOODPLAIN DEVELOPMENT DOCUMENTATION:

The floodplain administrator shall obtain and retain for public inspection and have available for the national flood insurance program coordinator or the federal emergency management agency representative conducting a community assistance visit, the following:

- A. Floodplain development permits and certificates of compliance.
- B. Certification required by section 12.01.13 of this chapter (lowest floor elevation).
- C. Certification required by section 12.01.13 of this chapter (floodproofing nonresidential structures).
- D. Certification of elevation required by section 12.01.12 of this chapter (subdivision standards).
- E. Certification required by section 12.01.13 of this chapter (floodway encroachments).
- F. Variances issued pursuant to section 12.01.14, "Variances And Appeals", of this chapter.
- G. Notices required under section 12.01.09, "Alteration Of Watercourses", of this chapter.

## 12.01.11: MAINTENANCE OF FLOOD PROTECTION MEASURES:

The maintenance of any and all flood protection measures (levees, dikes, dams or reservoirs) will be required of the jurisdiction where such measures provide protection. If these measures are privately owned, an operation or maintenance plan will be required of the owner to be on file with the planning department.

## 12.01.12: GENERAL STANDARDS FOR FLOOD HAZARD REDUCTION:

In all areas of special flood hazards, the following standards are required:

## A. Development Requirements:

1. All subdivision proposals shall be consistent with the need to minimize flood damage;
2. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize flood damage;
3. All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage; certification of compliance shall be required of the developer; ~~and~~
4. Where base flood elevation data has not been provided or is not available from another authoritative source, it shall be generated for subdivisions and other proposed developments which contain at least fifty (50) lots or five (5) acres (whichever is less); ~~and~~.
5. All subdivision proposals and other proposed developments shall assess the cumulative and project specific impacts of land use changes and development through a detailed hydrologic and hydraulic analyses and/or demonstration of the cumulative effect of the proposed land use changes or development.

## B. Anchoring:

1. All new construction and substantial improvements shall be anchored to prevent flotation, collapse or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy.
2. All manufactured homes must likewise be anchored to prevent flotation, collapse or lateral movement and shall be installed using methods and practices that minimize flood damage. Anchoring methods may include, but are not limited to, use of over the top or frame ties to ground anchors (see FEMA's "Manufactured Home Installation In Flood Hazard Areas" guidebook for additional techniques).

## C. Construction Materials And Methods:

1. Materials: All new construction and substantial improvements shall be constructed with materials and utility equipment resistant to flood damage.
2. Construction Methods And Practices: All new construction and substantial improvements shall be constructed using methods and practices that minimize flood damage.
3. Location Of Service Facilities: Electrical, heating, ventilation, plumbing and air conditioning equipment and other service facilities shall be designed and/or otherwise elevated or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

4. Drainage Paths: Within zones AH or AO, all new construction and substantial improvements shall be constructed so that there are adequate drainage paths around structures on slopes to guide floodwaters around and away from proposed structures.

5. Elevation And Floodproofing:

- a. New construction and substantial improvement of any structure shall have the lowest floor, including basement, elevated to or above the base flood elevation as follows:

In zone AO: Elevated above the highest adjacent grade to a height equal to or exceeding the depth number specified in feet on the FIRM by at least one foot (1'), or elevated at least two feet (2') above the highest adjacent grade if no depth number is specified.

In zone A: Elevated above the highest adjacent grade to a height equal to or exceeding the depth number specified in feet on the FIRM by at least one foot (1').

In all other zones where the base flood elevation has been determined: The lowest floor elevated at least one foot (1') above the base flood elevation.

- b. Manufactured homes shall meet the above standards.

Nonresidential structures may meet the standards in subsection C5c of this section. Upon completion of the structure, the elevation of the lowest floor, including basement, shall be certified by a registered professional engineer or surveyor to verify to the floodplain administrator that elevation requirements have been met. Notification of compliance shall be recorded as set forth in subsection 12.01.07C2b of this chapter.

- c. Nonresidential construction shall either be elevated to conformance with subsection C5a of this section or, together with attendant utility and sanitary facilities:

- (1) Be floodproofed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water;

- (2) Have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy; and

- (3) Be certified by a registered professional engineer or architect that the standards of this subsection are satisfied. Such certifications shall be provided to the floodplain administrator.

6. Requirements For All Crawl Space Construction:

- a. The building must be designed and adequately anchored to resist flotation, collapse, and lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy. Hydrostatic loads and the effects of buoyancy can usually be addressed through the required openings discussed in the next subsection. Because of hydrodynamic loads, crawl space construction is not recommended in areas with flood velocities greater than five feet (5') per second unless the design is reviewed by a qualified design professional, such as a registered architect or professional engineer.

- b. The crawl space is an enclosed area below the BFE and, as such, must have openings that equalize hydrostatic pressures by allowing for the automatic entry and exit of floodwaters. The bottom of each flood vent opening can be no more than one foot (1') above the lowest adjacent exterior grade.

- c. Portions of the building below the BFE must be constructed with materials resistant to flood damage. This includes not only the foundation walls of the crawl space used to elevate the building, but also any joists, insulation, or other materials that extend below the BFE. The required construction practice is to elevate the bottom of joists and all insulation two feet (2') above BFE. Insulation is not a flood resistant material. When insulation becomes saturated with floodwater, the additional weight often pulls it away from the joists and flooring. Ductwork or other utility systems located below the insulation may also pull away from their supports.
- d. Any building utility systems within the crawl space must be elevated above BFE or designed so that floodwaters cannot enter or accumulate within the system components during flood conditions. Ductwork, in particular, must either be placed above the BFE or sealed from floodwaters.
- e. Additional requirements for below grade crawl spaces:
  - (1) The interior grade of a crawl space below the BFE must not be more than two feet (2') below the lowest adjacent exterior grade (LAG), shown as D in figure 3 of this section.
  - (2) The height of the below grade crawl space, measured from the interior grade of the crawl space to the top of the crawl space foundation wall must not exceed four feet (4') (shown as L in figure 3 of this section) at any point. The height limitation is the maximum allowable unsupported wall height according to the engineering analyses and building code requirements for flood hazard areas. This limitation will also prevent these crawl spaces from being converted into habitable spaces.
  - (3) There must be an adequate drainage system that removes floodwaters from the interior area of the crawl space. The enclosed area should be drained within a reasonable time after a flood event. The type of drainage system will vary because of the site gradient and other drainage characteristics, such as soil types. Possible options include natural drainage through porous, well drained soils and drainage systems such as perforated pipes, drainage tiles, or gravel or crushed stone drainage by gravity or mechanical means.
  - (4) The velocity of floodwaters at the site should not exceed five feet (5') per second for any crawl space. For velocities in excess of five feet (5') per second, other foundation types should be used.

*Figure 1 Preferred crawl space construction.*

*Figure 2 Below grade crawl space construction.*

*Figure 3 Requirements regarding below grade crawl space construction.*

D. Utilities:

1. All new and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters or discharge from the systems into floodwaters. Sanitary sewer and storm drainage systems for buildings that have openings below the base flood elevation shall be provided with automatic backflow valves or other automatic backflow devices that are installed in each discharge line passing through a building's exterior wall.
2. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems and discharge from the systems into floodwaters; and
3. On site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

E. Review Of Building Permits: Applications for building permits shall be reviewed to assure that proposed construction will be reasonably safe from flooding. The test of reasonableness is a local judgment and includes use of historical data, high water marks, photographs of past flooding, etc., where available.

12.01.13: SPECIFIC STANDARDS FOR FLOOD HAZARD REDUCTION:

In all areas of special flood hazards where base flood elevation data has been provided as set forth in subsection 12.01.07A or B of this chapter, the following provisions are required:

A. Residential Construction:

1. New construction and substantial improvement of any residential structure shall have the lowest floor, including basement, elevated one foot (1') above base flood elevation.
2. Fully enclosed areas below the lowest floor other than a crawl space constructed in conformance with subsection 12.01.12C6 of this chapter subject to flooding are prohibited or shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs for meeting this requirement must either be certified by a registered professional engineer or architect or must meet or exceed the following minimum criteria:
  - a. A minimum of two (2) openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided.
  - b. The bottom of all openings shall be no higher than one foot (1') above grade.
  - c. Openings may be equipped with screens, louvers or other coverings or devices; provided, that they may permit the automatic entry and exit of floodwaters.

B. Manufactured Homes: All manufactured homes to be placed or substantially improved within zones A, AH and AE shall be elevated on a permanent foundation such that the lowest floor bottom of the structural frame or the lowest point of any attached appliances, whichever is lower, of the manufactured home is at least one foot (1') above the base flood elevation or at least two feet (2') when no base flood elevation data is available and shall be securely anchored to an adequately anchored foundation system in accordance with the provisions of subsection 12.01.12B2 of this chapter.

C. Nonresidential Construction: New construction and substantial improvement of any commercial, industrial or other nonresidential structure shall either have the lowest floor, including basement, elevated to the level of the base flood elevation or, together with attendant utility and sanitary facilities, shall:

1. Be floodproofed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water;
2. Have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy;
3. Be certified by a registered professional engineer or architect that the design and methods of construction are in accordance with accepted standards of practice for meeting provisions of this subsection based on their development and/or review of the structural design, specifications and plans. Such certifications shall be provided to the official as set forth in subsection 12.01.07C2 of this chapter.
4. Nonresidential structures that are elevated, not floodproofed, must meet the same standards for space below the lowest floor as described in subsection A2 of this section.

5. Applicants floodproofing nonresidential buildings shall be notified that flood insurance premiums will be based on rates that are one foot (1') below the floodproofed level (e.g., a building constructed to the base flood level will be rated as 1 foot below that level).
- D. Floodways: Located within areas of special flood hazard established in subsection 12.01.07A of this chapter are areas designated as floodways. Since the floodway is an extremely hazardous area due to the velocity of floodwaters which carry debris, potential projectiles and erosion potential, the following provisions apply:
1. Encroachments, including fill, new construction, substantial improvements and other development are prohibited unless it has been demonstrated through hydrologic and hydraulic analyses, performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge, and the federal emergency management agency has issued a conditional letter of map revision (CLOMR).
  2. If subsection D1 of this section is satisfied, all new construction and substantial improvements shall comply with all applicable flood hazard reduction provisions of this section and section 12.01.12 of this chapter.
- E. Recreational Vehicles: All recreational vehicles placed on sites within zones A, A1-30, AH, and AE on the FIRM will be fully licensed and ready for highway use (a recreational vehicle is ready for highway use if it is on its wheels or jacking system, is attached to a site only by quick disconnect type utilities and security devices, and has no permanently attached additions).

#### 12.01.14: VARIANCES AND APPEALS:

- A. Authority: The board of county commissioners shall hear and decide appeals and requests for variances from the requirements of this chapter.
- B. Appeals:
1. The board of county commissioners shall hear and decide appeals when it is alleged there is an error in any requirement, decision or determination made by the floodplain administrator of this chapter.
  2. Those aggrieved by the decision of the board of county commissioners may appeal such decision to the appropriate court as provided in Nevada Revised Statutes.
- C. Variances:
1. Application For Variance: In passing upon such applications, the board of county commissioners shall consider all technical evaluations, all relevant factors, standards specified in other sections of this chapter, and:
    - a. The danger that materials may be swept onto other lands to the injury of others;
    - b. The danger to life and property due to flooding or erosion damage;
    - c. The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner;
    - d. The importance of the services provided by the proposed facility to the community;
    - e. The necessity to the facility of a waterfront location, where applicable;

- f. The availability of alternative locations for the proposed use which are not subject to flooding or erosion damage;
  - g. The compatibility of the proposed use with existing and anticipated development;
  - h. The relationship of the proposed use to the comprehensive plan and floodplain management program for that area;
  - i. The safety of access to the property in times of flood for ordinary and emergency vehicles;
  - j. The expected heights, velocity, duration, rate of rise and sediment transport of the floodwaters and the effects of wave action, if applicable, expected at the site; and
  - k. The costs of providing governmental services during and after flood conditions, including maintenance and repair of public utilities and facilities such as sewer, gas, electrical and water system and streets and bridges.
2. Conditions May Be Imposed: Upon consideration of the factors of subsection C1 of this section and the purposes of this chapter, the county board of commissioners may attach such conditions to the granting of variances as it deems necessary to further the purposes of this chapter.
3. Standards For Granting Variances:
- a. Generally, the only condition under which a variance from the elevation standard may be issued is for new construction and substantial improvements to be erected on a lot of one-half (1/2) acre or less in size contiguous to and surrounded by lots with existing structures constructed below the base flood level, providing items in subsections C1a through C1k of this section have been fully considered. As the lot size increases, the technical justification required for issuing the variance increases.
  - b. Variances may be issued for the rehabilitation or restoration of historic structures.
  - c. Variances shall not be issued within any designated floodway if any increase in flood levels during the base flood discharge would result.
  - d. Variances shall only be issued upon determination that the variance is the minimum necessary, considering the flood hazard to afford relief.
  - e. Variances shall only be issued upon:
    - (1) A showing of good and sufficient cause such as renovation, rehabilitation or reconstruction. Variances issued for economic considerations, aesthetics or because variances have been used in the past are not good and sufficient cause;
    - (2) A determination that failure to grant the variance would result in exceptional hardship to the applicant; and
    - (3) A determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public or conflict with existing local laws or ordinances.
  - f. Variances, as interpreted in the national flood insurance program, are based on the general zoning law principle that they pertain to a physical piece of property, they are not personal in nature and do not pertain to the structure, its inhabitants, economic or financial circumstances. They primarily address

small lots in densely populated residential neighborhoods. As such, variances from the flood elevations should be quite rare.

- g. Variances may be issued for nonresidential buildings in very limited circumstances to allow a lesser degree of floodproofing than watertight or dry floodproofing, where it can be determined that such action will have low damage potential, complies with all other variance criteria except subsection C3a of this section and otherwise complies with subsections 12.01.12A and B of this chapter.

4. Notice When Variance Granted: Any applicant to whom a variance is granted shall be given written notice that the structure will be permitted to be built with a lowest floor elevation below the base flood elevation and that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced lowest floor elevation.

D. Records And Reports: The county clerk shall maintain the records of all appeal actions and report any variances to the federal emergency management agency upon request.

#### 12.01.15: LETTERS OF MAP REVISION/AMENDMENT:

National flood insurance program regulations provide procedures to remove property from the 100-year floodplain or from a special flood hazard area. Amendments and revisions to community flood insurance rate maps cannot adversely impact the floodplain or floodway delineations of the level of the 100-year flood.

There are several procedures provided whereby the federal insurance administrator will review information from the community, an owner, or a lessee of property where it is believed the property should not be included in a special flood hazard area.

Submissions to FEMA for revisions to effective flood insurance studies (FISs) by individual and community requesters will require the signing of application/certification forms. These forms will provide FEMA with assurance that all pertinent data relating to the revision is included in the submittal. They will also assure that: a) the data and methodology are based on current conditions; b) qualified professionals have assembled data and performed all necessary computations; and c) all individuals and organizations impacted by proposed changes are aware of the changes and will have an opportunity to comment on them.

FEMA procedures permit the following types of request:

A request for a revision to the effective FIS information (FIRM, FBFM, and/or FIS report) is usually a request that FEMA replace the effective floodplain boundaries, flood profiles, floodway boundaries, etc., with those determined by the requester. Before FEMA will replace the effective FIS information with the revised, the requester must: a) provide all of the data used in determining the revised floodplain boundaries, flood profiles, floodway boundaries, etc.; b) provide all data necessary to demonstrate that the physical modifications to the floodplain have been adequately designed to withstand the impacts of the one percent (1%) annual chance flood event and will be adequately maintained; c) demonstrate that the revised information (e.g., hydrologic and hydraulic analyses and the resulting floodplain and floodway boundaries) is consistent with the effective FIS information.

Requests for amendments or revisions to FEMA maps must be reviewed and submitted to FEMA by the (governing body) of (county or municipality) with the applicant for a map amendment or revision required to prepare all the supporting information and appropriate FEMA forms.

The scientific or technical information to be submitted with these requests may include, but is not limited to, the following:

- A. An actual copy of the recorded plat map bearing the seal of the appropriate recordation official county clerk or recorder of deeds indicating the official recordation and proper citation, deed or plat book volume and page number, or an equivalent identification where annotation of the deed or plat book is not the practice.
- B. A topographical map showing:
1. Ground elevation contours in relation to the NAVD 88 (national geodetic vertical datum).
  2. The total area of the property in question.
  3. The location of the structure or structures located on the property in question.
  4. The elevation of the lowest adjacent grade to a structure or structures.
  5. An indication of the curvilinear line which represents the area subject to inundation by a base flood. The curvilinear line should be based upon information provided by an appropriate authoritative source, such as a federal agency, department of water resources, a county water control district, a county or city engineer, a federal emergency management agency flood insurance study, or a determination by a registered professional engineer.
- C. A copy of the FHBM or FIRM indicating the location of the property in question.
- D. A certification by a registered professional engineer or licensed land surveyor that the lowest grade adjacent to the structure is above the base flood elevation.
- E. The completion of the appropriate forms in the federal emergency management agency's packets, amendments and revisions to national flood insurance program maps (MT-1 FEMA form 81-87 series and MT-2 FEMA form 81-89 series).
- F. The applicant shall provide the proposed map revision to the floodplain administrator in form and format compatible with the county geographical information system (GIS). The scale of the plan, improvements, monuments and other items shall be in model space correctly oriented to coordinate system as established by the GIS coordinator.

12.01.16: WARNING AND DISCLAIMER OF LIABILITY:

The degree of flood protection required by this chapter is considered reasonable for regulatory purpose and is based on scientific and engineering considerations. Larger floods can and will occur on rare occasions. Flood heights may be increased by manmade or natural causes. This chapter does not imply that land outside the areas of special flood hazards or uses permitted within such areas will be free from flooding or flood damages. This chapter shall not create liability on the part of Lyon County or any officer or employee thereof or the federal insurance administration for any flood damages that result from reliance on this chapter or any administrative decision lawfully made hereunder.

**Section 2.** If any section of this ordinance or portion thereof is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such holding shall not invalidate the remaining parts of this ordinance.

**Section 3.** All ordinances, parts of ordinances, chapters, sections, subsections, clauses, phrases or sentences contained in the Lyon County Code in conflict herewith are hereby repealed.

**Section 4.** This ordinance shall be in full force and effect from and after its passage, approval, and publication as required by law.

THIS RESOLUTION was proposed on the \_\_\_\_ day of \_\_\_\_\_, 201\_ by the following County Commissioners(s): \_\_\_\_\_.

THIS RESOLUTION has been PASSED, ADOPTED and APPROVED this \_\_\_\_ day of \_\_\_\_\_, 201\_ by the following vote of the Board of Commissioners, Lyon County:

AYES: \_\_\_\_\_  
NAYS: \_\_\_\_\_  
ABSENT: \_\_\_\_\_  
ABSTENTIONS: \_\_\_\_\_

Board of County Commissioners  
Lyon County

\_\_\_\_\_  
By: Chairman

Attest:

\_\_\_\_\_  
Clerk of the Board

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# **Appendix E**

## **Risk MAP Charter**

# Risk MAP Charter for the Carson River Watershed

## **Purpose:**

Working in a close collaborative effort, Carson Water Subconservancy District (CWSD), FEMA Region IX (FEMA), U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), U.S. Department of the Interior Bureau of Reclamation (USBR), State NFIP Coordinator, State Hazard Mitigation Office, and other partners (as listed on page 5) will identify, assess, communicate, and plan for flood risk within the Carson River Watershed (watershed), which includes portions of Alpine County in California and Douglas, Carson City, Storey, Lyon, and Churchill Counties in Nevada. The flood risk information provided can be used to enhance hazard mitigation plans, make informed decisions to improve resilience after flooding, protect the beneficial functions of floodplains, and raise awareness about local flood risks.

This charter:

- Details the long-term flood hazard mapping vision for the watershed;
- Describes the desired mapping, assessment, planning information, and planning products;
- Describes the assistance that CWSD and FEMA will provide;
- Summarizes local flooding concerns and indicates areas where floodplain changes are expected; and
- Describes the roles and responsibilities of the CWSD, FEMA, and other signatory partners.

## **Watershed Vision:**

In 2008, all counties along the Carson River adopted the “Carson River Watershed Floodplain Management Plan” (FPM Plan) that describes the long-term goals and objectives for floodplain management. These goals are based on identification and mapping of floodplains to create a broad-based awareness of flood hazards and provide the data necessary to support community floodplain management programs. The mapping program will provide many benefits to watershed communities, property owners, and citizens. These include:

- Increased public awareness and action to reduce risk to life and property;
- Ability to build upon flood hazard data and maps produced during the Flood Map Modernization (Map Mod) program;
- Assess present and future risk;
- Address gaps in flood hazard data to form a solid foundation for risk assessment and floodplain management and provide entities with information needed to mitigate flood-related risk;
- Protection of the natural and beneficial function of drainage-ways and floodplains, including trail corridors, parks, recreational areas, wildlife habitat, flood storage, and groundwater recharge; and,
- Encouraging “Good Neighbor Policies” throughout all communities within the watershed.

**Mapping and Assessment:**

The watershed experiences flooding incidents on an average of every five years. Types of flood hazards include riverine and alluvial fan flooding and debris flows. Major flood events are typically the result of rain-on-snow events. Flood storage in the upper watershed is limited and available storage is not regulated. Therefore, flood flows are not actively managed and large flows can occur downstream. The watershed contains areas of open floodplains that are continually under threat of change and development. The FPM Plan calls for the protection of the natural function of these floodplains, especially lands within Carson Valley, which provide the bulk of the flood storage for the entire watershed.

Based on previous studies, information obtained during community public meetings for the development of the FPM Plan, and discovery meetings for mapping activity statements, a Five-Year Master Mapping Plan was developed for the watershed. The plan identifies the sequence of work to be performed in order to meet the goals and objectives for floodplain mapping and associated assessments and is consistent with the community goals described in the FPM Plan.

**Regulatory Products:**

FEMA will provide Alpine, Douglas, Carson City, Lyon, and Churchill Counties with the following updated regulatory products to support floodplain management and flood insurance administration.

- **Flood Insurance Study (FIS) Report:** The FIS describes the county's flood history and provides technical information on the study.
- **Flood Insurance Rate Map (FIRM):** The FIRM identifies the county's flood hazard zones, base flood elevations, and floodway boundaries. This map is also used to determine where flood insurance may be required.

**Flood Risk Products:**

CWSD and partners will work closely with FEMA to produce the products listed below which identify locations and causes of flood hazard changes and quantify the risks associated with those changes. This will allow Alpine, Douglas, Carson City, Lyon, and Churchill Counties to use these updated data and products to make informed hazard mitigation, land use and development, and emergency management decisions.

- **Changes Since Last Flood Insurance Rate Map (FIRM):** Changes since the last FIRM identify areas where the floodplain, floodway, and/or flood zone designations have changed since the previous flood study. Engineering factors that may have contributed to any changes will also be identified.
- **Areas of Mitigation Interest:** Areas of mitigation interest identifies areas where conditions may contribute to the severity of the flood hazard and associated losses. These include areas with a history of flood claims, hydraulic or other structures that contribute to backwater impacts, and areas experiencing land use change or development.

**FEMA Resources to Support Flood Mitigation Actions:**

FEMA encourages floodplain management activities that exceed minimum requirements through programs such as the Community Rating System (CRS). The watershed currently has two CRS communities, Douglas County and Carson City. FEMA also offers Hazard Mitigation Assistance grant programs that fund eligible mitigation activities which reduce disaster losses and protect life and property from future disaster damage. Information on these programs will be provided, along with other related State, Federal, and association resources throughout the project.

**Communication and Coordination:**

FEMA, CWSD, and partners will work together to establish a consistent flow of information about project status, timelines, and next steps. In addition to regular status reports, CWSD will coordinate with the counties, cities, and other entities in the watershed. CWSD will establish a Flood Mapping Project Management Team (PMT) that will meet on a regular basis to ensure that the goals of this charter are implemented in a coordinated manner. The PMT includes representatives from all counties, cities, Federal, State, and other governmental entities throughout the watershed. CWSD is also the coordinating entity for the Carson River Coalition (CRC), a large watershed-wide stakeholder group. The CRC will be provided opportunities to review and comment on mapping programs and the implementation of the living river concept as described in the adopted Carson River Watershed Regional Floodplain Management Plan.

FEMA will work with Alpine, Douglas, Carson City, Lyon, and Churchill Counties to enhance their ability to communicate flood hazards and associated risk to people who live and work within the watershed.

Specific meetings for each phase of mapping include:

- **PMT Meetings:** These meetings will focus on setting project expectations, roles and responsibilities of the PMT, and on validating and gathering data.
- **Community Coordination Officer (CCO) Meeting/Open House:** Local officials will be provided with FIS and FIRM information and requirements for map adoption. Meetings will be closely followed by open house meetings where FEMA, CWSD, and local community officials will present project results to local citizens and explain the impact that the results will have on development, planning, and flood insurance.
- **Flood Study Review Meeting:** Local officials, State, Federal, Tribal, and non-governmental entities will be provided the opportunity to view and comment on drafts of the engineering analyses and flood risk data. This meeting may also include highlights of hazard mitigation planning and implementation of best management practices to reduce flood hazards in the watershed.

**Roles and Responsibilities:**

This Risk MAP Charter represents a good-faith effort by all parties to share data, communicate findings, and plan mitigation activities to protect the communities within the watershed from flood risk. It is not legally binding nor does it preclude a community from participating in the FIRM appeal process. The parties listed in the signature block

## Risk MAP Charter for the Carson River Watershed

below agree to collaborate on flood hazard identification activities, risk analysis products, and will consult with each other to integrate contributions into flood hazard identification efforts. It is intended to provide a common “Good Neighbor” strategy to address flood hazards and increase resilience within the watershed.

FEMA and CWSD will provide local officials with regular updates on project status, the data and products described above, and outreach guidance to include local awareness of flood risk. These efforts will better enable local communities to take action to reduce risk, through the adoption of the maps, development or enhancement of mitigation plans, and increased communication with citizens to inform them of their risk and the steps that they can take to mitigate that risk.

Alpine, Douglas, Carson City, Lyon, and Churchill Counties, and other entities will provide input and updates throughout the study process to verify data and ensure that the information accurately represents their communities.

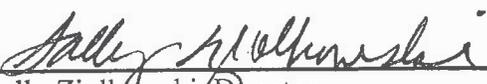
CWSD, FEMA, and local officials agree to communicate as needed over the course of each project outlined in the mapping program to review project milestones, outcomes, and impacts. CWSD and the PMT will meet at least twice a year to discuss, plan, and coordinate all mapping program projects.

If for any reason an entity who is a signatory to this document wishes to withdraw their participation from the Risk MAP Charter, they may do so at any time by submitting a written request to CWSD.

Risk MAP Charter for the Carson River Watershed

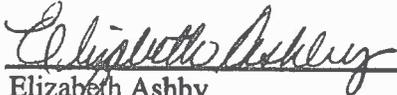
We, the undersigned, agree to work together to implement this Risk MAP Charter for the Carson River Watershed to the best of our abilities and within our legal authorities and delegations.

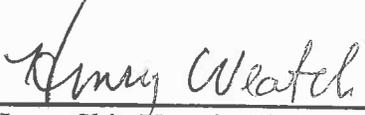
  
\_\_\_\_\_  
Chuck Roberts, Chairman  
Carson Water Subconservancy District  
Date Signed: 2/23/12

  
\_\_\_\_\_  
Sally Ziolkowski, Director  
FEMA Region IX Mitigation Division  
Date Signed: 2/13/2012

  
\_\_\_\_\_  
Alicia Kirchner, Chief  
USACE Sacramento District,  
Planning Division  
Date Signed: 3-15-12

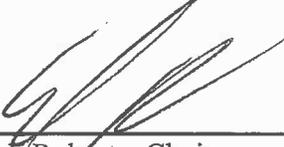
  
\_\_\_\_\_  
~~Kim Davis, NRE Coordinator~~ Jason King, State  
Nevada Division of Water Resources Engineer  
Date Signed: 12/23/12

  
\_\_\_\_\_  
Elizabeth Ashby  
Nevada Department of Public Safety  
State Hazard Mitigation Office  
Date Signed: 23 Feb 2012

  
\_\_\_\_\_  
Henry Skip Veatch, Chairman  
Board of Supervisors  
Alpine County, California  
Date Signed: 2/21/2012

  
\_\_\_\_\_  
Lee Bonner, Chairman  
Board of Commissioners  
Douglas County, Nevada  
Date Signed: 3/9/12

  
\_\_\_\_\_  
Bob Crowell, Mayor  
Carson City, Nevada  
Date Signed: 2/14/2012

  
\_\_\_\_\_  
Chuck Roberts, Chairman  
Board of Commissioners  
Lyon County, Nevada  
Date Signed: 2/23/12

  
\_\_\_\_\_  
Norman Frey, Chairman  
Board of Commissioners  
Churchill County, Nevada  
Date Signed: February 15, 2012

Risk MAP Charter for the Carson River Watershed



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Kenneth Parr, Area Manager

U.S. Bureau of Reclamation

Lahontan Regional Office

Date Signed: 04/16/12



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Ernest Schank, President of the Board of

Directors, Truckee-Carson Irrigation

District

Date Signed: 4/11/2012



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Jon Mittelstadt, Meteorologist in Charge

National Oceanic & Atmospheric

Administration

National Weather Service - Reno, NV

Date Signed: 4-26-2012

## **Appendix F**

### **Hydraulic Modeling Documents**

# Hydraulic Modeling and Floodplain Mapping Guidelines

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Carson River, NV & CA

**Date:** October 2011

**Prepared for:**

Carson Water Subconservancy District



**Funding Provided by:**

Nevada Division of Environmental Protection



**Project number:** 137049

## List of Acronyms

1-D	One-dimensional
2-D	Two-dimensional
ASPRS	American Society for Photogrammetry and Remote Sensing
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CRC	Carson River Coalition
CTP	Cooperating Technical Partners
CWSD	Carson Water Subconservancy District
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
DTM	Digital Terrain Model
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GIS	Geographic Information Systems
GPS	Global Positioning System
GUIDE	Guidelines and Specifications for Flood Hazard Mapping Partners
HEC-RAS	Hydrologic Engineering Centers River Analysis System
IMU	Inertial Measurement Unit
LiDAR	Light Detection and Ranging
LN	Break line format
Mr. SID	Multi-resolution seamless image database
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NDEP	Nevada Division of Environmental Protection
NFIP	National Flood Insurance Program
n	Manning's Roughness Coefficient
PT	Point line format
RMSE	Root mean square error
SA	Suggested Action
TIN	Triangulated Irregular Network
TSDN	Technical Support Data Notebook
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WSELs	Water-surface elevations
WSP	Water Supply Paper

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# 1 INTRODUCTION

*“Flooding in the Carson River Watershed is a natural process that occurs on a regular basis. It is also one of the most devastating and costly natural events that our communities face. The Carson River is unique in that we have no flood control structures and have extremely limited upstream storage capability. However, we have the best flood control mechanisms available – open floodplain lands.*

*The actions of one community have the potential to impact downstream communities, making flooding a watershed-wide challenge.”*

*-Carson River Watershed Regional Floodplain Management Plan*

These excerpts from the *Carson River Watershed Regional Floodplain Management Plan* (Plan) summarize the issues, concerns, and opportunities communities face along the Carson River. The Plan is a living document providing suggested actions and strategies for floodplain management within the Carson River watershed. All communities along the river have adopted this Plan to encourage the realization of the value and critical functions provided by floodplains for public safety and reduction of flood damage. Actions were developed to address the need for accurate data, reduction of negative impacts from existing infrastructure, and outreach and education.

In an effort to provide guidance for future floodplain mapping efforts along the Carson River, the Carson River Coalition (CRC), hosted by the Carson Water Subconservancy District (CWSD), organized a Hydraulics and Hydrology Committee in May 2010. This committee, made up of stakeholders and experts, met to provide guidance on modeling and flood mapping protocol for the Carson River. The committee discussed specific models and methodologies and chose a preferred set of models, procedures, specifications, and guidelines. Funded by the Nevada Division of Environmental Protection (NDEP), a modeling and mapping guide was chosen as a mechanism to summarize these preferences and provide a manual for the Carson River watershed.

This guide covers required modeling and mapping procedures for the Main Carson River and both East and West forks. The downstream extent shall be Lahontan Reservoir in Lyon County, Nevada. For the West Fork, the approximate upstream extent shall be Hope Valley, and for the East fork, Monitor Pass, both in Alpine County, California (Figure 1). This guide, and subsequent modeling/mapping, addresses several suggested actions (SAs) from the Plan:

- **SA-14:** Secure funding for and conduct watershed-wide unsteady-state state modeling to identify flood water storage requirements and to look at the cumulative effects of watershed development.
- **SA-15:** Support Federal Emergency Management Agency’s (FEMA) Map Modernization Program and encourage FEMA to update Flood Insurance Rate Maps (FIRMs) with current and future conditions. Significant verification of topography and other variables should be conducted prior to release of draft FIRMs.
- **SA-16:** CWSD continue to participate in FEMA’s Cooperating Technical Partner Program.
- **SA-17:** Strive for up-to-date and consistent data collection and maintenance to include updating of flood studies where necessary and conduct studies for significant water courses and alluvial fan areas that have not been analyzed. This data should be used to update FEMA maps and fill data gaps. Complete delineation of the floodway throughout river system and incorporate into FIRMs.
- **SA-18:** Flood studies and maps should be updated after significant flooding events.

The ultimate goal of this guide and modeling/mapping effort in the Carson River Watershed is to provide a consistent and complete tool to assess cumulative impacts of land use changes within the 0.2-percent chance (500-year) floodplain. There is also a strong desire among local stakeholders to use the modeling/mapping as a means for mitigating flood hazards to downstream communities, loss of riparian habitat and floodplain function, and degradation of water quality. Any proposed land use changes can be introduced to the model to evaluate cumulative impacts to floodplain extents, peak flow, peak flow timing, and flood volumes.

The CWSD, NDEP and participating communities require the procedures outlined in this guide, to the greatest extent practicable, accompanied by sound engineering judgment, for future floodplain modeling and/or mapping within the 0.2-percent (500- yr) floodplain extents along the Main Stem and East and West forks of the Carson River in the study areas outlined in Figure 1. This guide will also serve as a basis for any model/map revisions.

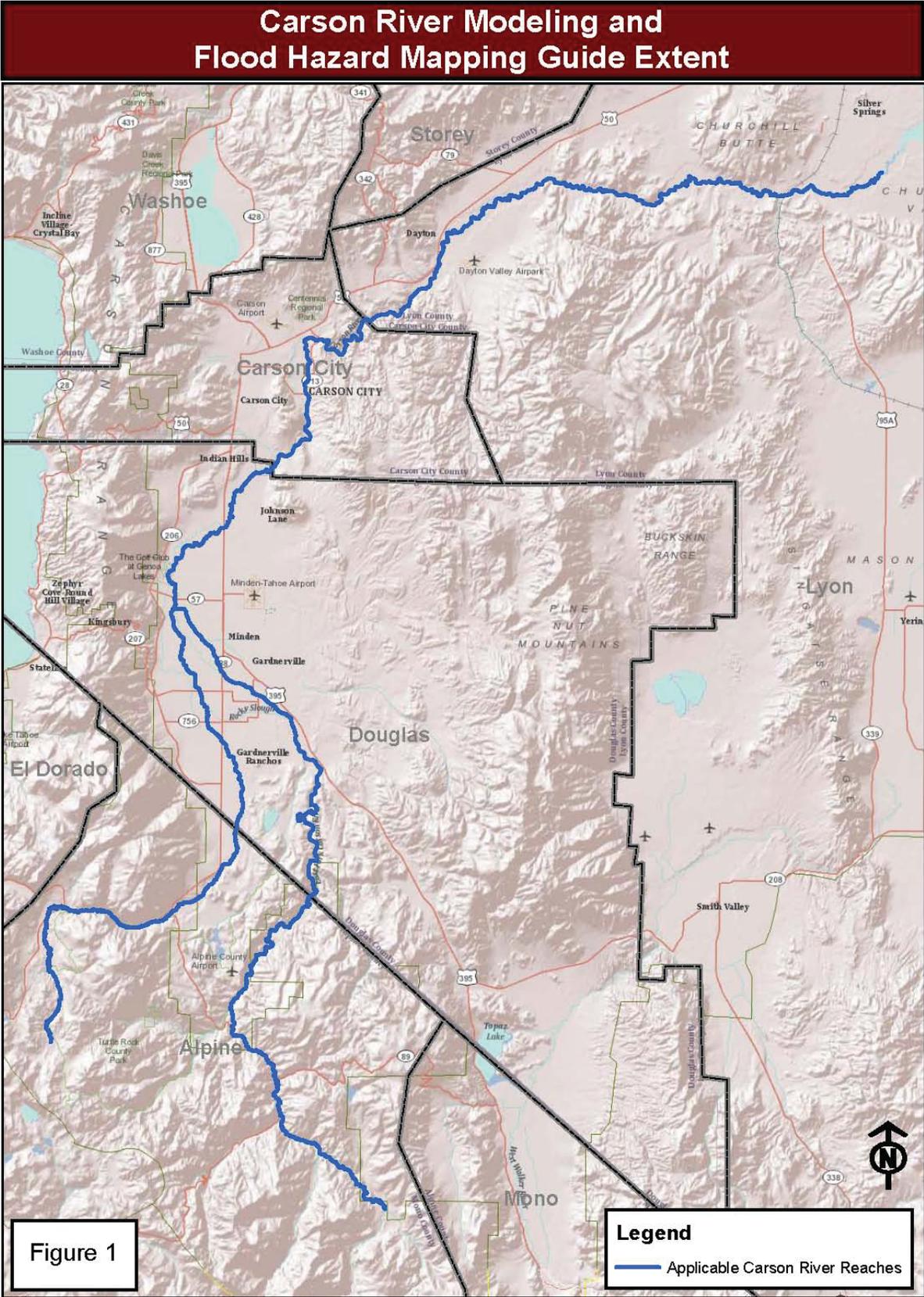


Figure 1: Study area map

## 2 PURPOSE AND SCOPE

The purpose of the Carson River *Hydraulic Modeling and Floodplain Mapping Guide* (Guide) is to provide criteria, standards, and modeling guidance for future hydrologic analysis, hydraulic modeling and flood hazard mapping studies on the Carson River within Lyon, Carson City, Douglas and Alpine counties. It provides a convenient source of technical information that is specifically tailored to the unique hydrologic and hydraulic characteristics of the Carson River watershed. Practitioners' use of the consistent set of criteria in this guide will result in uniform modeling practices throughout the watershed, across jurisdictional boundaries, and potentially reduce conflict between regulatory agencies and the land development community. It should be noted that this Guide only applies to the floodplains and floodways associated with main stem and the East and West forks of the Carson River. It is not intended to provide modeling direction for tributaries or alluvial fans associated with the Carson River. Topics not included in this Guide are to be conducted using best engineering judgment and local, state, and federal standards.

The Guide is not intended to replace or supersede federal regulations set forth in 23 Code of Federal Regulations (CFR) Part 650, 44 CFR Part 60, or 44 CFR Part 65. The Guide covers types of models to be used, acceptable software, data requirements, data collection, terrain development, and surveying standards, specific direction on hydrologic and hydraulic modeling parameter selection, and prescribes floodplain delineation techniques. This guide does not cover rainfall-runoff simulation.

### 3 CONCEPTUAL FRAMEWORK

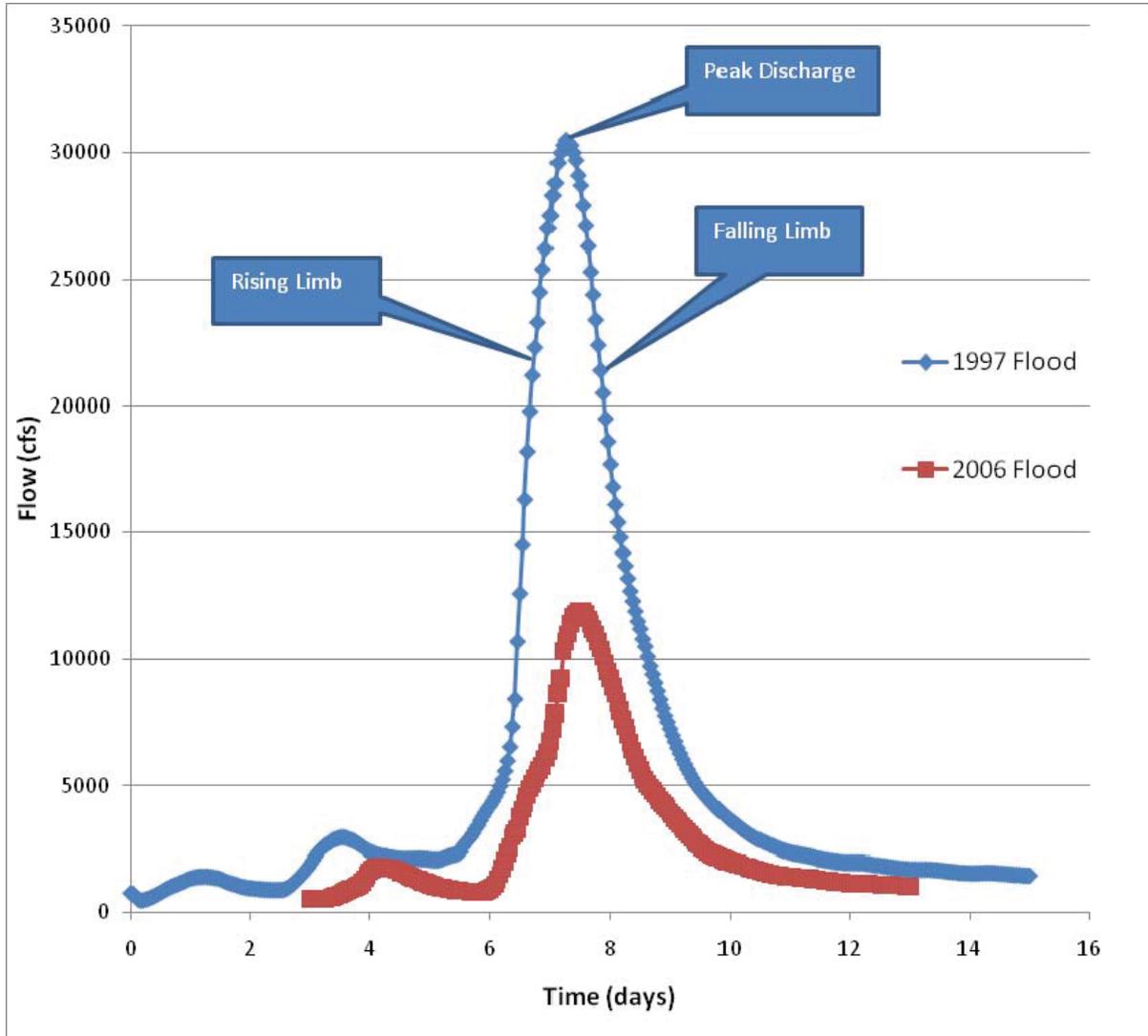
The following section summarizes a variety of pertinent concepts relating to the technical portions of the Guide. A broad overview of hydrology, hydraulic modeling, and Geographic Information Systems (GIS) is presented to familiarize the reader with these concepts.

#### 3.1 Hydrology

An accurate and useful hydraulic model is predicated on a sound hydrologic analysis for the study reach of interest. Generally, two different approaches can be used to represent the flow of water in a hydraulic model. These are known as steady-state flow and unsteady-state flow.

Steady-state flow assumes that depth, velocity, and discharge at a given location do not vary with time. A single flow value is assumed along the entire study reach. A common application of a steady-state flow evaluation is the use of peak discharges associated with flood events.

Unsteady-state flow assumes that discharge, as well as depth and velocity, can change over a given time period at a single location and throughout the study reach. This change in flow over time is often represented graphically by a hydrograph, with time on the  $x$  axis and discharge or flow on the  $y$  axis (Figure 2). Hydrographs for both the 1997 and 2006 floods on the Carson River at the United States Geological Survey (USGS) stream gage near Carson City are shown in Figure 2. It should be noted that although the length and magnitude of the two events shown in Figure 2 are quite different, the overall shape of the hydrograph curves is quite similar.



**Figure 2: Example hydrographs from the Carson River Near Carson City USGS stream gage**

The time period chosen often represents a specific storm event, extending from the time flow increases above normal baseflow until the storm peak has passed and flow returns to normal levels. The portion of the hydrograph with increasing discharge is known as the rising limb, while the section of decreasing discharge is called the falling limb. The highest point on the hydrograph curve indicates the peak discharge for the storm. The way that the watershed responds to precipitation determines the shape of the hydrograph. If runoff rapidly makes its way into the stream channel after the start of the storm, the rising limb will be quite steep, whereas a flatter sloping rising limb indicates that precipitation takes longer to arrive in the channel from the overbank regions. This explains why the two curves shown in Figure 2 have a similar shape, but different magnitudes. The area under the curve represents the volume of water associated with the storm event in question.

Both steady- and unsteady-state models have benefits, drawbacks and appropriate applications. Steady-state hydraulic models have the benefit of relative ease of setup and stability during analysis. However, they are not able to model the range of flows that occur during a storm event. Unsteady-state flow models are able to more accurately simulate the timing and volume of the flood event being modeled. In addition, an unsteady-state model is able to represent flow attenuation caused by storage of flood water in the channel and overbank areas. It is the desire of member agencies within the Carson Water

Subconservancy District to simulate the attenuation that occurs in the reaches where significant overbank storage exists. It is the desire of the member agencies to exercise a floodplain management strategy that considers both the hydrologic and hydraulic impacts of encroachments or modifications to the Carson River floodplain that would change these storage dynamics and result in downstream changes to the hydrograph.

### 3.2 USGS Streamflow Data

USGS operates and maintains streamgaging stations on rivers and streams throughout the world. These stream gages collect stage data, generally recording one stage value every 15 minutes. Stage is the height of the water-surface above a given stream gage datum. These data are available from USGS in numerous formats.

The raw 15-minute data, referred to as instantaneous data, are available through the USGS website (<http://waterdata.usgs.gov/nv/nwis/rt>). Specific data requests may be required to obtain instantaneous data prior to roughly 1990.

Mean daily flow data are also provided by USGS. These values represent an average of the recordings for a given 24-hour period. This averaging process tends to impact the instantaneous peak flow values that are reported, reducing the usefulness of this data set for statistical analyses in support of flood flow determinations.

Peak streamflow data represents the maximum instantaneous flow value that occurs during each water year. These data are not subject to averaging; therefore, they provide a better base for flood flow estimates. It should be noted that there may be gaps in peak flow measurements due to errors in measurement or damage to stream gages during extreme events. A minimum of 20 data points (water years) are recommended when performing statistical analyses on peak flow data.

As mentioned above, the automated stream gage digitally records stage, rather than directly recording discharge. Stage data are converted into discharge based on a stage-discharge rating curve, which is developed by taking direct discharge measurements in the river at various stage elevations over a period of many years. These discharge values are plotted against the related stage elevations to develop and approximate the rating curve for that stream gage location (Figure 3). During large flow events, care must be taken when attempting to extrapolate the rating curve beyond measured data points. It should also be noted that measurements of flow rate are performed with a variety of methods. Direct measurements have been performed using a flow meter or more recently with newer Doppler sounders. These types of measurements can be very accurate for the lower range of stages. At higher depths and velocities, these measurements can be more complex and less accurate. The data collected for these estimates includes the cross section at the location of the measurement (which is typically the same location over a period of time), velocity distribution, cross section area and estimated discharge. All of these data can be useful for model calibration.

Some of the methods used to estimate peak flow are based on indirect measurements. These measurements use the slope-area method after the event has occurred. This is done with cross section and high water mark surveys. The accuracy of these estimation techniques are highly dependent on the quality of the high water marks, which can often be difficult to accurately determine for a number of reasons, and upon estimation of roughness parameters for the reach in which the estimate is performed. If the indirect estimate is inaccurate, it can influence the rating curve fit to the data points and result in an inaccurate estimation of an event's peak, hydrograph shape and volume. Therefore, these data need to be reviewed for reasonableness when attempting to calibrate an unsteady flow model using gage data.

It is also important to understand data collection history. The location of the gage or the location for direct measurements may have changed over the history of the gaging station. This is also important to consider when using these data.

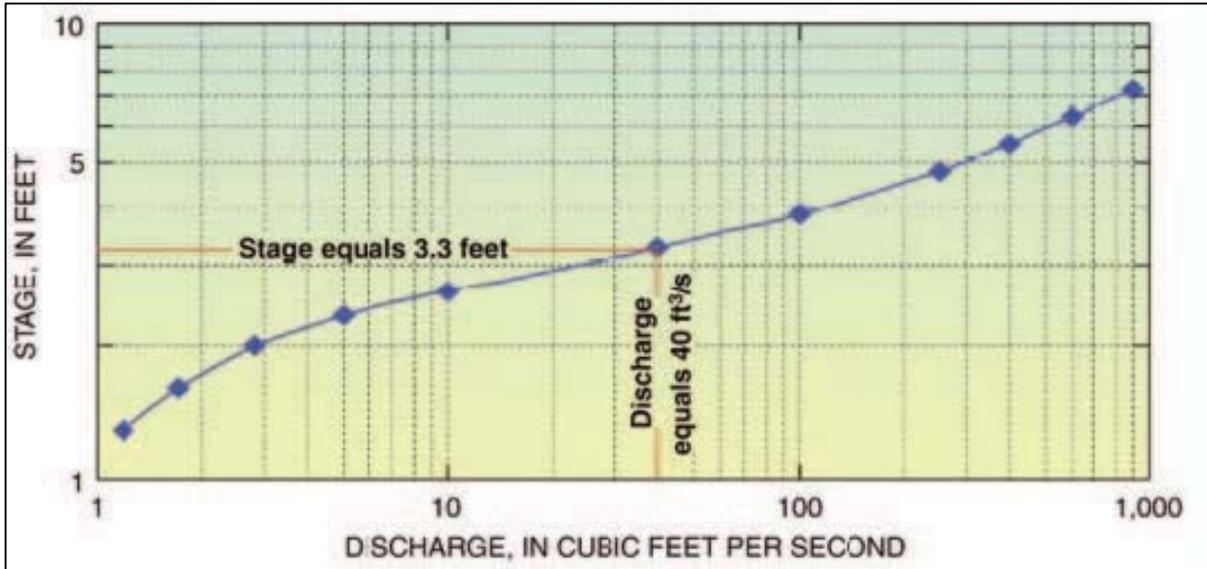


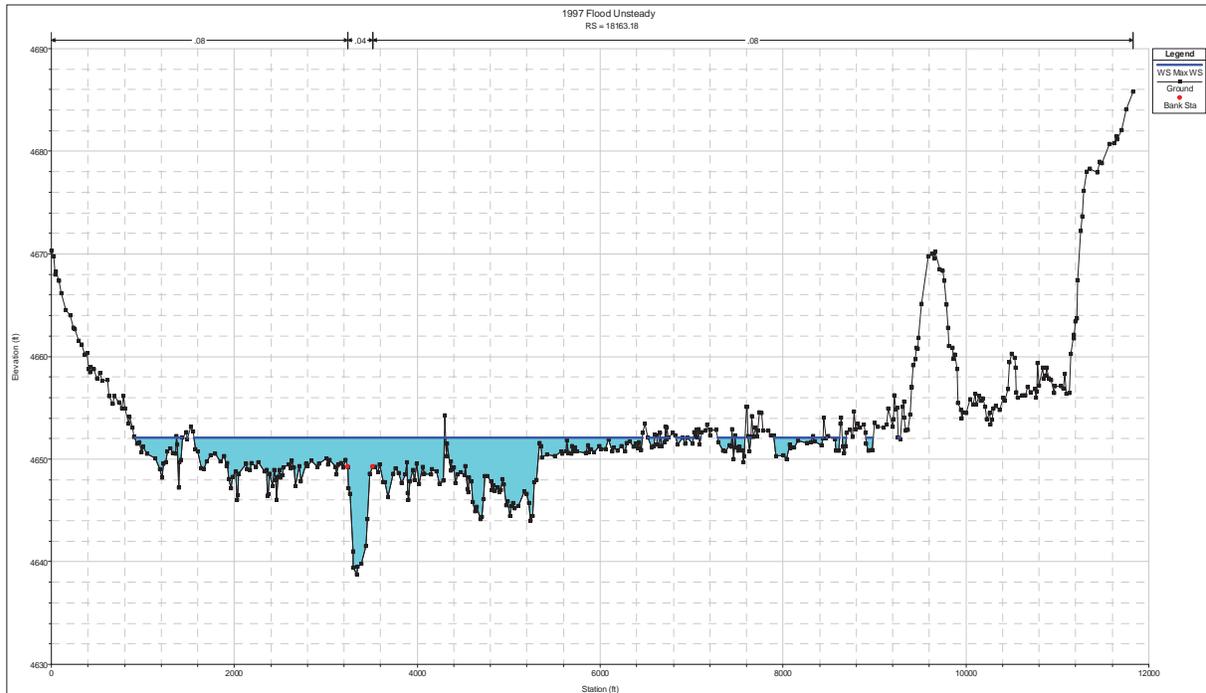
Figure 3: Example rating curve, after USGS, 2011

### 3.3 Hydraulic Modeling

Hydraulic models are used in many different settings to estimate water-surface elevations, flooding inundation limits, flow velocities, flow rates, and other hydraulic parameters. Models can be used to simulate irrigation systems and pipe networks as well as open channels and natural river systems. Numerous software programs have been developed for this purpose. Each software package has an appropriate use, depending on conditions and the type of data output desired. River systems, such as the Carson River, are generally evaluated using two types of models: one-dimensional (1-D) steady and unsteady flow models and/or two-dimensional (2-D) unsteady flow models.

#### 3.3.1 One-dimensional Modeling

One-dimensional models use a simplifying assumption that hydraulic parameters, such as water-surface elevations, are represented by an average value across an entire cross section when estimating stage, velocity distribution and energy losses between cross sections (Figure 4). This assumption is essentially correct for river systems where flowpaths in the channel and the overbanks are well-defined, and overbank flooding is at the same water surface elevation as the main channel. Often, these models can simulate bifurcated flow using lateral structures and interconnected stream reaches or storage areas (unsteady models). One-dimensional models can be run in steady- or unsteady-state, depending on the physical setting and the purpose of the modeling effort.



**Figure 4: One-dimensional model cross section showing constant water-surface elevation**

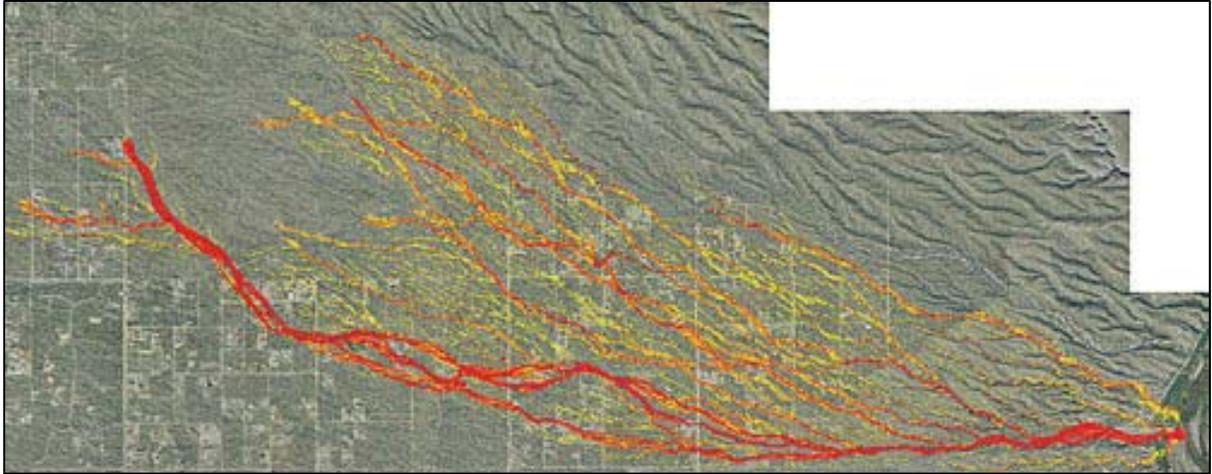
Unsteady-state flow 1-D models use a hydrograph as flow input. The full dynamic wave solution takes into account both conservation of mass and conservation of momentum. This unsteady-state analysis allows the model to account for both temporal and spatial changes in flow conditions within the system. The advantages to this system are that changes in flood wave timing, volume, and peak flows can be evaluated along a study reach. This makes 1-D unsteady-state modeling a valuable tool to evaluate downstream impacts of changes in the Carson River floodplain.

### 3.3.2 Two-dimensional Modeling

In generalized terms, 2-D models operate on a grid- or mesh-based routing scheme with a single water-surface elevation applied to each gridded section. Hydraulic parameters are calculated for each cell and compared to adjacent cells to route water through the grid network. Two-dimensional models are typically run with a hydrograph as input and are computationally more complex than 1-D models.

A common 2-D application is for analysis over complex topography (e.g., alluvial fans) where flow frequently bifurcates or converges while traversing through a watershed. Volume conservation is an important part of 2-D modeling. Like most 1-D models, most 2-D models also employ a rigid boundary assumption.

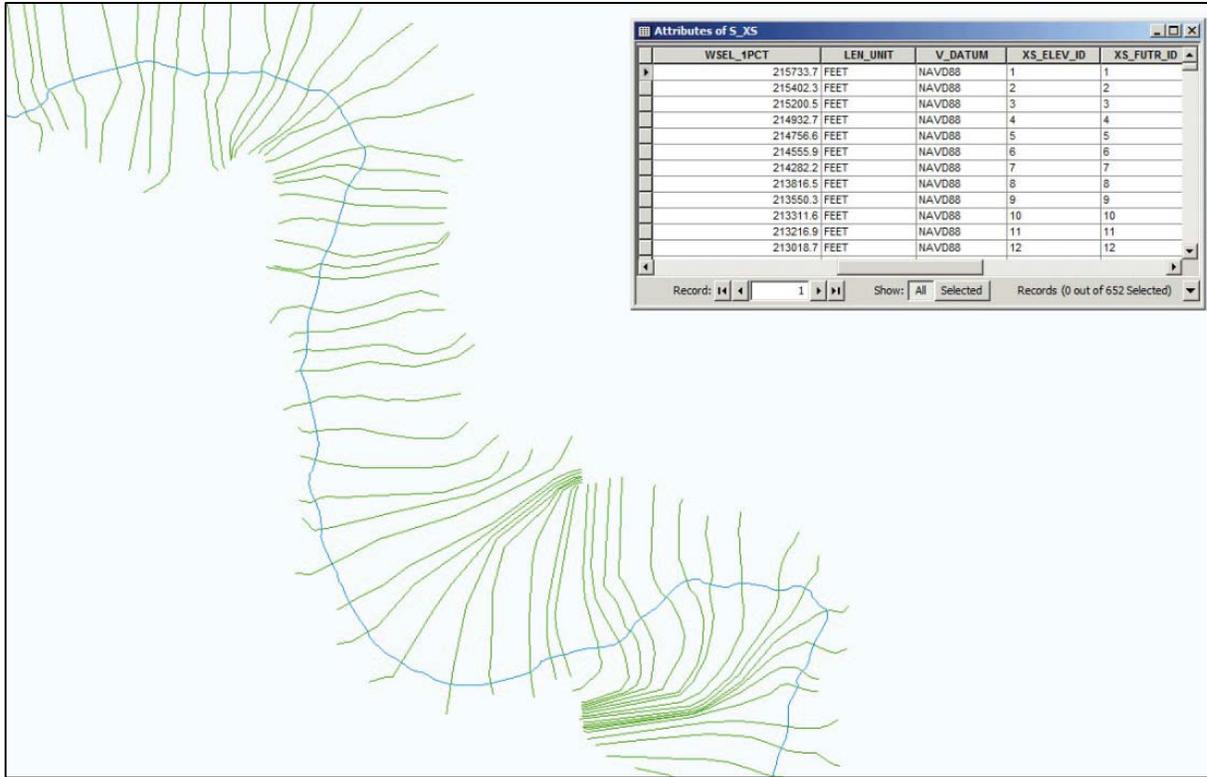
An example of 2-D modeling for an alluvial fan in the arid southwest is depicted in Figure 5. Using this tool, a visual impact analysis can be prepared for depths, velocities, and inundation limits within the study area. It should be noted, that this is simply an example of a 2-D application. Application of a rigid boundary assumption to an active alluvial fan is not a valid solution for this type of flooding hazard since it would not account for changes in geometry due to deposition, erosion or channel avulsions.



**Figure 5: Example: Two-dimensional modeling for alluvial fan**

### 3.4 Geographic Information Systems (GIS)

GIS is a multi-faceted tool that promotes use and development of spatially referenced data, data storage, and visual representation of the data across many disciplines. Distinct advantages of using the GIS platform for model development are the ability to reduce the effort and increase the accuracy associated with pre- and post-processing the results from hydraulic models. Many forms of spatial data can be used in the data processing allowing a more efficient and verifiable means of representing spatially variable data (land use, roughness, topography, flow patterns, etc.). For water resource professionals, GIS has become an integral tool in the day-to-day operations for investigating and solving problems. GIS aids in the development of graphical products for visual review with corresponding tabular attribute tables that containing the source data. An example of cross sectional data displayed in GIS with the source attribute data are shown in Figure 6.



**Figure 6: Example GIS visual and tabular product**

Within the GIS software platform, various extensions and tools are available to aid in the collection and extraction data for hydraulic and hydrologic analysis. Examples are the HEC-GeoHMS and HEC-GeoRAS tools developed by Environmental Systems Research Institute (ESRI) for the U.S. Army Corps of Engineers (USACE). Through the use of GIS, floodplain boundaries can be developed and displayed from water-surface elevations (WSELs) from a hydraulic model. GIS also has the capability to develop terrain/surface models from raw topographic data to support the extraction of geo-referenced hydraulic model geometry. Figure 7 is an example of a digital floodplain modeling output overlaid on a digital terrain.



Figure 7: Example GIS digital floodplain on terrain surface

GIS has the capability to provide aesthetically pleasing and technically sound map products that support data development, alternative analysis, stakeholder reviews, FEMA deliverables, and public involvement. An example of work maps developed in GIS to display the results of a floodplain re-delineation study for FEMA is shown in Figure 8.

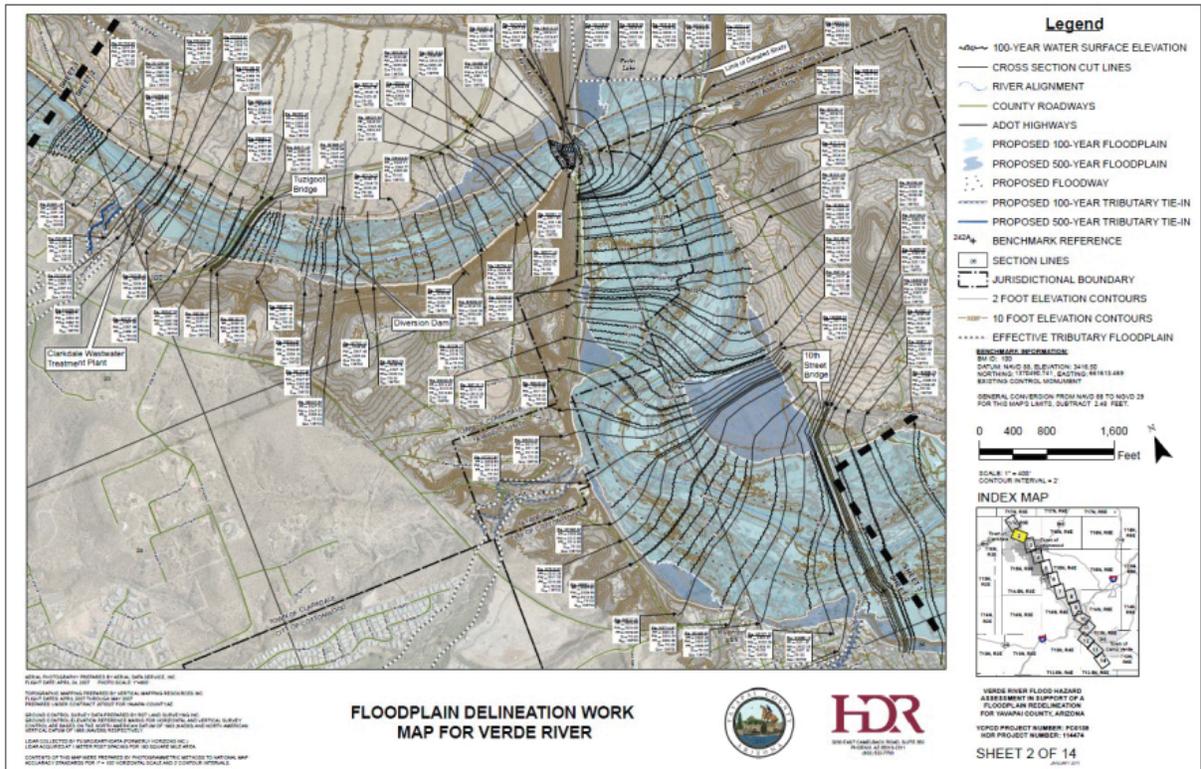


Figure 8: Example GIS floodplain re-delineation work map

### 3.5 Historic Flooding

The Carson River system periodically experiences flood events. Typically, these events occur during the winter season involving rain-on-snow. Three large floods have occurred since 1986. On February 19, 1986, a warm rainstorm resulted in a peak flow at the Carson River near Carson City stream gage of 13,200 cubic feet per second (cfs), while the Carson River Fort Churchill stream gage recorded a peak flow of 16,600 cfs. From December 30, 1996 to January 2, 1997, a series of warm rain storms produced rain on an unusually heavy snowpack, resulting in the largest flood on record. The Carson City stream gage peaked at 30,500 cfs, and the peak flow at the Fort Churchill stream gage was 22,300 cfs. Another warm storm occurring over December 30 and 31, 2005, resulted in a maximum flow of 11,900 cfs at the Carson City stream gage and a flood flow of 9,800 cfs at the Fort Churchill stream gage. The estimated recurrence intervals for these events are given in Table 1.

**Table 1: Historic Floods on the Carson River**

Date	Stream Gage Location	USGS Estimated Peak Flow (cfs)
February 1986	Carson River near Carson City	13,200
	Carson River near Fort Churchill	16,600
January 1997	Carson River near Carson City	30,500
	Carson River near Fort Churchill	22,800
January 2006	Carson River near Carson City	11,900
	Carson River near Fort Churchill	9,800

These events can be used as the basis of flow hydrographs for modeling efforts, as well as to calibrate models. As seen in Table 2, the recurrence interval of these flood events varies, depending on the location of the stream gage in question. Although the peak discharge of a certain event may not correspond to the statistically determined 1-percent chance (100-year) or 0.2-percent chance (500-year) flood flow, the shape of the flood hydrograph is very important for modeling the Carson River. The hydrograph shape represents the response of the watershed upstream of that point to a given storm.

It should be noted, that the reported estimates are determined with various methods with differing levels of confidence. Direct measurements are the most accurate form of measurement typically made by USGS. Direct measurements are performed using velocity meter or acoustic sounder. Unless unusual conditions exist at the time of measurement, USGS will typically rate these estimates as “good.” Another approach to making an estimate of peak flow is with the use of an indirect measurement. An indirect measurement is made days or weeks after the peak flow has receded. High water marks are field-identified and cross section surveys are performed for a series of cross sections in the vicinity of the high water marks. A slope area method calculation is performed to make the estimate. This slope-area calculation may be verified with a step-backwater analysis in some cases.

The accuracy of this type of estimate is dependant on many factors, such as:

- High Water Mark Data Quality – Obtaining reliable high water mark data is often difficult. Wave action, floating debris influences, superelevation on channel bends, degradation of high water marks from precipitation, presence of secondary high water marks that provide a false impression, etc., can make identification of accurate high water mark data difficult.
- Assignment of Accurate Roughness Values – Assignment of accurate roughness values may be a significant factor in some settings.
- Channel Changes – The cross section surveys are performed after the flooding event has receded. Channel bank erosion, channel bed erosion, channel bed aggradation and vegetation loss at the time of the survey may, or may not, be representative of the conditions that existed at the time of peak flow.

Anomalies in the Carson River estimates for the 1997 event have been noted and will require additional investigation to determine effective use of these data for calibrating the model.

## 4 TECHNICAL GUIDANCE

The following sections cover the technical guidance for floodplain modeling and mapping for the Carson River within the Study Reach defined in this guide (Figure 1). The use of the term “practitioner” refers to any persons, agency or firm conducting floodplain modeling or mapping or updating floodplain models or maps for the Study Reach.

### 4.1 Hydrologic Analysis

For unsteady-state flow modeling, the practitioner shall use flow or stage hydrographs for model input and boundary conditions. Historic hydrographs extracted from the data listed in Table 2 shall be used for calibration efforts. Synthetic hydrographs for the flood recurrence interval of interest (i.e., 1- percent chance, 0.2-percent chance) shall be developed using a balanced hydrograph method described below.

It should be noted that CWSD has developed regional hydrographs for the Carson River System within the study area covered by this guide. The practitioner shall use these data to the extents practicable.

#### 4.1.1 *Hydrologic Data*

USGS has installed numerous stream gages along the Carson River. A selection of those stream gages which provide useful flow data are listed in Table 2, along with the period of record of the instantaneous flow data, annual peak flow, and direct measurement data available for each stream gage. Other stream gage sites along the river have limited periods of record or do not collect stage and discharge information and are not included in this table.

##### 4.1.1.1 Mixed Population Data

For the Carson River Watershed, floods typically occur in response to rain-on- snow events in the Sierra Nevada Mountain Range. These floods generally occur in the winter months (historical occurrence has been between November and March) and can differ from spring melt (April to June) or summer rainstorm events. The practitioner shall investigate the historic gage records to determine if a mixed flood population exists and whether analysis warrants separating winter and spring/summer events.

**Table 2: Carson River USGS Stream Gages**

<b>Stream Gage ID #</b>	<b>Description</b>	<b>Instantaneous Flow Period of Record</b>	<b>Number of Records</b>	<b>Peak Stream Flow Period of Record</b>	<b>Number of Records</b>	<b>Field Measurements Period of Record</b>	<b>Number of Records</b>
10309000	East Fork Carson River Near Gardnerville	10/1/1990 - 9/30/2009	551360	5/28/1890 - 5/20/2009	90	11/6/1938 - 12/30/2010	888
10309100	East Fork Carson River at Minden	3/12/1994 - 9/30/1998	140321	6/2/1975 - 3/24/1998	15	4/1/1974 - 2/22/1999	175
10310000	West Fork Carson River at Woodfords	10/1/1993 - 9/30/2009	545656	6/9/1890 - 5/3/2009	94	10/21/1938 - 12/27/2010	887
10310358	West Fork Carson River at Muller Lane near Minden	3/18/1994 - 9/30/1998	152195	3/11-1995 - 6/7/1998	4	3/14/1994 - 10/7/1998	45
10310407	Carson River near Genoa	10/1/2001 - 9/30/2009	258915	4/14/2002 - 5/4/2009	8	9/28/2001 - 12/27/2010	100
10311000	Carson River near Carson City	10/1/1989 - 9/30/2009	513242	5/12/1939 - 5/4/2009	71	8/21/1938 - 12/27/2010	916
10311400	Carson River at Deer Run Rd Near Carson City	10/1/1990 - 9/30/2009	513298	1/15/1980 - 5/4/2009	25	3/15/1979 - 1/26/2011	347
10311700	Carson River at Dayton	4/12/1994 - 9/30/2009	323517	5/12/1994 - 5/19/2008	10	4/11/1994 - 1/14/2011	168
10312000	Carson River Near Fort Churchill	4/2/1987 - 9/30/2009	517792	6/20/1911 - 5/5/2009	99	9/27/1957 - 1/19/2011	712

### **4.1.2 Hydrograph Development**

For all hydraulic analysis conducted in the study area (Figure 1), a balanced hydrograph shall be developed using USGS stream gage data and the procedures outlined below. It is anticipated, however that balanced hydrographs will be developed by early 2012 at all stream gages for the study area and will be available from CWSD for use in hydraulic modeling.

#### **4.1.2.1 Annual Maxima Flood Frequency Analysis**

The practitioner shall develop an annual maxima flood frequency curve for the study reach of interest. For this analysis, only stream gages with 20 years of data (not necessarily continuous) or more shall be used. Instantaneous annual maxima stream flow values shall be collected for the specific reach of interest. These data shall be used to perform a Log Pearson Type III distribution using the statistical approach outlined in Water Resources Council Bulletin 17b. In general, station skew shall be used where practical. Any deviations from this shall be based on sound engineering judgment.

#### **4.1.2.2 Flow Duration Frequency Analysis**

The practitioner shall evaluate mean daily flow data to develop flow-duration-frequency relationships for the balanced hydrograph. Average daily stream flow values for the annual peak shall be used for the 1-day, 3-day, 5-day, 7-day, and if necessary, the 10-day averages to develop frequency curves for each duration. Water Resources Council Bulletin 17b shall be used for these analyses. These values shall be used in conjunction with an historic “pattern” hydrograph to develop a synthetic balanced hydrograph for the reach.

#### **4.1.2.3 Balanced Hydrograph**

Once evaluation of annual maxima and mean daily flow data is complete, the practitioner shall use these data points along with an historic “pattern” flood hydrograph, to construct a balanced hydrograph. The instantaneous peak flow estimate shall be straddled by the 1-day, 3-day, 5-day, 7-day, and 10-day peak values and to create a preliminary balanced hydrograph. Adjustments to the preliminary hydrograph shall be made to preserve volume and capture the shape, to the greatest extent possible, of the pattern hydrograph.

## **4.2 Data Collection and Data Development**

The following section summarizes the types, form, and specifications for data collection and development to support hydraulic modeling and mapping.

### **4.2.1 Aerial Photography**

Aerial photography provides significant value by providing the visual element of the study reach and its surrounding environment. The use of aerial photography is particularly important when preparing a product that displays spatially referenced information to an audience who may have limited knowledge of the site conditions.

To support project evaluations, the practitioner shall collect ortho-rectified aerial photography for the study reach as available. If aerial photography is to be collected specifically for a project, the following procedures shall be used:

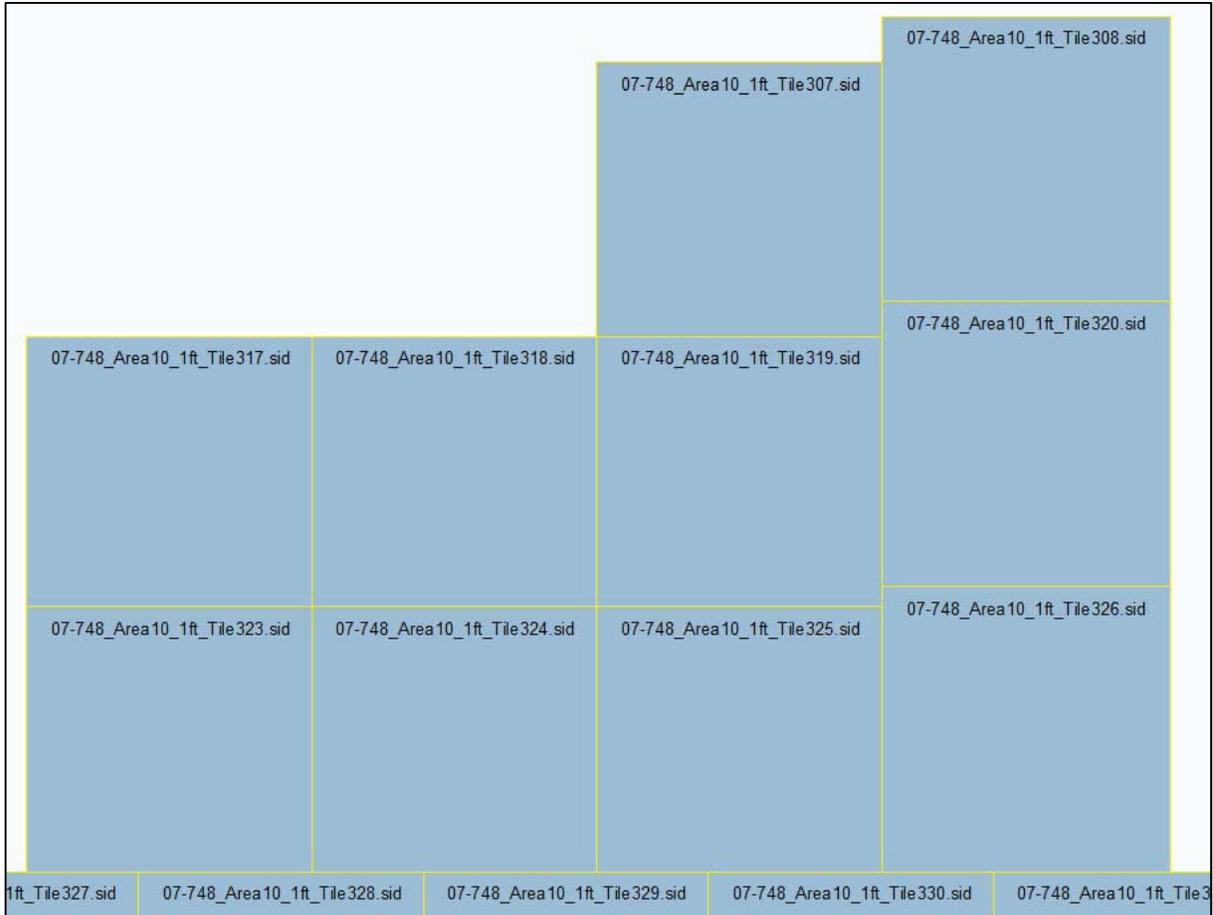
- The mapping collection for perennial rivers shall, to the extent practicable, be coordinated to occur during the low flow periods with the least amount of shadow coverages, thus providing the largest amount of exposed ground.
- Aerial photography collection for detailed projects shall, at a minimum, use 1"=600' photo scale based on post-processed airborne Global Positioning System (GPS) and Inertial Measurement Unit (IMU) coordinates for the center of the photos.
- The aerial photography collected shall be completed in cooperation with the topographic mapping collection, to ensure that both products reflect a single collection reference point in time.
- The contents of the mapping shall be performed to support the National Map Accuracy Standards for 1" = 100' horizontal scale and 2' contour intervals for both flat terrain and detailed studies used to supersede existing delineation data.
- The photographs collected shall be provided in a tiled format, with an index grid, and sequential naming using either alpha or alpha-numeric combinations from left to right and upstream to downstream.
- Documentation prepared by the aerial collection company shall include a collection report that maps the flight patterns, indicates the date and time of collections, provides a digitally reference supported grid (preferred GIS format).
- The practitioner shall prepare the delivery request of aerial photography using the Mr. SID (multi-resolution seamless image database) format with a description of the software packages utilized to produce them. This format is preferred due to the losses wavelet compression capability which yields high compression ratios and significant reduction in file sizes without compromising the quality of the raster image.

If the aerial photography collection is being conducted in support of a FEMA-level quality deliverable, the *Guidelines and Specifications for Flood Hazard Mapping Partners* [April 2003] (GUIDE) shall be followed with respect to Appendix A: Guidance for Aerial Mapping and Surveying.

The following three examples are critical excerpts that shall be followed from the GUIDE:

1. Aerial photography shall be flown under the following conditions:
  - While the sun angle is above 30 degrees;
  - When there is no snow cover;
  - When the flooding sources are in the main channels; and
  - When leaves are off the trees.
2. The assigned practitioner shall perform aerial surveys under the direct supervision of a registered land surveyor or American Society for Photogrammetry and Remote Sensing (ASPRS)-certified photogrammetrist, consistent with state regulations.
3. The practitioner shall abide by the requirements set forth with the GUIDE for vertical root mean square error (RMSE) standards in section A.8.6.1. Additionally, the practitioner shall abide by the requirements set forth with the GUIDE for pre-project and post-project deliverables in sections A.8.7.1 and A.8.7.2 respectively.

Figure 9 is an example of a gridded aerial photography deliverable within a geodatabase format to support a project coverage area.



**Figure 9: Example of a gridded aerial photography database deliverable**

#### 4.2.2 Terrain Data

Topographic data may be readily available for a study reach. In the event that a project is located in a remote area that does not have detailed topographic mapping, coarser data may be available from USGS for reference and use within the GIS platform.

The practitioner shall conduct an evaluation to determine sources of topographic coverage and coverage extents for the study reach. The practitioner shall use the most current topographic data meeting FEMA’s GUIDE, Appendix A. The data collected shall be in either point (PT) and break line (LN) format or Dense Light Detection and Ranging (LiDAR) (LAS or ASCII XYZ). Both products have unique variables for resolution, accuracy, and point spacing which affect the net size of the product produced.

A Digital Elevation Model (DEM), Digital Terrain Model (DTM), or Triangulated Irregular Network (TIN) may be used if supporting documentation or source files accompany them and the surface meets National Map Accuracy Standards.

The product of a terrain survey after post processing by the practitioner often represents the “bare earth” equivalent which omits certain elements that are necessary to support the definition of a detailed study. The practitioner is required to collect survey data for missing terrain data. Typical survey data to be collected, described in more detail below, include the following:

- **Supplemental Survey Data:** Areas within the study limits where the topography has changed since the original aerial/terrestrial data collection.
- **Bathymetric Data:** Areas below water on the date that aerial survey was collected.
- **Hydraulic Structures Data:** Any hydraulic structures such as bridges, culverts and inline structures that affect hydraulic grade line for which as built information is absent or questionable.

#### 4.2.2.1 Supplemental Survey Data

In many cases, the best available terrain data may be several years old. Changes in topography, such as new development or infrastructure, lateral migration of stream channels, and development of point bars/islands, may not be represented. The practitioner shall update these areas of topographic change since the date of original collection and integrate into original data. The practitioner shall perform the survey collection of XYZ data, using calibrated survey grade equipment that meets industry and FEMA standards at the time of collection.

In the event that topographic data meeting FEMA GUIDE standards does not exist, the practitioner shall collect new topographic data. Data collection shall use survey ground control methods for both horizontal and vertical survey based on the North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD88) respectively. Collection shall follow the FEMA GUIDE standards.

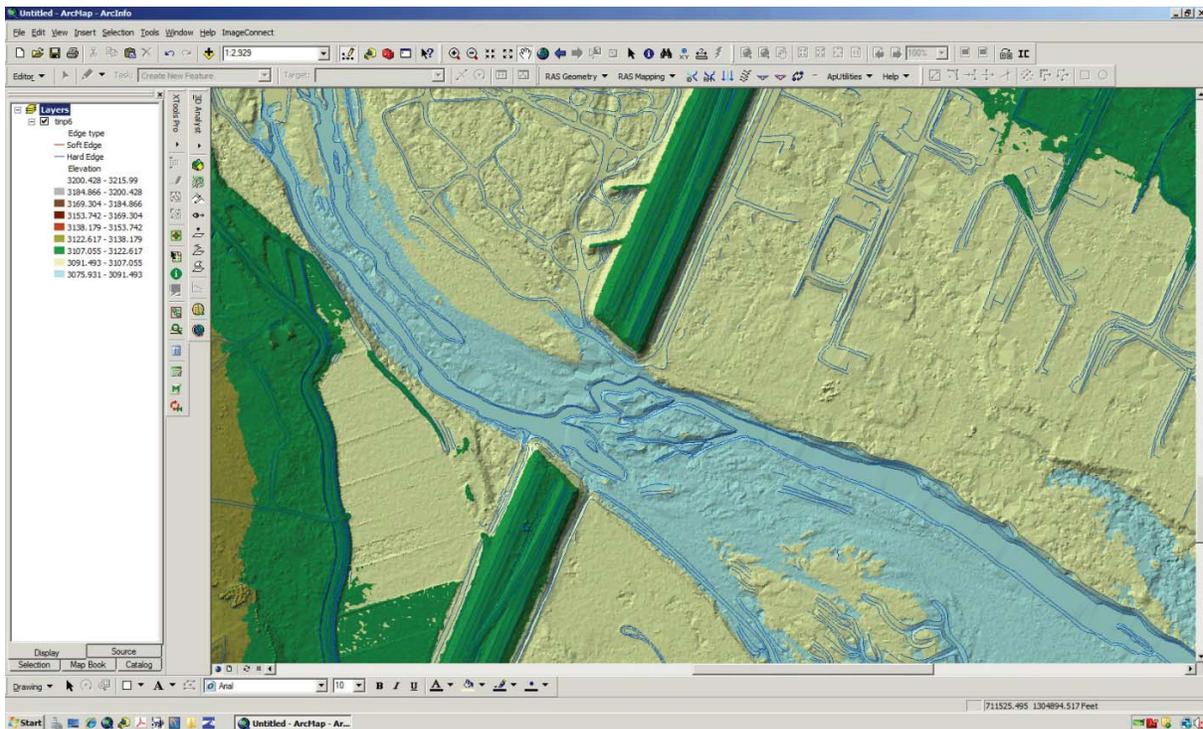


Figure 10: Example bare earth surface terrain missing bridge data

#### 4.2.2.2 Bathymetric Data

In most instances, additional survey may be necessary to collect underwater channel geometry or “bathymetric” information. The practitioner shall collect information in support of the project need(s) as directed by a qualified water resource specialist, whom shall identify the location and frequency of cross sections. These collections are also subject to industry standards and those set forth by FEMA’s GUIDE. In general, cross sections shall be collected to capture changes in channel grade, such as pools and riffles. Additionally, cross sections shall be collected at areas of channel expansion and contraction.

#### 4.2.2.3 Hydraulic Structures Data

Hydraulic structures, such as bridges, culverts or inline dams, are often removed from LiDAR collection for the development of the equivalent “bare earth” or ground coverage file. Depending on the availability, as-built data for hydraulic structures may be available from local municipalities or transportation authorities. As-built plans have the potential to provide a cost effective mechanism for obtaining data for modeling structures such as bridges, culverts, weirs, diversion structures, or dams.

In the event that adequate information from as-built documents is not available or conflicts with survey references, additional structure surveys will be necessary. Practitioners shall perform this survey collection of XYZ data, using calibrated survey grade equipment and methods that meet industry and FEMA standards at the time of collection to accurately capture the geometry of all hydraulic structures that may effect water-surface elevations for the study reach. For bridges, this may include high chord, low chord, guard rails, deck profiles, pier information, and/or abutments. For culverts, this may include inverts, crowns, culvert size and shape, wingwalls, sediment depths, and/ or deck profile. For inline dams, this typically includes a profile along the top of the structure.

#### 4.2.2.4 Additional Data

Additional data that may be collected to support hydraulic modeling and flood hazard mapping includes but is not limited to the following:

- Land use
- Vegetation cover
- Roads, Highways, Interstates
- At-grade-crossings, culverts, bridges
- Dams, Levees, Lateral Weirs, Irrigation Diversion Structures
- Siphons, Pump Stations
- Emergency Spillways
- Storm Water Retention/Detention Facilities
- Structures Identification (Habitable and Ancillary)
- Assessors Parcel Data

### 4.3 Manning’s Roughness Values

Developing an assessment of Manning’s roughness values is an important part of any hydraulic modeling analysis. The Manning’s n value assigns a roughness parameter that simulates resistance to flow within a hydraulic model. Best practices for determining the n values consist of aerial photo interpretation, field reconnaissance, review of effective studies, and review of agency literature or published requirements, and model calibrations (not discussed in this section). The practitioner shall review the best available data and identify local requirements which may govern the selection of roughness coefficients.

### 4.3.1 One Percent and Greater Flood Frequencies

Depending on the return frequency the practitioner is modeling and the type of hydraulic system being modeled, a combination of aerial and/or field reconnaissance methodologies can be employed to estimate Manning's roughness values. For the purposes of this guide and as outlined in FEMA's GUIDE, Manning's n values may be estimated using aerial photography with appropriate calculation methods (outlined below) for flood frequencies equal to or exceeding the 1-percent chance (100-year) flood. Although not required, an attempt must be made to incorporate field photos of channel and overbanks for use in Manning's n estimations.

### 4.3.2 Less Than One Percent Flood Frequencies

For all flood frequencies less than the 1-percent chance (100-year) flood, the practitioner shall conduct a physical field reconnaissance of the study reach or wash where access and conditions permit. During this investigation, digital photography shall be collected and documented for unique site characteristics affecting the Manning's roughness values. Locations of field photos shall be recorded on aerial maps.

The n value assessment of ephemeral washes versus perennial streams will greatly differ, due to the visibility of bed material. Visual inspections of perennial streams are limited to sand bars, areas of outcropping, or under water cross section investigations due to visual restrictions from the conveyance of water. Ephemeral washes are open, limited only by isolated discharge periods, and field reconnaissance in the form of walking the wash bottom can be performed.

Photographic documentation (described above) for an ephemeral washes is standard practice, however the use of a reference grid is highly recommended to provide a sense of relative size for the comparison of bed/channel form materials depicted. An example of an ephemeral wash n value inspection tool is depicted in Figure 11, using a 1 foot by 1 foot PVC pipe grid, which internally holds a string grid of 1 inch by 1 inch grid:



**Figure 11: Field reconnaissance inspection tool**

Photographic documentation for a perennial stream is more complex and is most often conducted from the banks of the wash or river. Although the stream bottom cannot be seen in the photography, the embankments and overbank vegetation are captured to support the development of the corresponding roughness values.

The practitioner shall develop a presentation map or series of presentation maps depicting the field reconnaissance conducted. These maps shall include the location of photographic collection points as described above with project reference information.

The practitioner shall develop a photographic documentation log, which displays the photography collected, identifies the site or photo number and the date of collection. An example of a photograph log template documenting field investigation is shown in Figure 12 for a single point.



**Figure 12: Example of field reconnaissance photo log at a single point**

Using the photography log and the presentation maps for the field reconnaissance, the practitioner shall prepare calculations to compute the corresponding Manning’s roughness coefficient,  $n$  value, based on the individual factors observed in the field.

Many textbooks and manuals have been written that describe the Manning’s  $n$  value and the factors involved in the selection. Three publications often referenced for such guidance are Barnes (1967), Chow (1959), and Ree (1954). These publications may be used as appropriate to support Manning’s  $n$  determinations.

The step-by-step procedures for developing the Manning’s  $n$  value are detailed in USGS’s Water-Supply Paper 2339 (WSP 2339), *Guide for Selecting Manning’s Roughness Coefficients for Natural Channels and Floodplains*. A simplified and brief description of the process is provided below. It should be noted that developing roughness values for floodplain can be quite different than the values used for channels. Additionally, seasonal variability for roughness coefficients may need to be considered, but is not detailed here-in.

Cowan (1956) developed a procedure for estimating the individual efforts of five factors that commonly occur to guide in the estimation of the  $n$  value for a channel. Cowan’s equation for developing the  $n$  values indicates the following computation:

$$n = (n_b + n_1 + n_2 + n_3 + n_4) * m$$

Where:

- $n_b$  = a base value of n for a straight, uniform, smooth channel in natural materials
- $n_1$  = a correction factor for the effect of surface irregularities
- $n_2$  = a value of variations in shape and size of the channel cross section
- $n_3$  = a value for obstructions
- $n_4$  = a value for vegetation and flow conditions
- $m$  = a correction factor for meandering of the channel

The selection of a base n value for channel sections is based on the classification of a stable or sand channel. Stable channels remain relatively unchanged throughout most ranges of flow, while sand channels are assumed to have unlimited supply of sand with bed materials moving with relative ease to take on new bed form configurations. The roughness coefficients applied to a longitudinal reach, channel or floodplain are often located at sections of regular geometric shape or irregular shape for many naturally occurring channels.

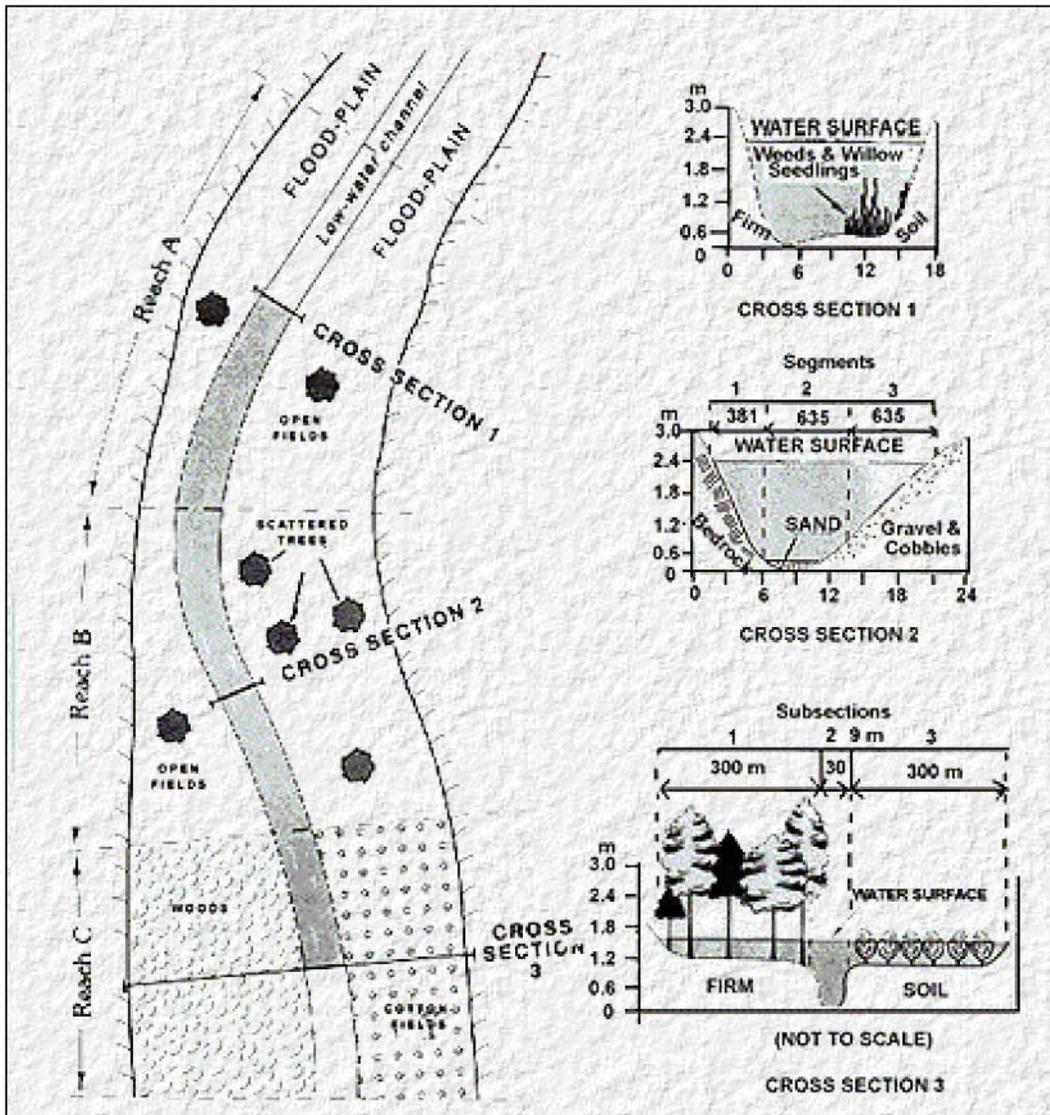


Figure 13: Graphic of floodplain subsections for Manning's n calculations (from WSP 2339)

Refer to Appendix A for suggested base Manning's n values dependant on channel bed materials.

Adjustment factors for the channel n values add increments of roughness to the base n value  $n_b$  for each condition which impacts the roughness. The following summarizes the adjustment factors for channel n values:

- Irregularity ( $n_1$ ): A correction factor which accounts for the ratio of width to depth in eroded and scalloped banks. In some cases large adjustments are necessary if irregular banks contain project points into the stream.
- Variation in Channel Cross Section ( $n_2$ ): A correction factor which accounts for the alternating of large and small cross sections, sharp bends, constrictions, and lateral shifts in the low-water channel bed.
- Obstruction ( $n_3$ ): A correction factor which accounts for both naturally occurring and man made obstructions within the channel and floodplain, assigned four levels of obstruction: negligible, minor, appreciable, and severe.
- Vegetation ( $n_4$ ): A correction factor which accounts for the affects of vegetation dependant on the depth of flow, percentage of wetted perimeter covered by vegetation, density, degree of vegetation flattening by high water, and vegetation alignment.
- Meandering ( $m$ ): A correction factor dependant on the ratio of the total length of meandering in a channel to the straight length of a channel. Meandering is separated into three categories of minor, appreciable, and severe. This correction should only be considered when the flow is confined to the channel.

Table 1 in the WSP 2339 gives base n values, while Table 2 provides recommendations for the corresponding correction factors (n value adjustments) for  $n_1$  through  $n_4$  and  $m$  for channels. These values are separated by levels of impact and provide guidance with respect to the ranges of correction that may be applied.

The n value computed for channel roughness is determined by following the series of decision-based adjustments based on user review and application of corrections to the based n value. Similarly the n value computed for floodplains are subject to a base value which is adjusted to compensate for vegetation density in the floodplain through respective subsections.

A flow chart for procedures for assigning n values was developed within WSP 2339, which is referred to as Figure 21 in that document, providing guidance for the order of operations for both channel and floodplain roughness computations.

There are several references, guides, and technical white papers that a user can refer to for Manning's n values for typical channels. An extensive compilation of n values for channels (streams) and floodplains can be found in Chow's *Open-Channel Hydraulics* handbook (Chow, 1959). Excerpts to the most common channel values from this book have been included within the Hydrologic Engineering Centers River Analysis System (HEC-RAS) user's hydraulic reference manual to support the engineering community. In general, the bed value shall be in a range of 0.020 to 0.05 for an alluvial system in the silt to cobble range. Overbanks shall range from 0.030 to 0.20 depending on the naturally occurring vegetation and coverage materials, assuming no significant obstructions. Blocked obstructions and man made features may have an influence on the resulting overbank roughness coefficients.

An example of Manning’s n value ranges and respective values within Table 3 is provided for reference:

**Table 3: Example Manning’s n Values for Floodplains and Channels**

Type of Channel and Description	Minimum	Normal	Maximum
<i>A. Natural Streams</i>			
<b>1. Main Channels</b>			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150

#### 4.4 Terrain Development

As an underlying support to the hydrologic and hydraulic modeling software packages, various types of digital terrain surfaces are used to extract model geometries. These surfaces shall be prepared from aerial survey data comprised of either digital point and break line files or mass points, such as Airborne LiDAR. Both of these data sets are commonly used. For the purposes of this Guide, the practitioner shall evaluate the opportunities for both products and their utility for the development of a single or multiple surfaces to support hydraulic modeling for the study area.

There are many software packages currently available for developing TIN or DTM from raw survey products. Both the TIN and/or DTM shall be developed from mass point files or point and break line data. Alternatively, raster or DEM data may be used for a terrain surface, however the resolution shall be small (1/2 foot square grid cell resolution) to prevent degradation and loss of quality from the source data.

The float file format is used within HEC-RAS Mapper to support post processing of HEC-RAS hydraulic model results. The float file format may be used with Mapper to support flood hazard delineation within the HEC-RAS system.

Surface models used for 2-D modeling differ based on software requirements. Data used to develop the surface model shall be in the form of “bare earth” LiDAR data (.LAS) or 3D ASCII data files (.TXT) or equivalent.

National Map Accuracy Standards for surface development and use with hydraulic modeling have been established by FEMA. The requirements for a standard TIN differ from that of a LiDAR product. The practitioner shall follow the FEMA GUIDE for mapping partners and the specific requirements of each products development and submittal criteria. Copies of all developmental information are to be provided in both electronic and hard copy for approval within a study.

Traditional photogrammetric surveys are subject to the requirements set forth by the FEMA GUIDE, specifically Appendix A, Section A.7. LiDAR surveys are subject to the requirements set forth by the FEMA GUIDE, specifically Appendix A, Section A.8 and the recent procedural memorandum No. 61 from FEMA, which addresses revised requirements for the topographic data prepared for use within a new flood hazard analysis for the Nation Flood Insurance Program (NFIP). As part of the best practices

for developing terrain data, it is essential to collect copies of the survey control data, flight report, and final sign and sealed survey report that clearly declares the contents of the submittal meet the FEMA standards discussed above. The resulting Root Mean Square Error (RMSE), both vertical and horizontal accuracies, scale, and resolutions must be declared for reference and comparison to the standards. The practitioner shall prepare finalized products with a licensed surveyor's certification, stating that products prepared comply with the FEMA GUIDE, Appendix A requirements.

In the event a single TIN surface file size is too large for utilization within the hydraulic or GIS software applications, the practitioner shall prepare mosaic TINs. Due to the potential for interpolation errors, an overlapping buffer is necessary to prevent errors during the data extraction process. A buffer zone equal to five percent of the tile size shall be incorporated around the adjoining tiles. Refer to FEMA GUIDE, Appendix A, Section A.4.4 for additional information related to the requirements for mosaic TINs.

The practitioner shall record the process used to develop the mosaicked TINs and provide the process results and a copy of the reference map in both electronic and hard copy. This documentation shall be maintained for use in the preparation of the final technical document delivery for FEMA.

## 4.5 Hydraulic Modeling

This section of this Guide covers hydraulic model selection and best practices for developing models. It addresses both 1-D and 2-D modeling. In general, the practitioner shall use both 1-D and 2-D models, as appropriate and unsteady-state flow inputs. Unsteady-state flow development is covered in Section 4.1 Hydrologic Analysis.

### 4.5.1 Model Selection

The selection of either 1-D or 2-D modeling shall be governed by the type of stream or overbank floodplain environment to be modeled.

#### 4.5.1.1 One-dimensional

A 1-D model shall be used in areas where both the channel and overbank flow paths are either clearly defined or easily discernable from aerial photography and topographic data. Additionally, a 1-D model shall be used in situations where hydraulic structures, such as bridges, culverts and weirs need to be evaluated for their effects on hydraulic grade lines.

While there are numerous versions of hydraulic models available, HEC-RAS shall be used due to its accessibility as public domain software, computational framework, validation, forward compatibility with previous version of the software, continued support, unsteady-state modeling features, and the ability to interface successfully with supporting platforms such as AutoCAD and GIS.

The most current version of the software shall be used for modeling and can be downloaded directly from the USACE at the following website:

<http://www.hec.usace.army.mil/software/hecras/hecras-download.html>

#### 4.5.1.2 Two-dimensional

A 2-D hydraulic model shall be used for complex unsteady-state flow environments with shallow dispersive flow which commonly bifurcates between channels, rills, or sections of undefined flow paths. As a general rule of thumb, the 2-D application is best suited when shallow flow paths traverse through the study area in a relatively random, dynamic matter, exchanging flow across multiple channels.

Shallow overbanks floodplain areas and alluvial fans typically experience this type of flow behavior.

#### 4.5.2 One-dimensional Hydraulic Model Development

The following section covers the best practices and specifications for developing a 1-D HEC-RAS model for the Carson River.

##### 4.5.2.1 Cross Sections

Cross sections shall be oriented perpendicular to flow within the stream channels and overbank regions. This often results in section lines with one or more bends, to account for changes in flow direction across the channel and overbanks, as seen in Figure 14.

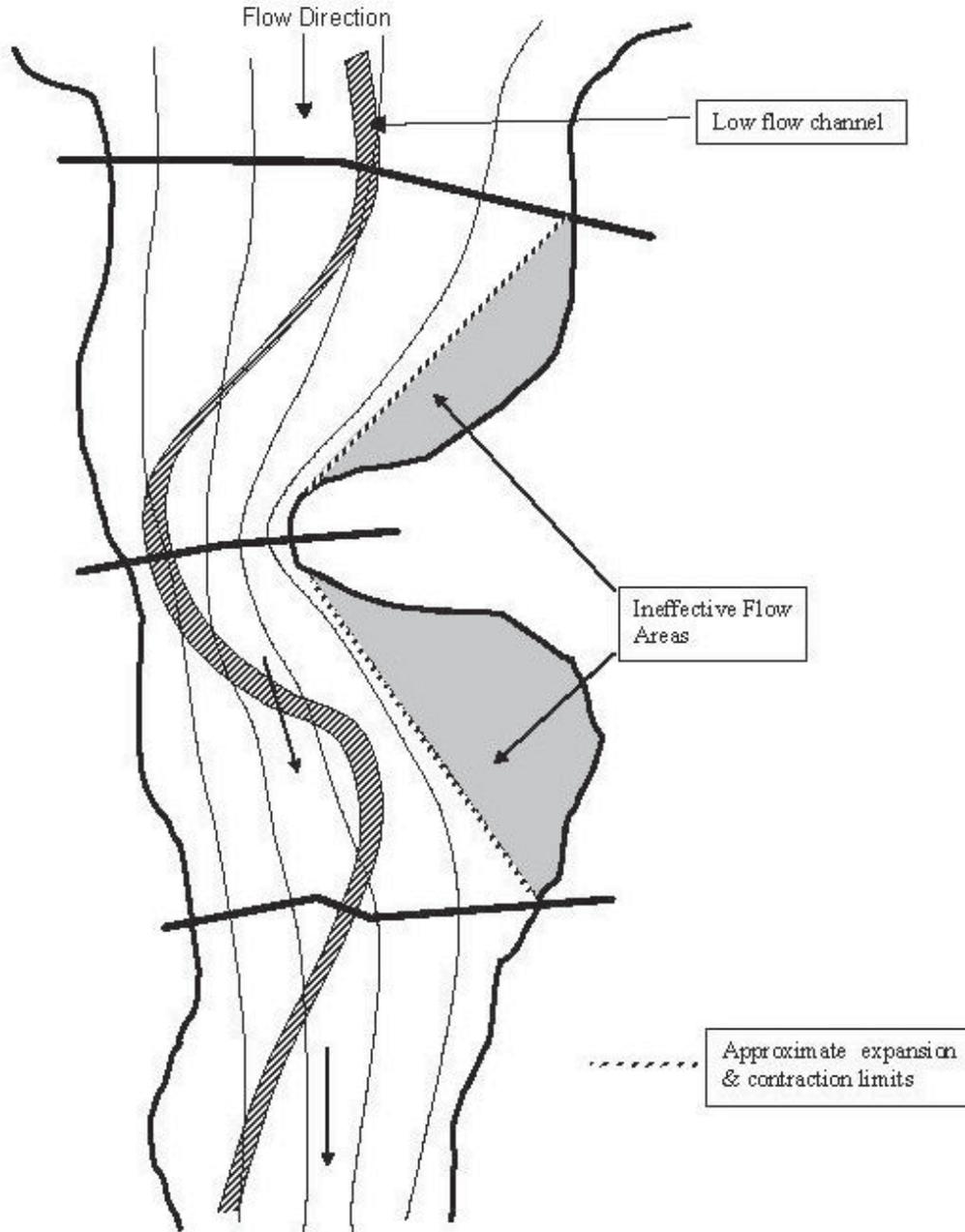


Figure 14: Cross section layout (after Arizona DWR, 2002)

Each section should be long enough to extend past the anticipated floodplain boundary of the event being modeled. The model assumes that cross section geometry remains roughly the same up and downstream for one half the distance to the next section. Therefore, sections need to be placed closely enough to represent large changes in the river system. Unsteady-state flow modeling requires sections be spaced more tightly, due to the model's sensitivity to changes in hydraulic parameters. Factors to be considered when determining cross section spacing include: significant flow contractions and expansions, pool/riffle sequences, changes in channel and floodplain roughness, and flow change locations. Sections should be placed as near as possible to surveyed cross sections to minimize usage of interpolated elevations.

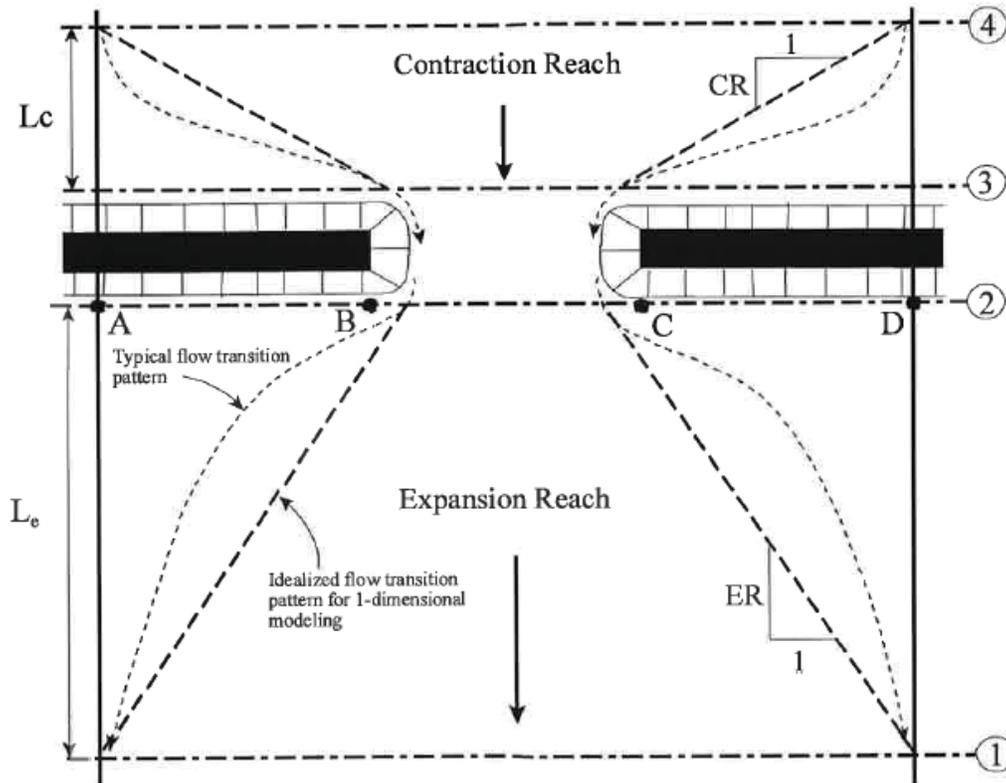
#### 4.5.2.2 Ineffective Flow

Portions of the river system which do not actively convey flow shall be accurately represented in the model. These are known as ineffective flow areas. Examples include eddies and slackwater areas behind large obstructions, as well as those areas above or below hydraulic structures where water is not being conveyed downstream. The ineffective flow areas option in HEC-RAS shall be used to render flow in these areas ineffective. Practitioners shall follow guidance outlined in the HEC-RAS Users Manual and Hydraulic Reference Guide.

Determination of ineffective flow areas in the vicinity of bridges and/or culverts depends on flow expansion (ER) and contraction (CR) ratios (Figure 15). This ratio represents the extent of ineffective flow along the channel per unit of length of ineffective flow across the channel. These factors are used to determine the distance above and below the structure that a portion of the flow is rendered ineffective. The practitioner shall follow guidance found in the USACE *HEC-RAS Hydraulic Reference Manual*. Examination of the specific structure and its placement in relation to the channel and floodplain, along with engineering judgment is also required when establishing ineffective flow areas. In many cases a 1:1 CR and 2:1 ER are used.

#### 4.5.2.3 Hydraulic Structures

When modeling bridges and culverts, a minimum of four cross sections are required to represent the hydraulic performance of the structure and impact to water-surface elevations. Figure 15 is a schematic of the required sections from chapter 5 of the USACE *HEC-RAS Hydraulic Reference Manual*.



**Figure 15: Cross section layout for modeling bridges (after USACE, 2010)**

Cross sections 1 and 4 should be placed far enough up and downstream of the structure to be outside of the extent any flow expansion or contraction, as well as ineffective flow, caused by the structure. Cross sections 2 and 3 should be placed near the upstream and downstream faces of the structure, usually at the toe of the associated roadway embankment.

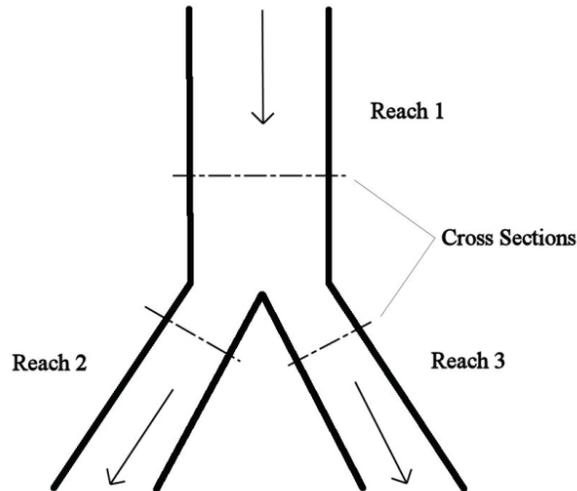
The shape, location, and dimensions of bridge piers must also be included in the model. For those bridges and culverts built on a skew, the skew angle must be calculated and entered into HEC-RAS to reduce the open area available for flow. The bridge high and low chord data must be determined and entered into the model. Survey data or as-built drawings should be used to determine the overtopping elevation of the bridge deck. If guard rails or fencing exists on the bridge, it may be appropriate to use the top of these features as the high chord elevation, depending on their ability to trap debris and/or impede flow. Any bridge abutments that block the open area of the bridge must be coded into the model as well.

When modeling culverts, entrance loss coefficients need to be selected that are appropriate to the structure in question. Table 6.3 of the USACE *HEC-RAS Hydraulic Reference Manual* provides guidance on values for various culvert configurations. The exit loss coefficient is commonly assumed to be 1.0.

At least one cross section is required to correctly model an inline weir placed in the channel. This section shall be placed upstream of the structure to allow the model to correctly calculate the impact of the weir on water-surface elevations.

#### 4.5.2.4 Split Flow

In many stream systems bifurcated or split flow occurs when multiple channels with unique channel inverts and water-surface profiles form within a larger floodplain. In this situation, it is necessary to use a split flow approach to more accurately estimate independent hydraulic conditions in each channel. The modeler shall use a defined junction and separate stream reaches to represent the situation if conditions warrant. See Figure 16 for an example of a split flow situation, including an example cross section layout. The model performs an iterative calculation process to determine the magnitude of flow in each channel.



**Figure 16: Split flow configuration**

Another flow split situation occurs when water leaves the main channel along an extended length and enters another channel, a storage area or travels as overbank flow. In this situation, a lateral weir shall be used adjacent to the channel to more accurately represent this type of split. In this case, the lateral weir should be laid out along the high points of the anticipated overtopping section. It should be noted that in many cases flow will not only leave but reenter the main channel along this split reach. The modeler shall associate lateral weirs with the appropriate “losing” stream for a steady-state model. For unsteady-state flow models such as the Carson River the model can assess flow in both directions over the weir.

#### 4.5.2.5 Weir Flow

Flow over lateral weirs and hydraulic structures is sensitive to the weir coefficient used. This coefficient represents both the form (broad-crested, rectangular, etc.) of the weir as well as the resistance to flow created by the roughness of the weir surface. Hence, a concrete floodwall would tend to have a higher weir coefficient, resulting in higher discharge, than a vegetated earthen levee. Appropriate weir coefficient values can be found in the USACE *HEC-RAS Hydraulic Reference Manual*. Lateral weirs shall be used at any point along the river where water “breaks out,” or intermittently leaves and re-enters the channel.

#### 4.5.2.6 Storage Areas

Storage areas shall be used to represent the overbank region in areas where velocities are low to zero and water-surface elevation is better approximated by volumetric calculations. Examples include offline ponds and detention basins. These areas should be connected to the main channel and/or adjacent

storage areas using lateral weirs placed the high points of the channel bank, and an elevation/storage curve or other representative function to represent the storage area.

### **4.5.3 Boundary Conditions**

For 1-D, unsteady-state flow modeling on the Carson River, there are several boundary conditions that may be used at the modeler's discretion. The following discussion is a summary of the principal types of boundary conditions anticipated for the Carson River. In general, however the modeler shall use regional hydrology developed by CWSD for the purposes of modeling the Carson River. Updates may be available and the practitioner shall contact CWSD to obtain the most current hydrology for input to the model. For specific guidance on entering data and boundary conditions not covered in this Guide, refer to chapter 8 in the latest version of the *HEC-RAS River Analysis System Users Manual*.

#### **4.5.3.1 Flow Hydrograph**

As described in Section 5, a series of flow hydrographs have been developed at USGS stream gage locations for the Carson River within the area covered by this Guide. Hydraulic models shall use these hydrographs, where applicable as upstream or downstream boundary conditions. The most common use will be for upstream boundary conditions. In the event that the study reach begins or ends at a location not coincident with USGS stream gage locations, output hydrograph from adjacent models shall be used for boundary conditions.

#### **4.5.3.2 Stage Hydrograph**

Stage hydrographs are similar to flow hydrographs and may also be used as upstream or downstream boundary conditions. These data follow the same direction described above for flow hydrographs.

#### **4.5.3.3 Internal Boundary Stage/Flow Hydrographs**

It is possible to introduce an internal boundary condition in the model to force a stage or flow hydrograph at an area where values are known, such as a USGS stream gage. Modelers shall follow procedures outlined in the flow and stage hydrograph sections above.

#### **4.5.3.4 Rating Curves**

Rating curves are available through USGS, as described in Section 3.2, and may be used as a downstream boundary condition where appropriate. The primary application for the Carson River would be for calibration of known flood events. Rating curves may also be used for modeling theoretical events, where appropriate. For low gradient water-surface profiles the modeler shall use a rating curve only if it is far enough downstream from the study reach to prevent errors introduced by that rating curve.

#### **4.5.3.5 Downstream Boundary Condition**

Normal depth boundary conditions can be used as a downstream boundary condition. Friction slope shall be entered as the water-surface slope in the downstream vicinity of the reach. The boundary condition shall also be applied far enough downstream of the study reach to prevent errors introduced by the normal depth calculations. If a normal depth boundary condition is used as a downstream boundary condition, calibration efforts must be made to ensure that the computed rating matches observed measurements at gage locations, if available for the downstream reach of the model.

#### 4.5.4 Model Calibration

To the extent practicable, HEC-RAS models for the Carson River shall be calibrated to known historic flood events using available high water marks, direct and indirect measurement data, historic event hydrographs and photographs showing flooding extents. Stage data shall be used at downstream and internal model boundaries. The flowing steps, taken from the *HEC-RAS Users Manual Version 4.1*, shall be generally followed for calibration:

1. Run a range of steady-state flow discharges and adjust Manning's n values so that model calibrates to rating curves at USGS stream gages and any known high water marks.
2. Review historic 15 minute flow data and select several flood events to use for unsteady-state calibration. These events shall encompass a wide range of flows (low to high and back to low). Table 1 provides a list of potential calibration events.
3. Adjust storage areas and lateral weirs to produce matches in flow hydrographs.
4. Adjust Manning's n values to produce matches in stage hydrographs.
5. Fine tune Manning's n values using vertical variation capabilities for low to high stages.
6. Verify calibration by running events not used in calibration.

For a complete discussion on calibration see chapter 8 in *HEC-RAS Users Manual Version 4.1*. Modeler shall also follow FEMA Guidelines and Specifications for Flood Hazard Mapping Partners Appendix C, Section C.3.3.4.

#### 4.5.5 Floodway Development

When necessary, regulatory floodways shall be developed following standard modeling procedures outlined in chapter 10 of *HEC-RAS Users Manual Version 4.1* and Appendix C, section C.4 in FEMA's GUIDE.

Because modeling is being performed in unsteady-state flow for the Carson River, mapping partners must receive approval from the FEMA regional project officer and agreement from the communities involved before performing a floodway analysis. Practitioners shall also verify the allowable water-surface elevation rise due to floodway encroachment for all local municipalities covering the project reach. If no standard exists, the NFIP regulation of 1-foot maximum shall be used.

For unsteady-state 1-D modeling, floodways can only be determined using Method 1 as described in the *HEC-RAS Users Manual Version 4.1*. Modelers shall follow the recommended procedure from chapter 10 in *HEC-RAS User's Manual Version 4.1* as follows:

1. Begin with a 1-percent chance flood, calibrated unsteady-state flow plan.
2. Create a steady-state flow plan using the peak flows from the unsteady-state plan results.
3. Perform a steady-state flow encroachment, beginning with Method 4 equal conveyance.
4. Copy the 1-percent chance plan and rename to represent "new" encroached plan.
5. Adjust downstream boundary condition (i.e., hydrograph, rating curve) to reflect target water-surface elevation rise at all stages/flows.
6. Import steady-state flow plan encroachment stations into "new" unsteady-state encroached plan developed in step 4.
7. Run the unsteady-state model and check results against base 1-percent chance model described in step 1.
8. Adjust encroachments as necessary to achieve target water-surface elevation rise throughout the study reach.

#### **4.5.6 Two-dimensional Hydraulic Model Development**

The practitioner shall use FEMA-approved 2-D hydraulic models. Two-dimensional modeling guidelines and procedures shall be covered in future versions of this guide.

### **4.6 Floodplain and Floodway Mapping**

Upon completion of the hydraulic modeling, the resulting water-surface elevations and water-surface extents can be exported to the AutoCAD and/or GIS software environment. Alternately, the hydraulic results can be used directly with HEC-RAS Mapper. Tools included within both software packages conduct an intersection between water-surface elevations extracted from HEC-RAS and the terrain surface, yielding a third representing flooding limits. The process is conducted for each return event, producing a group of floodplain and floodway limits. The practitioner shall select either method described above, document the process, and provide copies in support of the Technical Support Data Notebook (TSDN) deliverable.

The inundation limits reflected by the floodplain and floodway polygons produced by either method described above shall be reviewed by the practitioner. The results generated frequently contain small “pocket islands” that reflect an elevated feature which exists above the modeled water-surface elevation, but does not meet FEMA’s requirements to be maintained as an island of zone X. In addition, the practitioner shall review the data for triangulated danglers on the perimeter of the data set, these appear in the form of triangular sections either dangling to the interior or exterior of the data set as a result of the interpolation between the surfaces. These danglers shall be removed and documented using the best engineering judgment for the study area.

In the event that multiple elevation surface files (mosaicked tiles) are used to support the post processing, the practitioner shall inspect the areas subject to overlap and manually refine the resulting floodplain and floodway line work with respect to the topographic data, reported water-surface elevations, and existing features. This process shall be documented and performed using the best engineering judgment in the areas of occurrence.

The final floodplain and floodway line work shall be compared by the practitioner against project contours to validate the resulting boundary. This entails a comparison of the hydraulic WSEL, floodplain line work location, and governing contours. The practitioner shall document the review process.

#### **4.6.1 FEMA Standards**

The floodplain and floodway products prepared from successful floodplain delineation and cleanup, shall be packaged for delivery by the practitioner, according to the FEMA GUIDE, Appendix L. Digital Flood Insurance Rate Maps (DFIRM) are digital versions of flood maps formatted following FEMA guidelines and specifications. DFIRMs allow communities to view flood insurance rate maps with digital media or through the internet.

Key features of the DFIRM data set that the practitioner shall address are coordination, standards, horizontal and vertical accuracies with controls, data structure, quality control, deliverable format, and metadata. Per FEMA, the DFIRM database specifications contain the following additional defined spatial and non-spatial data items and tables:

- Subbasins with links to discharges, storm data, and regression equations;
- Gages, including rain gages, stream gages, and coastal gages;
- Nodes with links to node discharge data and zipped hydrologic models;
- Profile base lines;
- Overbank flow paths;
- Additional cross section data, including links to a frequency (rating) table and the zipped hydraulic models;
- Additional coastal transect data, including links to the zipped coastal models;
- Primary frontal dunes;
- Modeled coastal shorelines;
- Outline of the studied area(s) with links to FEMA case information;
- Photographs, sketches, and similar documents linked to spatial features;
- Documentation for variable data that may be developed for the flood study/mapping project (e.g., topographic data, land use, soils, roughness);
- Zipped files containing general information on methodology (e.g., Technical Support Data Notebook defined in Appendix M of the GUIDE); and
- Zipped Flood Insurance Study (FIS) report components (e.g., FIS text, flood profiles, floodway data tables).

The practitioner shall comply with the DFIRM standards listed above and use the FEMA DFIRM database prototype to support the product development for the Carson River. The practitioner shall refer to the FEMA website directly to inquiry for changes or updates to requirements.

[http://www.fema.gov/plan/prevent/fhm/dfm\\_dfhm.shtm](http://www.fema.gov/plan/prevent/fhm/dfm_dfhm.shtm)

A copy of the DFIRM database prototype can be downloaded directly from FEMA at the following location:

<http://www.fema.gov/library/viewRecord.do?id=3175>

The practitioner shall prepare the digital DFIRM database using metadata per FEMA requirements listed in the GUIDE, Appendix L, Section L.6 and or L.8. The metadata examples for draft digital data identify the requirement of the following key components of product identification and information:

- Citation Information
- Project Description with Abstract and Purpose
- Time Period of Content
- Status
- Spatial Domain
- Keywords
- Place
- Access Constraints
- Use Constraints
- Point of Contact
- Native Data Set Environment
- Cross Reference
- Data Quality Information
- Spatial Data Organization Information
- Spatial Reference Information
- Entity and Attribute Information

- Distribution Information
- Metadata Reference Information

#### **4.6.2 Work Map Components**

The practitioner shall prepare topographic and aerial photographic work maps in support of the TSDN for submittal to FEMA. The practitioner shall develop an index map depicting the study area. The index map shall include project full name or title, agency project reference number, practitioner project number, study limit explanation, description of authority for study, communities/town/cities/or tribes participating within the study area, elevation reference mark or benchmark elevation control data, project title, north arrow, scale bar, survey and aerial photography collection methods and standards utilized. The date of production shall be included upon the final products (including the cover sheet).

The work maps shall be prepared in full size format (24"x36") in portrait or landscape format and index, key legend, project full name or title, agency project reference number, practitioner project number, north arrow, scale bar, and a index map depicting the relative location for the panels focus with the study area.

The work maps shall be prepared using a standard engineering scale, selected using best engineering judgment for the display of data prepared in support of the study area. Examples of standard engineer scale are 1"=200' for 1"=400' for the viewport map scale. Additional FEMA requirements for mapping related products can be found in the GUIDE, Appendix M, Section M.2.1 through M.2.3.

The resulting work maps shall be signed by a registered professional engineer (within the state of study analysis) in support of the TSDN deliverable to FEMA. The practitioner shall prepare both electronic and hard copies for both the coversheet and work maps products.

## 5 MODEL STORAGE AND MANAGEMENT

CWSD is currently participating in the FEMA Cooperating Technical Partners (CTP) program. The goal of this program is for local communities, participating in NFIP, to take an active role in maintaining up-to-date flood hazard maps for their respective jurisdictions. CWSD shall act as the clearing house for any up-to-date hydraulic models for the Carson River intended to update flood hazard mapping through FEMA. CWSD will store and manage models to make certain that land use changes have been incorporated and impacts have been reviewed by stakeholders and respective interested municipalities. Copies of completed models will be distributed by CWSD to any parties interested in making land use changes. This Guide will serve as the basis for any changes to these models. Once changes have been made a new proposed condition version shall be delivered back to CWSD for updates to the database. Additionally, any updates to hydrologic data along the study areas covered in this Guide shall be submitted to CWSD for review and incorporation into the database.

Modeling additions or changes for the project area shall be documented based on FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners Appendix M: Guidance for Preparing and Maintaining Technical and Administrative Support Data*. Updates/additions to the model and associated reporting shall be archived at both the CWSD and FEMA as study reaches are completed.

## 6 REFERENCES

- Arcement, G.J. and Schneider, V.R., 1989 Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains: USGS Water Supply Paper 2339.
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- U.S. Army Corps of Engineers, 2010, *HEC-RAS River Analysis System Hydraulic Reference Manual Version 4.1*, Hydrologic Engineering Center, CPD-69.
- U.S. Geological Survey, 1982, *Guidelines for Determining Flood Flow Frequency*, Bulletin #17B of the Hydrology Subcommittee.

APPENDIX A: Manning's Roughness Tables from HEC-RAS Users Manual

**Table 3.1**  
**Manning's 'n' Values**

Type of Channel and Description	Minimum	Normal	Maximum
<i>A. Natural Streams</i>			
<b>1. Main Channels</b>			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150
<b>2. Flood Plains</b>			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
<b>3. Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged</b>			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070

**Table 3.1 (Continued)**  
**Manning's 'n' Values**

Type of Channel and Description	Minimum	Normal	Maximum
<i>B. Lined or Built-Up Channels</i>			
<b>1. Concrete</b>			
a. Trowel finish	0.011	0.013	0.015
b. Float Finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunit, good section	0.016	0.019	0.023
f. Gunit, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	
h. On irregular excavated rock	0.022	0.027	
<b>2. Concrete bottom float finished with sides of:</b>			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
<b>3. Gravel bottom with sides of:</b>			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
<b>4. Brick</b>			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
<b>5. Metal</b>			
a. Smooth steel surfaces	0.011	0.012	0.014
b. Corrugated metal	0.021	0.025	0.030
<b>6. Asphalt</b>			
a. Smooth	0.013	0.013	
b. Rough	0.016	0.016	
<b>7. Vegetal lining</b>	0.030		0.500

**Table 3.1 (Continued)**  
**Manning's 'n' Values**

Type of Channel and Description	Minimum	Normal	Maximum
<i>C. Excavated or Dredged Channels</i>			
<b>1. Earth, straight and uniform</b>			
a. Clean, recently completed	0.016	0.018	0.020
b. Clean, after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
<b>2. Earth, winding and sluggish</b>			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and clean sides	0.030	0.040	0.050
<b>3. Dragline-excavated or dredged</b>			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
<b>4. Rock cuts</b>			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
<b>5. Channels not maintained, weeds and brush</b>			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.100	0.140

**DRAFT**

# Model Management, Distribution, and Update Guide

Carson River Regional Hydraulic Model

*Alpine County, CA, Douglas County, NV, Carson City, NV  
and Lyon County, NV*

**March 2017**

Prepared for  
Carson Water Subconservancy District



HDR Project Number: 10019907





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- Appendix A: Model Request Form
- Appendix B: Modeling Submission Form
- Appendix C: Quality Control Review Form



## Acronyms and Abbreviations

0.2-percent	0.2 percent annual chance flood
1-percent	1 percent annual chance flood
1D	one-dimensional
2D	two-dimensional
CWSD	Carson Water Subconservancy District
FEMA	Federal Emergency Management Agency
GB	gigabyte
HDR	HDR Engineering, Inc.
HEC-RAS	Hydrologic Engineering Center's River Analysis System
model	Carson River Regional Hydraulic Model
PMR	physical map revision
TB	terabyte
US-95	U.S. Highway 95
USGS	U.S. Geological Survey



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# 1 Introduction

As part of continuing efforts to provide sound floodplain management in the Carson River Watershed, the Carson Water Subconservancy District (CWSD) is developing detailed hydrology, hydraulic models, and floodplain mapping for the East Fork, West Fork, and main stem of the Carson River in Carson City, Lyon County and Douglas County in Nevada, and a small portion of Alpine County in California.

## 1.1 Modeling and Mapping Goals and Objectives

CWSD contracted with HDR Engineering, Inc. (HDR) to develop a detailed hydraulic model for the Carson River Corridor, the goal of which is to provide revised, updated flood hazard mapping for the West Fork, East Fork and main stem of the Carson River from the lower sections of Alpine County, CA to Lyon County, NV. This modeling and mapping is being submitted to the Federal Emergency Management Agency (FEMA) for a physical map revision (PMR) to major portions of Lyon County, Carson City, and Douglas County panels.

A secondary goal of the modeling is to provide a complete and consistent tool to assess cumulative impacts of regional and local changes to the floodplain corridor. These may include encroachments, stormwater improvement projects, or land use changes within the floodplain. Using the model to assess the timing, volume, and peak flow impacts of proposed projects ensures the evaluation and possible mitigation of flood hazards to downstream communities, loss of riparian habitat and floodplain function, and degradation of water quality.

When completed, the model will represent a single tool to help water resource practitioners in the public and private sectors comply with National Flood Insurance Program (NFIP) guidelines and regulations as well as meeting local floodplain management objectives for the multiple communities that are impacted by flooding events on the Carson River.

## 1.2 Project Area

The downstream terminus of the Carson River Regional Hydraulic Model (Regional Model) is approximately 4 miles upstream of the U.S. Highway 95 (US-95) bridge crossing in Lyon County, Nevada. The approximate upstream extent for the West Fork of the Carson River is the U.S. Geological Survey (USGS) stream gage at Woodfords, California (ID #10310000), in Alpine County, California. The approximate upstream extent for the East Fork of the Carson River is the USGS stream gage near Gardnerville, Nevada (ID #10309000), in Douglas County, Nevada (**Figure 1**).

## 1.3 Model Development

HDR developed the overall model in three phases with each piece approximately covering the Lyon County, Carson City, and Douglas County areas (**Figure 1**). Phase 1 covers the reach of the Carson River from approximately Dayton, NV down to 4 miles above US-95. Phase 2 includes the reach of the Carson River from the USGS Carson City stream gage down to

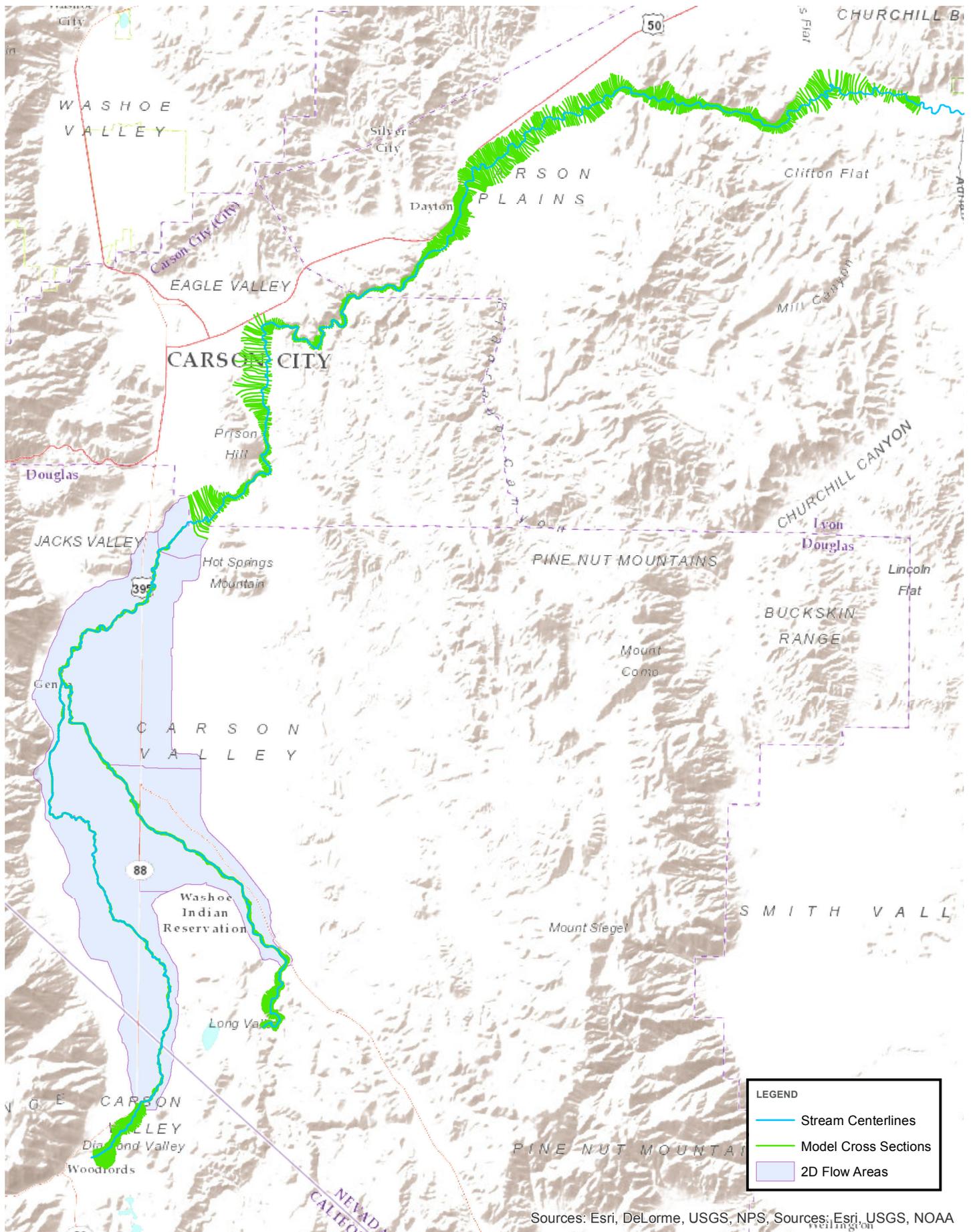


Dayton, NV. Phase 3 extends from the USGS stream gages on the East and West forks of the Carson River downstream to the USGS stream gage at Carson City.

After completion of each of the three phases, the models were submitted to FEMA for a Physical Map Revision.

## **1.4 Purpose of this Guide**

This document provides guidance regarding the management, distribution, modification, submission, and review of the model. It describes procedures associated with requesting a copy of the model; requirements for modifying, running, and submitting the model; and describes the review process that occurs after submission of a revised model version.



Sources: Esri, DeLorme, USGS, NPS, Sources; Esri, USGS, NOAA

**CARSON RIVER PHYSICAL MAP REVISION  
FULL MODEL EXTENTS**

**LEGEND**

- Stream Centerlines
- Model Cross Sections
- 2D Flow Areas



FIGURE 1

## 2 Model Components

### 2.1 Model Version

HDR completed the model using the U.S. Army Corps of Engineers' (Corps) HEC-RAS, Version 5.0.3, which was released in September 2016. This or later versions of the software should be used for any modifications.

### 2.2 Model Completion Dates

Originally developed in three phases, HDR will ultimately combine each phase of the model into a single HEC-RAS model after FEMA's approval of each phase. HDR completed the modeling of Phase 1 in May 2012, Phase 2 in April 2014, and Phase 3 in December 2016.

### 2.3 Model Type and Setup

Phases 1 and 2 of the model extend from the Carson City USGS stream gage downstream to Lahontan Reservoir. The modeling tool selected for use on the portion of the Carson River MAS 1 and 2 areas shown on Figure 2 was HEC-RAS 4.1.0. Both of these phases use only one-dimensional (1D) model components for a number of reasons. The Carson River in this area generally consists of a well defined main channel with relatively small floodplain areas. This lends itself to the use of a 1D model. Phase 3 includes the main stem of Carson River upstream of the USGS Carson City stream gage, as well as the East and West forks of the Carson River upstream to the Gardnerville and Woodfords USGS gages, respectively. This portion of the Carson River has very complex floodplain conditions with highly bifurcated flow patterns that are very challenging to model with a one dimensional modeling tool due to the number of independent and commingling split flow patterns that arise during larger events. When the original FEMA model was developed in the early 1980s for Douglas County, these complex flow patterns required the original study contractor (Soil Conservation Service) to make many simplifying assumptions and split flow analyses to attempt to capture these complex dynamics using the one-dimensional modeling tool (WSP-2) that was available to them at the time. In the current state of the art, we now have the ability to model these types of flow complexities using a two-dimensional model combined with far superior topographic data than was available to the SCS. This provides the ability to capture these complex flow dynamics with a much higher degree of confidence in the results.

The modeling tool selected for use on the portion of the Carson River MAS 3 area shown on Figure 2 is HEC-RAS 5.0.3. The model developed with this tool uses a one-dimensional domain to represent the primary channel and associated bridges with two-dimensional (2D) domains to represent the overbank portions of the floodplain. Overbank flows in the Carson Valley are generally shallow, bifurcated flows with relatively low velocity and unpredictable flow patterns. The presence of many agricultural berms that often wash-out during flooding events are what cause many of the unpredictable flow patterns.



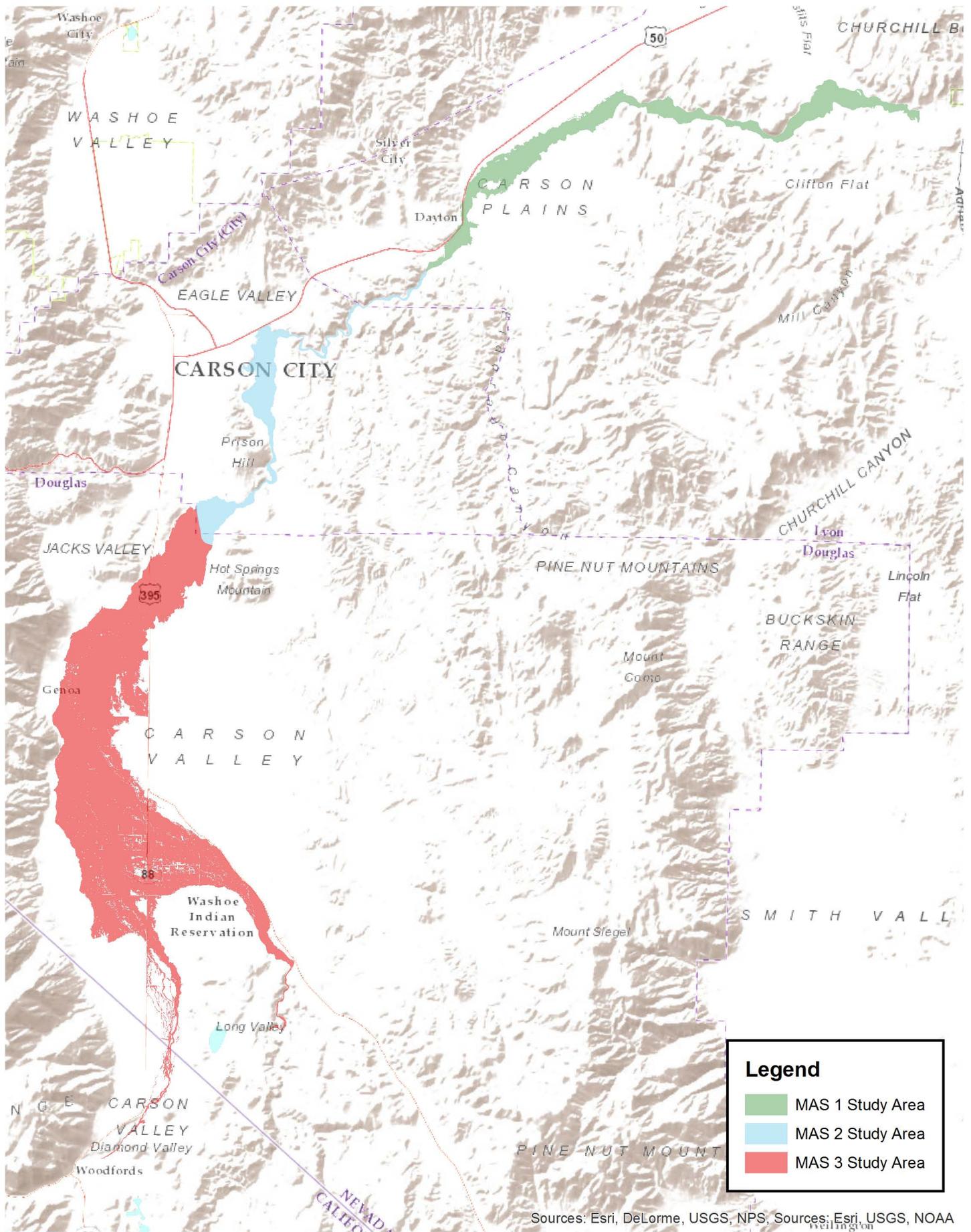
The current model has three plans included in the overall project. The following plans will be available for public use:

- The 1 percent annual chance (1-percent) Zone AE floodplain plan;
- The 0.2 percent annual chance (0.2-percent) Zone X floodplain plan; and
- The 1 percent annual chance floodway plan.

## 2.4 Summary of Files Stored

The model consists of a set of several types of files, all of which are required to successfully run the model and review results. These files include the following:

- \*.prj – Project file, contains current plan files, project units, and project description
- \*.g01 – Geometry file, contains all model components that represent physical features, such as cross-sectional data, hydraulic structures, 2D flow areas, etc.
- \*.u01 – Unsteady flow file, contains inflow hydrographs, initial conditions, and boundary condition information
- \*.dss – Time series data file, can contain inflow information for a model run, or can also contain output results
- \*.p01 – Plan file, directs which geometry and flow files will be used during a model run, also controls simulation time frame, computational time step, and other model parameters
- \*.O01 – Output file, contains computed results for the associated plan
- \*.hdf – Binary data storage file, can be a 2D output file, which contains time series results data for 2D and some 1D model components. Is also used to store data about terrain datasets.
- \*.tif – Graphics file, contains spatial data associated with a terrain dataset.
- \*.vrt – Visualization file that specifies the layers used in a terrain dataset or a results map



**Legend**

- MAS 1 Study Area
- MAS 2 Study Area
- MAS 3 Study Area

Sources: Esri, DeLorme, USGS, NPS, Sources; Esri, USGS, NOAA

**CARSON RIVER REGIONAL MODEL  
MAS 1, 2 AND 3 STUDY AREAS**

FIGURE 2





## 3 Model Storage

### 3.1 Location of the Model Files

The most up-to-date model files will be stored on CWSD premises, or in an online storage facility of their choosing. The model may also be stored on external hard drives at CWSD for distribution.

### 3.2 Data Storage Requirement

Due to the 1D/2D nature of the model and the regional extents of the model, it is anticipated that model file sizes will be relatively large for model input and particularly output files. Each plan and associated output can easily be 10s of gigabytes (GB) worth of data. Therefore, CWSD will house the base model geometry and any subsequent updates on a minimum 1 terabyte (TB) server drive. Model users will need to have access to computer storage in the range of 20 gigabytes to accept and run the model successfully.

## 4 Model Distribution

A primary selection criterion for the modeling platform was that the tool had to be a well supported, free, public domain software package in order to ensure that there were no financial or access limitations to stakeholders or practitioners using the model. HEC-RAS is public domain software that is free to download and use, with well supported documentation and widespread use in the industry. Therefore, the model is available to practitioners for the purposes of evaluating proposed projects in the floodplain corridor.

It is the vision of the CWSD however, that final modifications, updates and quality checks of any proposed conditions within the model area will be conducted by a qualified consultant under contract with the CWSD. This is to ensure consistent, correct updates to the model.

### 4.1 Model Distribution Fee

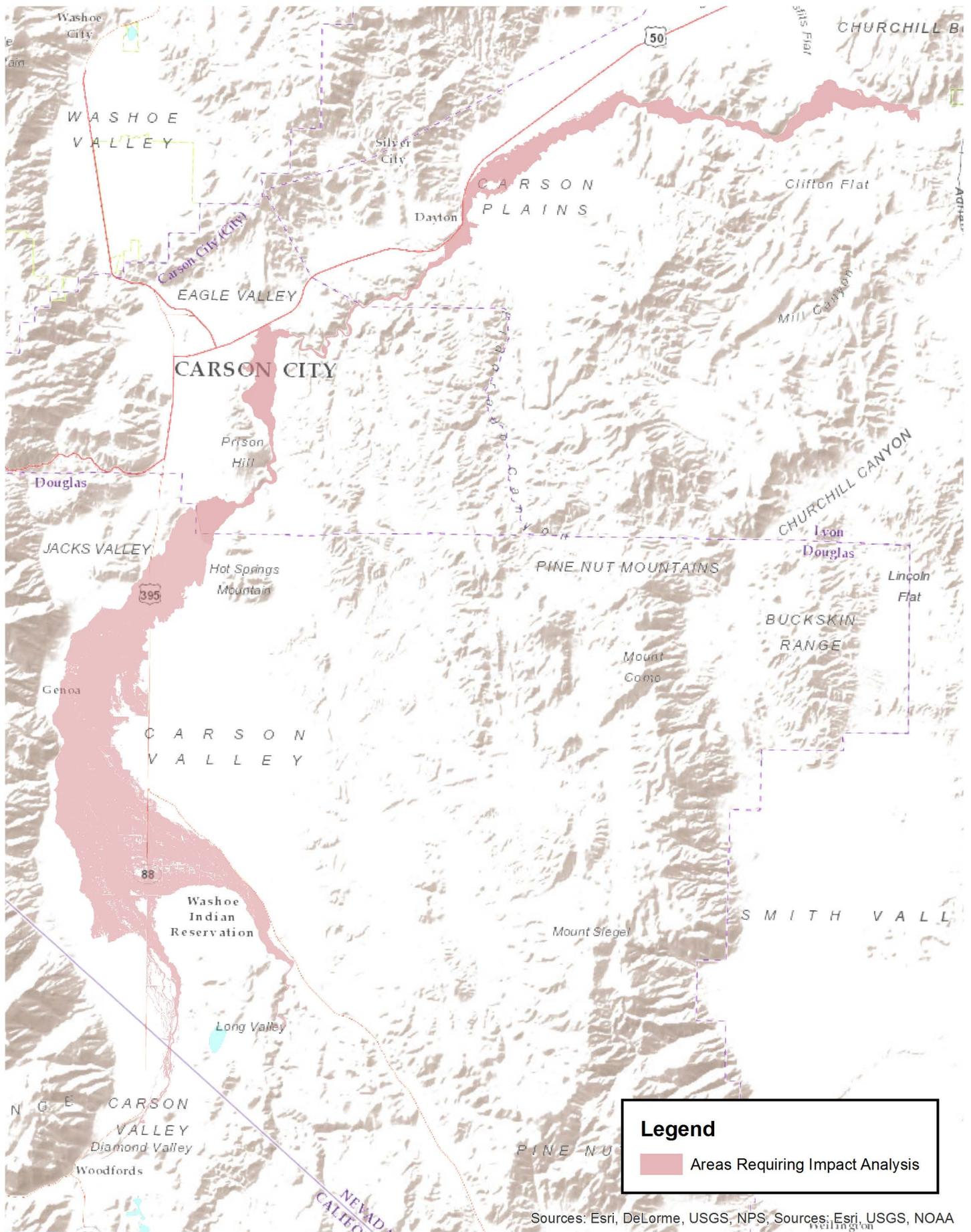
In order to pay for updates and maintenance of the Regional Model, the CWSD will charge a modeling use fee to be determined in future ordinance updates by affected communities.

### 4.2 Projects Requiring Modeling

One of the main modeling objectives as defined by the CWSD and cooperating municipalities is to track the hydraulic and hydrologic impacts of land use changes, civil drainage projects, or development throughout the entire Carson River Corridor. Future ordinance revisions will require the use of this model to incorporate changes and assess hydraulic impact for all areas within the newly established Flood Hazard Areas. This includes all Zones A, AE, AH, AO, and Floodway.

Upon FEMA approval of these revised flood zones and model, FEMA regulatory requirements will be in effect for all areas shown on the current FEMA effective Flood Insurance Rate Maps.

**Figure 3** is a map showing the model proposed areas that will require a flood impact analysis. These boundaries have not yet been approved by FEMA and may therefore change as a result of the technical review and acceptance process. Therefore, this model would be considered preliminary by FEMA but also be treated as “best available information” with regard to compliance with 44 CFR 60.3. A project proponent would likely be required by FEMA to evaluate the impacts of their proposed project with both the existing effective model and the preliminary model. Subsequent sections in the guide describe the process for obtaining, modifying, and submitting the model for review.



Sources: Esri, DeLorme, USGS, NPS, Sources; Esri, USGS, NOAA

**CARSON RIVER REGIONAL MODEL  
AREAS REQUIRING MODEL IMPACT ANALYSIS**

FIGURE 3



### 4.3 Model Request

Although final modifications for proposed projects will be made by a consultant contracted under CWSD, the model may be distributed for project proponents to do alternative analyses or conduct their own impact assessment.

In order to obtain the model, a formal model request shall be made to the CWSD for each project requiring analyses. The requesting party shall obtain an electronic request form from the CWSD website. This request form shall be filled out and submitted electronically, by mail, or in person to the CWSD. The Model Request Form is attached in Appendix A. CWSD staff shall review the model request and distribute the model accordingly. This model will constitute the “Base Model Plan” which will be the basis of comparison for water surface impacts.

### 4.4 Files to be Transferred

Due to their large file size, no output files will be distributed with the model unless a special exemption is approved. Therefore, it is the model consultant’s responsibility to run the “Base Model Plan” once obtained to generate hydraulic output files for comparison purposes. The following files will be transferred to the model requestor:

- \*.prj – The overall project file
- \*.g01 – The 1-percent floodplain geometry file
- \*.g02 – The 0.2-percent floodplain geometry file
- \*.g03 – The 1-percent floodway geometry file
- \*.p01 – The 1-percent floodplain plan file
- \*.p02 – The 0.2-percent floodplain plan file
- \*.p03 – The 1-percent floodway plan file
- \*.u01 – The 1-percent floodplain flow file
- \*.u02 – The 0.2-percent floodplain flow file
- \*.u03 – The 1-percent floodway flow file
- \*.hdf, \*.vrt, and associated \*.tif - The most current existing conditions terrain files
- \*.hdf and associated \*.tif – the most current Manning’s n land use file

These files constitute the necessary files to open and run the model for all three flood hazard areas. Depending on the project type and area, all three plans may not be necessary but all will be provided. The file date and time stamp will be noted in the delivery log and should not be altered by the model recipient.

The model shall be left in the original file folder upon transport to a local server and simply opened and run in HEC-RAS with no alteration to the files to retain original time stamps. Modifications to the model for any proposed conditions will be made on copies of the “Base Model” files within this original folder. This will ensure preservation of the original “Base Model Run.”

The model folder shall be named with the project name, date, and FEMA panel number of the proposed project. This folder shall not be modified and shall be submitted back to CWSD in this format. **Figure 4** is an example of the folder and file structure.

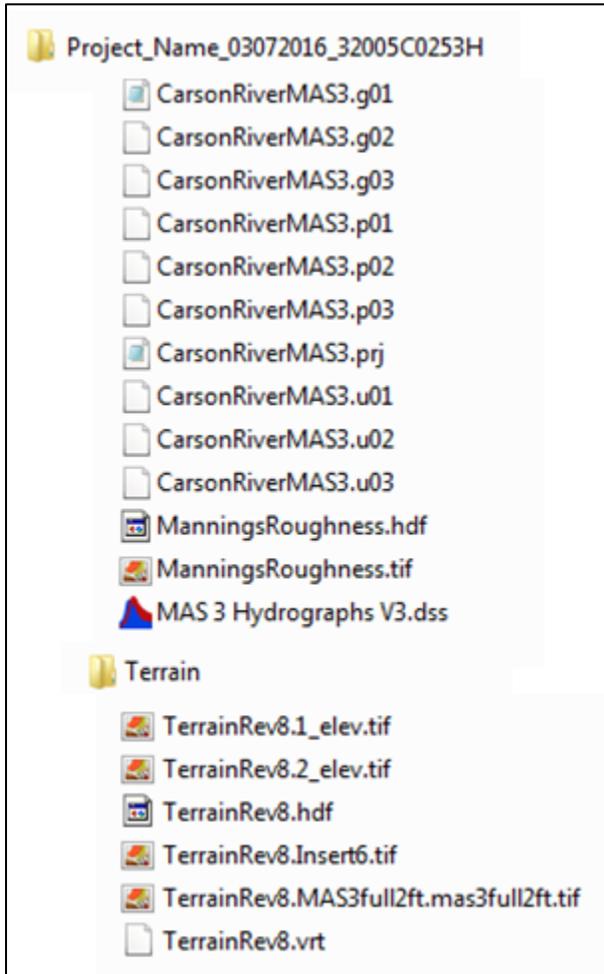


Figure 4: Model delivery folder naming convention

## 4.5 Format of Transfer

Due to large file sizes, the model will be transferred via USB external hard drive. The capacity of the drive should be at least 20 GB. The party requesting the model will provide the drive to CWSD for model transfer.

## 5 Model Modifications

The Modeling Fee described in section 4.1 will be used to contract with a qualified consultant to make final revisions to the model to reflect the proposed project modification to the floodplain based on input from the project proponents. The modeling consultant will follow sound engineering guidelines, up-to-date specifications, regulatory requirements, and modeling best practices in accordance with the latest version of the model and industry standards. The model consultant must ensure the model meets appropriate standards set forth by the review agencies. FEMA's review through the Conditional Letter of Map Revision (CLOMR) process is governed by 44 CFR 60.3 and 65.12.

Since there are three separate models that describe the Carson River within the overall study area, there may be instances where a project's impacts include not only localized impacts but could also result in increases in downstream peak discharges. Also, the hydraulic impacts of a project that is located near the upstream or downstream end of one of the model reaches shown on Figure 2 could result in changes to the water surface elevation or discharge that is the basis of the adjoining model. Should that occur, the proponent may be required to make appropriate modifications to all impacted models for the Carson River or its associated tributaries as represented on the current FIRMs.

### 5.1 Proposed Project Information

The proponent of the proposed project occurring within the Special Flood Hazard Area outlined in Figure 3 shall provide the CWSD with enough information about the proposed project to accurately update the Regional Model. The project proponent may submit this information in a number of forms including:

- A set of engineering plans for the proposed project
- A proposed conditions HEC-RAS model based on the Regional Model
- A drainage report summarizing proposed changes

If insufficient information is submitted to update the model CWSD will make a request to the project proponent for more information.

### 5.2 Model Modifications

Model modifications shall be made to a copy, within HEC-RAS, of the original "Base Model" plan. As stated in Section 4.4, the model shall be left in the original file folder and simply opened and run in HEC-RAS with no alteration to the files to retain original time stamps. Modifications to the model for any proposed conditions will be made on copies of the "Base Model" files within this original folder. This will preserve the original "Base Model Run".

The consultant shall use the *File > Save As* option to make appropriate copies of the "Base Model" plan, geometry, and flow files. This process shall be followed for all proposed plans used for impact analyses. The new file plan names shall include the date of copy in the name as an eight digit string in the following format: MONTH DAY YEAR (example: 03042016).



Modifications to the model geometries shall be made in accordance with CWSD's *Hydraulic Modeling and Floodplain Mapping Guidelines* (2011) (*Modeling Guide*), which is included in the model delivery package.

For 2D elements not covered in the *Modeling Guide*, modeling changes shall be made to the "Base Model" existing terrain as terrain layers or overlays and/or to the 2D modeling domain as described in the following documents:

- February 2016 *HEC-RAS River Analysis System User's Manual*, Version 5.0 (<http://www.hec.usace.army.mil/software/hecras/documentation/HEC-RAS%205.0%20Users%20Manual.pdf>)
- and
- February 2016 *HEC-RAS River Analysis System 2D Modeling User's Guide*, Version 5.0 (<http://www.hec.usace.army.mil/software/hecras/documentation/HEC-RAS%205.0%202D%20Modeling%20Users%20Manual.pdf>) or later versions.

Consultants shall also follow best practices outlined in the February 2016 *HEC-RAS River Analysis System Hydraulic Reference Manual*, Version 5.0 (<http://www.hec.usace.army.mil/software/hecras/documentation/HEC-RAS%205.0%20Reference%20Manual.pdf>) or later versions.



## 6 Model Run

As described in Section 5, the CWSD contracted consultant shall run the “Base Model” and any “Proposed” model plans in the originally provided modeling folder with no alteration to the “Base Model” plans. Consultants shall run the model in unsteady-state mode with a subcritical or mixed-flow regime (if necessary for model stability). Modeling time steps shall be chosen to satisfy the Courant Condition in the specific plan or smaller to stabilize the model run. Consultants shall use default “Calculation Options and Tolerances” unless modification is necessary for model stability or as a best practice described in the *Modeling Guide*.

### 6.1 Operation System Requirements

At the time of this guide’s publication, HEC-RAS, Version 5.0.3 runs on the following operating systems: Windows XP, Vista, 7, 8, 8.1, and 10. Both 32-bit and 64-bit versions are supported. HEC-RAS can be run on a desktop PC. Following are minimum hardware requirements with recommended parameters shown in parentheses.

- Intel-based PC or compatible machine with Pentium processor or higher (Intel I3 or higher with multiple cores is recommended)
- Hard drive with at least 5-10 GB of free space
- Minimum of 2 GB of RAM (4 GB or more recommended)
- Mouse, touch pad or touch screen
- Color Video Display (Recommend running in Super VGA (1024x768) or higher, and as large a monitor as possible)

### 6.2 Run Times

It is anticipated that with the combined 1D/2D model, run times for the Douglas County, Nevada portions of the model may be in the 10 to 20 hour range or longer depending on model iteration and level of model instability. For final plans submitted to CWSD, modelers shall run the entire hydrograph event for the same time period as the “Base Model” run. Modelers should allow enough time to anticipate up to a 24-hour run time depending on the chosen time step and changes to the model that may cause instabilities.



## 7 Model Submission

CWSD's long-term goal for this modeling effort is to be the clearinghouse for distributing and updating this Regional Model. CWSD will collect and store the most current versions of the model after completion of each proposed project has been integrated into the model by the CWSD contracted consultant.

CWSD is not responsible for submitting this model to any regulatory agencies or municipalities on behalf of the project proponent. CWSD will provide a final updated version to the project proponent in the format described in section 4.4 of this document for their use in regulatory requirements.

### 7.1 Items to be Submitted to CWSD by the Consultant

#### 7.1.1 Modeling Memorandum

The model consultant shall submit a brief memorandum describing the proposed conditions model changes and a summary of impacts to water surface elevations, flow magnitudes, and flow patterns as appropriate.

#### 7.1.2 Modeling Files

Upon completion of the proposed conditions model and finalized runs for both the existing and proposed condition models, model consultants shall submit the final modeling folder. This folder shall be identical to the one described in Section 0 with the addition of the following for proposed conditions modeling and output files as appropriate:

- New plan(s) (\*.p0\*)
- New geometry(s) (\*.g0\*)
- New flow(s) (\*.u0\*)
- Revised project (\*.prj)
- Output files (\*.00\*),
- DSS files (\*.dss)
- HDF files associated with each plan (\*.p0\*.hdf)
- Proposed terrain Files (\*.hdf, \*.tif, and \*.vrt)
- Proposed Manning's n files (\*.hdf and \*.tif)
- RASMapper files (\*.rasmap)
- Output folders generated by HEC-RAS

#### 7.1.3 Internal Quality Check of Modeling

Model consultants shall submit evidence that a model internal quality check (QC) was completed.

#### 7.1.4 Submission Forms

Model consultant shall fill out and submit the Modeling Submission Form contained in Appendix B.



## 7.2 Submission Format

Model consultants shall deliver submissions to CWSD on an external hard drive, thumb drive or DVD.



## 8 Model Finalization

### 8.1 CWSD Review and Sign Off

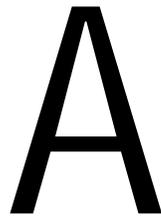
After submission of the final proposed conditions model and technical memorandum, the CWSD will review the documentation to ensure completeness of the submission package, consistency of the technical memorandum, and compliance with the intent of this guide. The CWSD will not comment on any technical modeling aspects but will review the impacts to hydrology and hydraulics as stated in the technical memo.

The CWSD will make comments on the technical memorandum as appropriate and submit to the consultant and project proponent. The consultant will then respond to any CWSD comments and makes the necessary revisions to the technical memo. CWSD will ensure that the memo revisions provide an acceptable resolution of the comments. Once all comments and revisions have been accepted, the CWSD reviewer will close out the QC review, sign and date the form, and store it electronically with the model version.

Floodplain regulatory compliance review responsibility lies with each of the NFIP communities impacted by the proponent's project. The project proponent should be prepared to address the requirements from multiple jurisdictions if the impacts of a proposed project have systemic impacts to the Carson River rather than just localized impacts. The responsibility for obtaining such approvals from each impacted jurisdiction lies with the project proponent.

### 8.2 Model Packaging and Archiving

After all QC comments and responses are closed out, the model, technical memo, QC comment sheets, and all associated digital files will be zipped into a compressed folder and archived at CWSD. The zipped folder will have the same name and format as described in **Figure 4** with the addition of the files described in Section 7.1.2.



A

Model Request Form



# Carson River Regional Model

## Model Request Form

Project Name		Date	
--------------	--	------	--

### Requester Information

Name	
Agency/Firm	
Position	
Address	
Phone	
Email	
FIRM Panel Number	

Township		Range		Section	
----------	--	-------	--	---------	--

### Project Description

--

Signature		Date	
-----------	--	------	--



**B**

Modeling Submission Form



# Carson River Regional Model

## Model Submittal Form

Project Name		Date	
--------------	--	------	--

### Requester Information

Name	
Agency/Firm	
Position	
Address	
Phone	
Email	
FIRM Panel Number	

Township		Range		Section	
----------	--	-------	--	---------	--

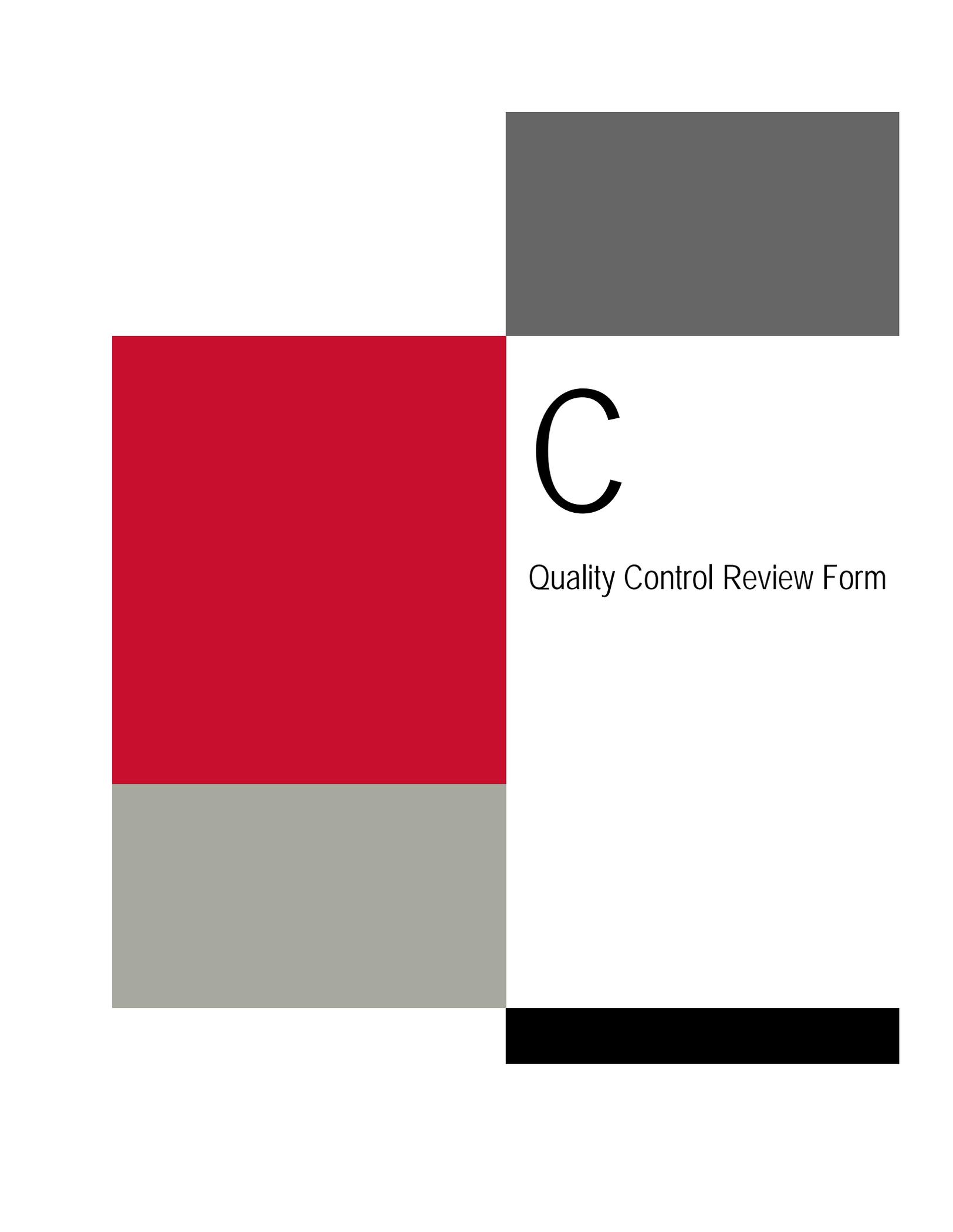
### Model Revision(s) Description

--

### Submittal Format

Disk	<input type="checkbox"/>	Thumb Drive	<input type="checkbox"/>	External Drive	<input type="checkbox"/>
------	--------------------------	-------------	--------------------------	----------------	--------------------------

Signature		Date	
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C

Quality Control Review Form



## **Appendix G**

### **CRS Annual Monitoring Reports**

**CRS ANNUAL REPORT**  
**(Period of July 1, 2016 to June 30, 2017)**

On Activities Associated with the

**Carson River Watershed**  
**REGIONAL FLOODPLAIN MANAGEMENT PLAN**

Submitted for:

**DOUGLAS COUNTY**  
and  
**CARSON CITY**  
and  
**STOREY COUNTY**

September 22, 2017

Prepared by:



**Brenda Hunt, Watershed Program Manager**  
**Deborah Neddenriep, CFM, Water Resource Specialist 2**

**Carson Water Subconservancy District**  
**777 E. William Street, #110A**  
**Carson City, NV 89701**

This annual report provides progress on the [Carson River Regional Floodplain Management Plan's \(Regional Plan\)](#) suggested actions for Carson City, Douglas and Storey County. This report outlines regional floodplain management actions which provide credit for the National Flood Insurance Program's Community Rating System (CRS). July 1, 2016 to June 30, 2017, Regional Floodplain Management work initiated, completed, or administered by the Carson Water Subconservancy District (CWSD) are documented in this report.

### **1.0 Background**

In 2008, the Regional Plan was formally adopted by the boards of the Carson Water Subconservancy District, Douglas, Carson City, Lyon, and Churchill Counties in Nevada, and Alpine County in California to provide a consistent approach to planning efforts, programs and projects, help protect community members from flooding hazards, and conserve floodplain lands. A [Supplemental Update of the Regional Plan](#) was subsequently adopted by these five counties in 2013. A small portion of Storey County is within the Carson River Watershed but its board has not formally adopted the Regional Plan or its Supplemental Update. The Regional Plan and FEMA Discovery update began in mid-2017 and is scheduled to be completed by 2018 (See specifics in Section 2.1.c.1 below).

The Regional Plan's purpose is to create long-term vision and strategies for floodplain management to protect watershed resources and mitigate flood hazard impacts in the Carson River Watershed. The Regional Plan also identifies responsible parties and funding sources for implementation.

The regional plan objectives include the following:

- Manage economic development without sacrificing floodplain and river form and function;
- Ensure public safety upstream and downstream;
- Protect property rights while conserving natural resources;
- Protect and improve wildlife habitat and water quality;
- Provide and maintain river continuity and connection of the river to its floodplain;
- Promote conservation of lands within the river corridor.

In 2006, CWSD became a Cooperative Technical Partner (CTP) with FEMA. Through this program CWSD can apply for FEMA to conduct floodplain mapping, flood studies, mitigation planning, public outreach, and other projects that reduce the flood risk in the Carson River Watershed. Since 2006, CWSD has received seven funding grants from FEMA. Each grant application includes a Mapping Activity Statement (MAS) which identifies the various flood studies and activities that will be accomplished (See specifics in Section 3.3 and 3.5 below).

## **2.0 Activities Conducted for this Reporting Period**

### **2.1 Stakeholder Involvement**

Several stakeholder groups provide watershed level input and assistance in the implementation of the Regional Plan.

#### 2.1. a Carson River Coalition Meetings

The Carson River Coalition (CRC) is a bi-state, multi-county stakeholder group, hosted by the Carson Water Subconservancy District (CWSD) and funded by CWSD and the Nevada Division of Environmental Protection (NDEP). Planners, engineers, floodplain managers, and other staff members from all watershed counties participate in this group. In addition, employees from many other local; state and federal entities; and non-governmental agencies such as conservation districts, State Floodplain Manager, State Division of Emergency Management, FEMA, US Bureau of Reclamation, National Weather Service and The Nature Conservancy participate in CRC working groups with private citizens. CRC meetings are open to the public; meeting information is available at [www.cwsd.org](http://www.cwsd.org).

A two-day CRC Watershed Forum was held on February 22-23, 2017. A conference schedule is available upon request.

#### 2.1. b River Corridor/Floodplain Management Working Group –The River

Corridor/Floodplain Management Working Group is a sub-committee of the CRC with a focus on regional floodplain management issues. This group met three times (7/27/2016, 12/7/2016, and 5/11/2017) during the last year to discuss implementation of river and flood projects, and plans for FEMA funding. Agendas and Meeting notes are available on our website. In addition, a Carson River Regional Flood Management Workshop was conducted March 8, 2017, to discuss best options for mitigating flood risk from a record amount of snowmelt in the Sierra.

#### 2.1.c Federal Emergency Management Agency (FEMA) Risk MAP Program

In 2011, CWSD and various federal, state, and county government bodies signed the first FEMA Region IX Risk MAP Charter formalizing collaborative efforts for flood management in the Carson River Watershed. In October 2016, Storey County became a signatory to the Charter. This collaboration enhances hazard mitigation plans, improves community resiliency after flooding, protects beneficial functions of floodplains, and raises awareness about local flood risks. A RiskMap Charter meeting was held March 8, 2017 to discuss projects CWSD should pursue for FEMA Mapping Activity Statement (MAS) 8 funding and 2017 flooding issues and damages to date. The agenda and meeting notes are available at CWSD.

#### 2.1.c.1 Risk MAP Discovery

In 2011, CWSD working closely with local watershed communities staff members, conducted the Risk MAP Discovery process to better understand the local flood risk, mitigation efforts, etc., and to spur watershed-wide discussions about increasing the area's resilience after flooding. The 2012 Discovery Report identified high flood risk areas and flood hazard solutions, for mitigating risk on a watershed-wide basis and prioritized projects per County. CWSD is updating Discovery report, in conjunction with a Regional Floodplain Management Plan update and both will be completed by 2018.

### **2.2 Low-Level Flooding/Stormwater Management**

The area subject to the General Permit for small Municipal Separate Storm Sewer System (MS4s) initially identified as the Carson City Urban Area by the EPA, is multi-jurisdictional including non-contiguous parts of Carson City, Indian Hills, and Douglas County (Johnson Lane and Clear Creek). Based on 2010 Census data, Douglas County and Lyon County expect areas requiring MS4 permit may increase in the future. No action related to MS4 was taken by CWSD during this reporting period.

#### 2.2.b Promote Low Impact Development (LID) Use in the Carson River Watershed

In April 2015, the CWSD board approved the Low Impact Development in the Carson River Watershed report (LID Report). The report outlines how LID can assist local communities in managing stormwater, underscores LID benefits, discusses useful LID practices in our area, recommends how to implement LID. CWSD staff presented the LID Report to county staff and planning commissions, except in Douglas County. CWSD plans to address Douglas County Planning Commission once LID Report can be placed on their agenda. Planning discussions regarding how best to assist the Counties further with implementation of LID projects have occurred. The *Draft Carson River Adaptive Stewardship Plan Update 2017* identifies LID projects as a management measure to aid water quality improvement. CWSD is keeping a dialogue open with Counties about LID implementation and potential LID project locations.

### **3.0 Implementation of Suggested Actions**

The [Regional Floodplain Management Plan](#) divides implementation strategies into six categories and provides suggested actions for each category. The following sections provide an overview of the work conducted for each category during this reporting period.

#### **3.1 Protect Floodplain Natural Functions and Values and Responsible Entities**

*Progress during this period on Suggested Actions 1 -10 of the Regional Plan include:*

- Weed management and streambank stabilization projects have continued throughout the Dayton Valley reach of the Carson River. Planning continues for additional projects located on both private property and on lands owned by various public entities near Dayton and Ft. Churchill State Park. Areas

damaged by the winter flooding and record water levels were accessed; however, the water remained too high throughout June 2017 to access sites properly for damages, so there may be additional sites located during the next reporting period.

- CWSD helps fund the Alpine Watershed Group (AWG) to continue their work in the Upper Carson River Watershed.
  - AWG has partnered with American Rivers to complete Phase II of the Hope Valley Meadow/Floodplain and West Fork restoration in late 2016. This phase of the project stabilized an oxbow which had been identified as likely to fail. CWSD conducted two site tours in the Spring and Summer of 2017. The project survived the highwater runoff relatively unscathed and is functioning as expected.
  - American Rivers conducted a meadow assessment of the upper reaches and additional restoration sites are being pursued with AWG and USFS partners in Hope, Charity and Faith Valley's.
  - Alpine County finalized the purchase of the Markleeville Creek Floodplain Restoration Project site on 12/23/13. The project is at 95% design and is expected to cost around 1.2 million. Funding continues to be pursued from various sources including California's Department of Water Resources Integrated Regional Water Management (IRWM) grant program, Supplemental Environmental Project funding through the Lahontan Regional Water Quality Control Board, Wildlife Conservation Board, and the Sierra Nevada Conservancy.
  - Last reporting period, AWG and the USFS, USBLM, and Alpine County partnered and completed the restoration, improvement and enhancement of shoreline areas and limited off highway vehicle access along the East Fork of the Carson River between Centerville Flats and Hangman's Bridge. The project focused on providing recreation access while restoring riparian vegetation and limiting future damage. The AWG and USFS are looking at other areas along the East Fork to conduct a similar project.

### **3.2 Higher Regulatory Standards**

CWSD is working collaboratively with County planners and floodplain managers to update local flood regulations.

*Progress during this period on Suggested Actions 11 – 13 of the Regional Plan include:*

- Floodplain Ordinances were drafted which align with the new FIRMs in each county. These draft ordinances will need to be modified per County to incorporate the final model update protocol, any specific mitigation measures, and different (higher) County regulatory standards. The delivery

of updated floodplain ordinances is dependent on effective date of revised FIRMS.

- Protocol and Procedures for Carson River Flood Model was also completed and will also need to be finalized with the counties once the FIRMs become effective.

### **3.3 Flood Data Information and Maintenance**

*Progress during this period on Suggested Actions 14 – 22 of the Regional Plan include:*

- a. MAS 4 completed final phase of the Carson River Physical Map revision supports FEMA’s map modernization program (SA – 15). These maps have been in review since submission in March 2017 with the anticipation they will be effective by the end of 2018. MAS 5 was completed December 2016 and included from the Alpine Creek in Douglas County and the Eagle Valley Drainage in Carson City Restudy and Remapping projects. MAS 6 has been underway since September 2016 and includes Goni Canyon (SA- 15) and Ramsey Canyon in Lyon County Restudy and Remapping.
- b. MAS 4 completion also finalized un-steady state model from Carson Valley in Douglas County through Carson City to Lyon County above Lahonton Reservoir (SA – 14).
- c. CWSD continues to work with FEMA as a Cooperating Technical Partner. It is working on MAS 6 and MAS 7 and has applied for and received funding for MAS 8 (SA- 16).
- d. As part of MAS 7, CWSD is working with the US Army Corps of Engineers to map alluvial Fans in the Carson River Watershed. These alluvial fan maps will be implemented in the Regional Plan.
- e. Douglas, Lyon and Storey County are working with USGS to fly LIDAR as a higher level of detail which can be implemented in future FEMA mapping efforts. This data will be implemented in MAS 8 in Lyon and Storey Counties.

### **3.4 Channel Migration and Bank Erosion Monitoring**

*Progress during this period on Suggested Actions 23 – 29 of the Regional Plan include:*

- CWSD continues to fund Carson Valley Conservation District (CVCD); Dayton Valley Conservation District (DVCD); and Lahontan and Stillwater Conservation Districts (LSCD) to monitor known hazard areas and channel migration to document and update changes to the river channel (SA-23).
- CWSD worked with counties and conservation districts to lobby the Nevada Legislature to fund \$250,000 for the State Clearing and Snagging Fund. Administered by the NWR Division and combined with CWSD funds, this funding was used by local conservation districts to undertake clearing and snagging projects throughout the watershed to assist hazard removal.

- CWSD funded DVCD and CVCD to complete a winter flood damage inventory in federally declared disaster areas and met with FEMA officials in Spring of 2017.
- CWSD assisted in funding CVCD bio-engineering techniques used by the Carson Valley Conservation District and The Nature Conservancy at River Fork Ranch along Brockliss Slough and the East Fork to promote use of non-structural and bio-engineering for river restoration and rehabilitation projects (SA-28).
- CWSD provided match funding for a DVCD monitoring study cataloguing bank stabilization projects completed. Federal funds were provided by NDEP Clean Water Act 319. The project will help determine what projects are still in place and what will need repair. The final report was completed and submitted to NDEP during this reporting period.
- CWSD continues to fund Alpine Watershed Group (AWG) in Alpine County, California. AWG is the first line of defense for flood hazard mitigation in the Watershed. This organization's ongoing work to rehabilitate and restore river function in Alpine County benefits the entire watershed.
- AWG, in partnership with Humboldt-Toiyabe National Forest (USFS), Bureau of Land Management (BLM), Friends of Hope Valley and Alpine County, was awarded a restoration grant from California State Parks' Off Highway Motor Vehicle Recreation (OHMVR) program.
  - Phases I and II of the OHMVR grant project restored riparian habitat along the banks of the East Fork of the Carson River currently impacted by off-road vehicle travel associated with dispersed camping. All restored sites are located on USFS and BLM lands within Alpine County. The project area includes the reach of the East Fork from its confluence with Silver Creek to Hangman's Bridge just east of Markleeville. Implementation began in the fall 2015, the third phase (an ~450 feet bank stabilization project) was completed and finalized during this reporting period.
- The Friends of Hope Valley in partnership with the Alpine Watershed Group continue to plant willow stakes and complete bio-engineering bank stabilization projects with volunteers in Hope Valley. CWSD supports Markleeville Creek Day and the Alpine Aspen Festival with staff assistance and funding so these organizations can continue their monitoring, bank stabilization, and rehabilitation efforts.

### **3.5 Floodplain and Flood Hazard Outreach and Education**

*Progress during this period on Suggested Actions 30 – 34 of the Regional Plan include:*

Progress during this period:

- MAS 5 provided CWSD funding to assist counties in Nevada Flood Awareness Week (FAW) held Nov. 14-19<sup>th</sup>, 2016. CWSD staff met monthly throughout

2016 with the FAW planning committee. Led by Nevada's Floodplain Management office, activities included state and county proclamations, specific events, billboard advertisements and PSAs. Douglas County, Carson City, and Lyon County hosted FAW events.

- With funding from MAS 7, staff is working with the FAW committee monthly to plan and implement Flood Awareness Week (FAW) to be held Nov. 12-17, 2017. A website was created in 2014 and is updated with current information regularly. The website is hosted by Nevada Division of Water Resources (NDWA) at [NevadaFloods.org](http://NevadaFloods.org). The FEMA grant will support additional billboard placement in the Carson River Watershed for 2017.
- MAS 6 funded creation of four "Floodplains as Community Assets" videos (A 30 second PSA, and 3 other short videos aimed toward public officials, the development community, and the agriculture/public) were created during the reporting period. The videos are available on the [Carson River Watershed YouTube Channel](#).
- Watershed website provides link to the Floodplain Management Plan and its updates, on [www.cwsd.org](http://www.cwsd.org).
- County floodplain and emergency manager information are being updated and will be available shortly on the Flood Awareness section on [www.cwsd.org](http://www.cwsd.org).
- Floodplain protection and flooding articles were included in CWSD's newsletter, "Watershed Connections" that is distributed to over 1000 individuals throughout the six counties located in the Carson River watershed.
- Several community events, STEAM nights, and Carson River Work Days were attended by staff where the floodplain model was run and the importance of floodplain protection discussed with adults and students.

### **3.6 Reduction of Infrastructure Impacts**

There are opportunities throughout the watershed for the enhancement and/or design and maintenance of roads, culverts, grade controls, and bridges to accommodate floodwaters better, protect floodplains, and decrease harmful erosion.

Progress made during this period:

- Both Douglas and Lyon County are exploring options for creating a Stormwater Fee to enhance stormwater operations throughout each County. CWSD is supportive of these efforts.
- During this reporting period CWSD met with agricultural producers, the Counties, Nevada State Lands, and FEMA to discuss using FEMA emergency funds to fix/replace and potential upgrade grade structures damaged during winter/spring flooding.

**4.0 Conclusion**

CWSD is working diligently to coordinate the completion of the 38 suggested actions in the Floodplain Management Plan 2008/2013 adopted by the five counties along the Carson River. The County's continued partnerships are essential in implementing these actions.

Please contact CWSD staff with any questions or comments regarding the above report:

Ed James 775.887.7450; [edjames@cwsd.org](mailto:edjames@cwsd.org)

Brenda Hunt 775.887.9005; [brenda@cwsd.org](mailto:brenda@cwsd.org)

Debbie Neddenriep 775.887.1260; [debbie@cwsd.org](mailto:debbie@cwsd.org)

## **Appendix H**

### **2018 Risk MAP Discovery**

# Discovery Report

FEMA Region IX

Carson River Watershed, HUC 16050201, 16050202, 16050203

Alpine County, California  
Douglas County, Churchill County,  
Lyon County, Carson City,  
and Storey County, Nevada



**FEMA**

January 2018

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# 1 EXECUTIVE SUMMARY

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The Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment, and Planning (Risk MAP) projects begin with Discovery. This Discovery Report discusses risk for the Carson River Watershed in Alpine County, California, and Carson City, Douglas County, Churchill County, Lyon County, and Storey County, Nevada. A Discovery Report has two goals: to inform communities of their risks related to natural hazards, and to enable communities to take actions to reduce their risk. The data provided here assists communities become more resilient by updating a variety of local plans, communicating risk, informing the modification of development standards, identifying mitigation projects, and ultimately taking action to reduce risk.

The Discovery process for the Carson River Watershed contacted community stakeholders and collected data. The data collected were reviewed, and discussions were held about recent flood events, areas of new growth, floodplain mapping needs, and desired mitigation projects. The Discovery process is the first of many collaborative steps toward implementation of actions that lead to reduction of risk to life and property.

## 2 GENERAL INFORMATION

---

The Carson River watershed is comprised of approximately 3,965 square miles and includes portions of six counties and two states in east-central California and west-central Nevada, extending for a distance of about 184 miles (Figure 1). The geographic units of the Carson River watershed are:

- Alpine County, California
- Carson City, Nevada
- Churchill County, Nevada
- Douglas County, Nevada
- Lyon County, Nevada
- Storey County, Nevada

The headwaters of the Carson River lie at altitudes of 10,000 to 11,000 feet in the Sierra Nevada Mountain Range (Alpine County). The East and West Forks of the river join to form the main stem of the Carson River in Carson Valley (Douglas County). The river then flows through the Carson River Basin until its terminus at the Carson Sink (3,970 ft) (Churchill County). The Carson River Watershed has become increasingly urbanized, with an increase in both alluvial fan and riverine flooding events over the past few decades. Many communities and flooding sources in the Carson River Watershed have been prioritized in the past for detailed flood studies, and much progress has occurred to identify and mitigate flood hazards. This report is intended to summarize the information gathered as part of the updated Discovery process for the Carson River Watershed.

The U.S. Geological Survey (USGS) defines the Carson River as three separate hydrologic unit codes (HUC) as follows:

- 16050201 Upper Carson
- 16050202 Middle Carson
- 16050203 Lower Carson

Annual streamflow of the Carson River is extremely variable, ranging from a low of about 26,000 acre-ft in 1977 to slightly more than 926,000 acre-ft in water year 2017 near Fort Churchill. Flooding occurs often in the Carson River Basin. Floods in the basin are categorized as main channel flooding, localized (flash) flooding, or debris flows. The majority of main channel flooding is caused by rain-on-snow events in the higher elevations. Rapid snow melt causes the river channel to fill quickly and overflow its banks. Localized flooding, on the other hand, generally occurs in alluvial fans during the summer months, and is caused by intense rainfall during thunderstorms. Debris flows occur when water from rapid snowmelt or intense rainfall mixes with sediment. Flooding in 2017 was a result of repeated large precipitation events followed by nearly continual runoff events.

Approximately 606 square miles of the watershed are located in Alpine County, California, while the remaining 3,359 square miles of the watershed are located in Nevada.

The five hydrographic areas in the Nevada portion of the watershed are:

1. Carson Valley (Minden, Gardnerville, Genoa – Douglas County)
2. Eagle Valley (Carson City)
3. Dayton Valley (Dayton, Virginia City – Lyon County)
4. Churchill Valley (Fallon – Churchill County)
5. Carson Desert (Fallon, Stillwater – Churchill County)

The Clear Creek sub-watershed in Douglas County/Carson City, Nevada is within the geographic boundaries of the Carson River Watershed.

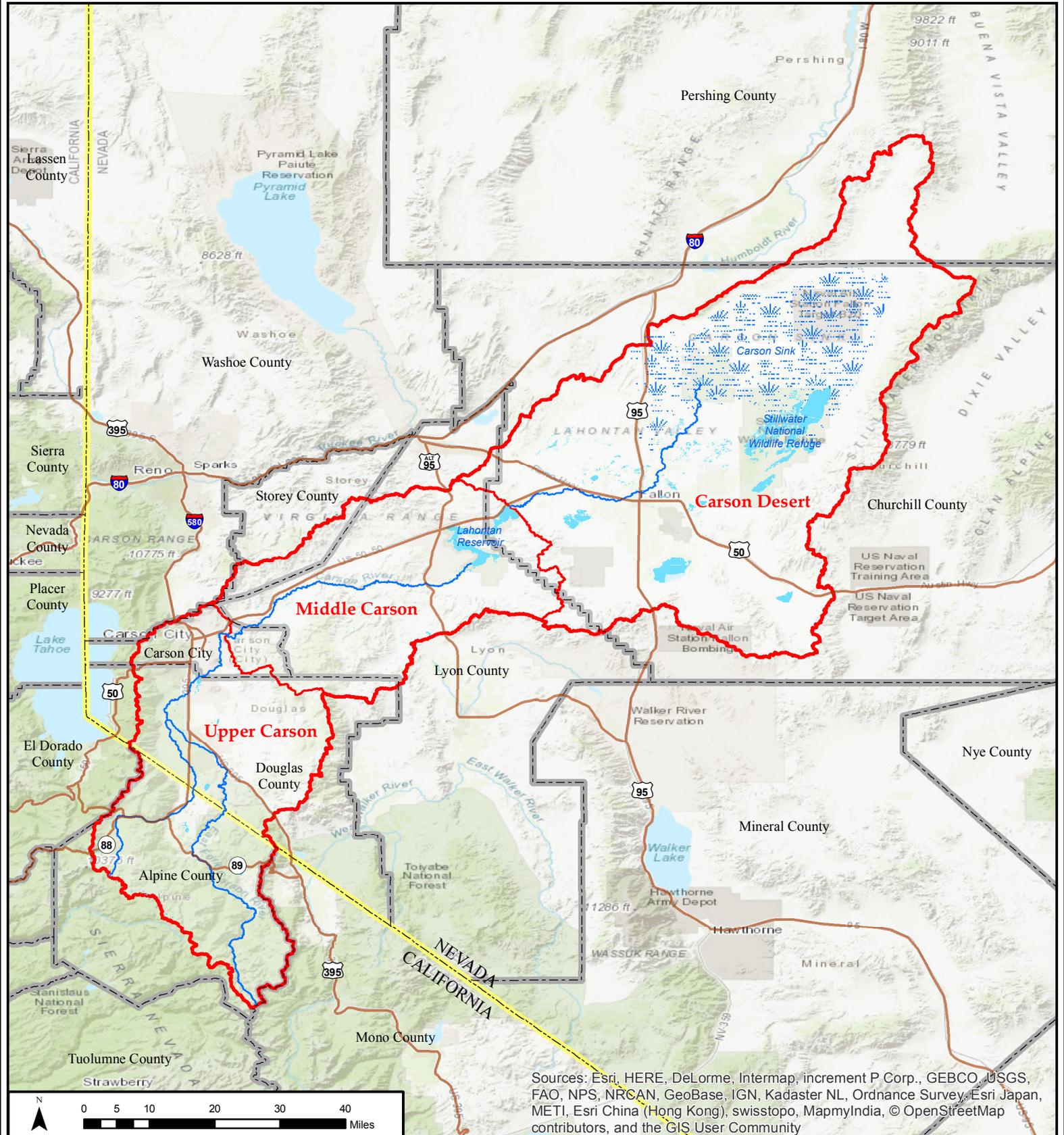
The sub-watersheds in Alpine County, California are designated as follows:

- A. Wolf Creek
- B. East Fork Carson River
- C. Markleeville Creek
- D. West Fork Carson River

Segments of the river have been remapped over the past several years using detailed mapping procedures which updated their previous Zone A (BFE Unknown) designation. over the past several years. These projects were identified in the previous Discovery Report (2012) and Regional Floodplain Management Plan (2008, 2013).

The flood mapping as part of FEMA Mapping Activity Statement (MAS) #1 and #2 with the Carson Water Subconservancy District was were completed in December 2012 (MAS #1) and 2014 (MAS #2), and included the portions of the Carson River through Lyon County and Carson City. MAS #3, completed in 2015, included hydraulic modeling of the Carson River in Carson Valley, and MAS #4 included floodplain mapping in the Carson Valley was completed in 2016. The Douglas County portion of the mapping was submitted to FEMA in March 2017 and is still in review. The new map for the Douglas County portion of the Carson River Watershed may be effective by the end of 2018. MAS #5 mapped alluvial fan watersheds in Douglas County, and Eagle Valley Golf Courses A&B Drainages in Carson City, also completed in 2016. Non-regulatory projects included Identification and Mitigation studies in Douglas and Churchill County; Public Outreach and

Education; and Inundation flood maps of the Upper Carson River. MAS # 6 mapped alluvial fan watersheds in Carson City and Lyon County. Non-regulatory projects completed were an Identification and Mitigation project in Douglas County, Public Outreach and Education; and creation of Carson City Inundation maps. These MAS #6 projects were completed by September 2017. MAS #7 is in progress (9/25/2015-6/30/2019) and will update map the Saliman / Voltaire alluvial fan drainage; create a Johnson Lane Area Drainage Master Plan in Douglas County; update the 2012 Discovery Report and 2013 Watershed Floodplain Management Plan. It also funded Public Outreach and Education. MAS #8, which has just gotten underway (9/1/2017-8/31/2019), will create a Dayton Valley Area Drainage Master Plan in portions of Lyon and Storey Counties; update floodplain ordinances in Alpine County in California, and Douglas, Carson City, and Lyon Counties in Nevada; and work with state and federal partners to continue Flood Outreach and Education.



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

**MAP SYMBOLOGY**

-  Project Area
-  Watershed
-  Water Body
-  Carson Sink
-  Waterway
-  State Boundary
-  County Boundary
-  Major Road

**PROJECT LOCATOR**



**FIGURE 1.**

**NATIONAL FLOOD INSURANCE PROGRAM**  
**Project Area Map**

Carson River Watershed

HUC-8 Codes

- 16050201
- 16050202
- 16050203



**FEMA** Discovery Report Release Date: 12/01/2017

### 3 WATERSHED STAKEHOLDER COORDINATION

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Current efforts of the 2017 watershed stakeholder coordination phase of Discovery seek to expand and update the information obtained in the 2012 Discovery process. Extensive flooding has occurred since the 2012 Discovery; therefore, community needs and concerns are focused on addressing these additional and unique flood hazards.

The project team (Appendix A) conducted two outreach meetings with community officials and stakeholders as part of this process. In addition to the six jurisdictions within the Carson River Watershed, additional stakeholders were identified, generally consisting of associations and government agencies that are involved with the Carson River Watershed and the Carson River Coalition (CRC). The list of community and stakeholder contacts was gathered is included in Appendix B to this document.

In July 2017, community and additional stakeholders were invited to attend Discovery meetings as part of the CRC's Floodplain and River Management Working Group (formerly CRC River Corridor Working Group) meeting. On August 1, 2017, the communities and stakeholders were sent a memorandum that identified the upcoming meetings and data to be collected.

The Discovery Meetings were hosted by the Carson Water Subconservancy District (CWSD) as follows:

Tuesday, August 15, 2017, 1:00-3:00 pm  
State of Nevada Governor's Mansion, Nevada Room  
606 Mountain Street, Carson City, NV 89703

Tuesday, October 24, 2017, 3:00-5:00 pm  
Sierra Room at Carson City Community Center  
850 E. William Street, Carson City, NV 89703

The goals of the meetings were to:

- Provide an overview of the project
- Introduce new members and stakeholder agencies to the process
- Discuss the project scope
- Collect community feedback on:
  - Areas of growth
  - Need for additional flood studies
  - Areas where mitigation projects are needed
- Discuss ways in which flood risk can be reduced in the watershed
- Gather available technical data to support hydraulic and hydrologic studies; and
- Discuss the project timeline

August 15, 2017 Discovery Meeting:

An introduction to Risk MAP was presented and followed by discussion sessions with each jurisdiction. The presentation described Risk MAP program goals and objectives, the Discovery meeting goals and objectives, and the timeline moving forward. This meeting

introduced attendees new to the Discovery process to the type of information sought and outcomes to be expected. Stakeholders were given the opportunity to complete and discuss with project team members the Community Questionnaire and Community Fact Sheets (Appendix C); review maps; potential mitigation projects; and identify new areas of concern during break out session

Stakeholders unable to attend the meetings were also given additional time to review and comment on Discovery data collected. On September 1, 2017, digital copies of the Community Questionnaires filled out at the August 15 meeting were sent to each jurisdiction for review. Additional information was requested because of the stakeholder input. Proposed, current, and completed project information was also requested in an effort to update the lists for each community.

#### October 24, 2017 Discovery Meeting:

At the second Discovery meeting, individual jurisdictions reviewed the summaries from the first meeting. Next, they reviewed, updated and ranked potential flood mitigation projects with project team members for each county. Collected information is provided throughout this report. A list of Discovery meeting attendees, agenda, and handouts are provided in Appendix D.

## 4 DATA ANALYSIS

A list of the data collected is provided in Table 1. Table 1 outlines the data types, a short description, the source and how the data was delivered. The following sections (4.1 - 4.4) provide additional details about how the data can be used.

*Table 1. Data Collection for the Carson River Watershed.*

Data Types	Description	Source	Deliverable
Community Assistance Visits	Community Fact Sheet	Nevada Division of Water Resources, Local Agencies	Updated Fact Sheets
Community Boundaries	Location of jurisdictional boundaries	Prior Discovery maps	Discovery Map; Geodatabase
Community Rating System	Community Fact Sheet	FEMA's Community Rating System Communities and their Classes"	Updated Fact Sheets
County Boundaries	Location of County Boundaries	Prior Discovery maps	Discovery Map; Geodatabase
Dams	Location of dams	NDWR Inventory	Discovery Map; Geodatabase
Declared Disasters	Community Fact Sheet	NDEM	Updated Fact Sheets
Demographics, Industry	Community Fact Sheet	US Census Bureau QuickFacts, and American Fact Finder	Updated Fact Sheets
HUC 8 Watersheds	Watershed boundary	USGS Watershed Boundary Dataset	Discovery Map; Geodatabase
Insurance Policies and Claims	Community Fact Sheet	FEMA database	Updated Fact Sheets
Letters of Map Change (LOMCs)	Number and locations of letters of map change	FEMA National Flood Hazard Layer	Discovery Map; Geodatabase
Mitigation Plans Status	Community Fact Sheet	Community Website	Updated Fact Sheet
Mitigation Projects Obligated	Community Fact Sheet	Data.gov: FEMA Hazard Mitigation Program Summary	
Mitigation Projects: Recent, ongoing, planned, Desired		Community information, Discovery Meetings	Discovery Map; Geodatabase
Repetitive Loss	Community Fact Sheet	NDWR, Local Agencies	Updated Fact Sheet
Streams and Rivers	Stream centerlines based on USGS topo	USGS Watershed Boundary Dataset	Discovery Map; Geodatabase
Stream Gages		USGS	Discovery Map; Geodatabase
Major Roads	Location of interstates and major highways	TIGER, Data.gov	Discovery Map; Geodatabase
Special Flood Hazard Areas	Location of FEMA flood hazard areas	FEMA Digital Flood Insurance Rate Maps	Discovery Map; Geodatabase
Stream Gages	Location of stream gages operated by USGS	USGS National Hydrography Dataset	Discovery Map; Geodatabase
Study Needs: FEMA			
Topographic Availability	LiDAR	CWSD	Discovery Map; Geodatabase
Wetland	Wetland delineations	U.S. Fish and Wildlife Service	Discovery Map; Geodatabase

## 4.1 DATA THAT CAN BE USED FOR FLOOD RISK PRODUCTS

The Flood Risk Products available to a community are a Flood Risk Map (FRM), Flood Risk Report (FRR) or Flood Risk Database (FRD). These products are non-regulatory resources that supplement the flood hazard information produced by the regulatory Flood Insurance Rate Map (FIRM), Flood Insurance Study (FIS) and FIRM database products.

A Flood Risk Report presents:

- Background (purpose, methods, risk reduction practices)
- Project Results (changes since Last FIRM, Depth & Analysis Grids, Flood Risk Assessment, Enhanced Analyses), and
- Summarized by locations - communities and watersheds.

A FRM visually promotes risk awareness by showing results of Risk MAP project non-regulatory datasets, and promotes additional flood risk data not shown but located within the FRD.

A FRD shows:

- Changes Since Last FIRM
- Depth and Analysis Map
- Flood Risk Assessment (HAZUS)
- Areas of Mitigation Interest

Flood risk products help community members and officials view and visualize their local flood risk, allowing communities to make informed decisions about reducing flood loss and mitigating potential damage from flood hazards. These individuals may include property owners, emergency management officials, community planners and developers, real estate and insurance specialists and other professionals and community decision-makers.

### 4.1.1 Topographic Data

Local jurisdictions have worked diligently to improve flood risk data throughout the entire watershed; therefore, LiDAR has been collected on a flood-study-based effort (individual segments of the Carson River). LiDAR has been processed for areas shown in the Discovery Map (Appendix F). At the current time, LiDAR data is being processed for data collected in Lyon County, and will be available in 2018. LiDAR was collected in 2017 in Douglas County for the Johnson Lane ADMP. LiDAR collection is scheduled in Churchill County in 2019.

The topographic data that can be used for flood risk products in the Carson River watershed consists of the following LiDAR segments collected between 2011 and 2017 (Table 2).

*Table 2. LiDAR Status for the Carson River Watershed.*

Segment/Detailed Study Mapping	Date Acquired
Churchill County	2013
Lyon County	2011, 2017
Carson City	2013, 2017
Douglas County	2013, 2017

#### 4.1.2 USGS Gages

The USGS stream gaging network is vital to the National Weather Service's river forecast and warning program and the goal to reduce flood damages and loss of life. The locations of USGS stream gages in the watershed are shown on the Discovery Maps and listed in Table 3. The seven sites that are active National Weather Service River Forecast sites are indicated. A number of sites have been discontinued since the 2012 Discovery, and are listed at the bottom of the table.

Table 3. USGS Stream Gages

No.	Gage Number	Station Name and Location	Forecast
1	10308783	LEVIATHAN C AB MINE NR MARKLEEVILLE, CA	
2	10308785	LEVIATHAN MINE PIT FLOW NR MARKLEEVILLE, CA	
3	10308784	LEVIATHAN MINE ADIT DRAIN NR MARKLEEVILLE, CA	
4	103087891	ASPEN C ABV LEVIATHAN MINE NR MARKLEEVILLE, CA	
5	103087887	LEVIATHAN MINE POND 4 NR MARKLEEVILLE, CA	
6	103087885	LEVIATHAN C CHANNEL UNDERDRAIN NR MARKLEEVILLE, CA	
7	103087889	4L C NR MARKLEEVILLE, CA	
8	103087892	ASPEN C OVERBURDEN SEEP NR MARKLEEVILLE, CA	
9	10308200	E.F. CARSON R BL MARKLEEVILLE C NR MARKLEEVILLE, CA	CEMC1
10	10308789	LEVIATHAN C AB ASPEN C NR MARKLEEVILLE, CA	
11	10308794	BRYANT CK BL MOUNTAINEER C NR MARKLEEVILLE, CA	
12	10308792	LEVIATHAN C AB MOUNTAINEER C NR MARKLEEVILLE, CA	
13	10310000	WEST FORK CARSON RIVER AT WOODFORDS, CA	WOOC1
14	10309000	EAST FORK CARSON RIVER NEAR GARDNERVILLE, NV	
15	10310400	DAGGETT CREEK NEAR GENOA, NV	
16	10310447	AMBROSETTI POND NR GENOA, NV	
17	10311000	CARSON RIVER NR CARSON CITY, NV	STWN2
18	10310500	CLEAR CREEK NR CARSON CITY, NV	
19	10311100	KINGS CANYON CREEK NR CARSON CITY, NV	
20	10311090	NORTH FORK KINGS CANYON CREEK NR CARSON CITY, NV	
21	10311200	ASH CANYON CK NR CARSON CITY, NV	
22	10311300	EAGLE VALLEY CREEK AT CARSON CITY, NV	
23	10311400	CARSON RIVER AT DEER RUN ROAD NR CARSON CITY, NV	
24	10311750	CARSON RIVER ABV SIXMILE CYN CK BLW DAYTON, NV	
25	10312000	CARSON RIVER NR FORT CHURCHILL, NV	FTCN2
26	10312150	CARSON RIVER BLW LAHONTAN RESERVOIR NR FALLON, NV	CBLN2
27	10351400	TRUCKEE CA NR HAZEN, NV	
28	103122190	S-LINE DIVERSION CANAL NEAR STILLWATER, NV	
29	10312275	CARSON RIVER AT TARZYN ROAD NR FALLON, NV	
30	10312277	PAIUTE DRAIN BL TJ DRAIN NR STILLWATER, NV	
31	10310407	CARSON R NR GENOA, NV (Daily data only)	
32	10311700	CARSON RIVER AT DAYTON, NV (Winter operations only)	
<b>DISCONTINUED GAUGES (SINCE 2012 DISCOVERY)</b>			
	10308800	BRYANT C NR GARDNERVILLE, NV	
	10312210	STILLWATER POINT RESERVOIR DIV CANAL NR FALLON, NV	

## 4.2 OTHER DATA AND INFORMATION

### 4.2.1 Mitigation Plans/Status, Mitigation Projects

Hazard Mitigation Plans (HMPs) are prepared to help communities reduce long-term risk to life and property from natural hazards. The plans include comprehensive mitigation strategies intended to promote flood-resilient communities. Table 4 lists the HMPs, their status, and their availability for review.

Table 4. HMPs Status and Availability

Jurisdiction	HMP	Issue Date	Expiration Date	Available for Review
Alpine County	Natural Hazard Mitigation Plan	2017	2022	Yes
Carson City	Hazard Mitigation Plan	August 4, 2016	August, 2021	Yes
Churchill County, City of Fallon	Multi-Jurisdictional Hazard Mitigation Plan	2016	2021	Yes
Douglas County	Hazard Mitigation Plan	2013	2018	Yes
Lyon County, City of Fernley, City of Yerington, Yerington Paiute Tribe	Multi-Jurisdictional Hazard Mitigation Plan	July, 2018	2023	Note 1
Storey County	Hazard Mitigation Plan	2015	2020	Yes

Note 1. The Multi-Jurisdictional HMP for the Lyon County jurisdictions is being updated as of the preparation of this Discovery Report, scheduled for completion in July, 2018. The HMP Effective 2013 is available for review.

### 4.2.2 Coordinated Needs Mapping Study (CNMS) and National Flood Insurance Program (NFIP) Mapping Study Needs

FEMA organizes, stores, and analyzes flood hazard mapping information for identifying and managing flood hazard mapping needs. The CNMS inventory contributes to the identification of risk in two important ways. The first is by indicating where the depiction of flood hazards on the FIRMs has been validated through detailed assessment. The second is by showing which previously studied or unstudied flooding sources inadequately represent flood hazards. In this way, CNMS leads to the improvement of flood hazard data.

For this Discovery update, flood hazard mapping needs data was provided to FEMA for inclusion in the CNMS database. These data both validate flood hazards with adequate detailed assessments, and flooding sources that are either unstudied or inadequate and require improvement of the flood hazard data.

### 4.2.3 Socio-Economic Analysis

Table 5 used US Census QuickFacts updated as of 2015. Community fact sheets for each jurisdiction containing more detailed demographic information are provided in Appendix C.

Table 5. Socio-economic analysis.

Jurisdiction	Population	Median Age	Median Household Income	Top Industry
Alpine County	1,071	39.3	\$52,917	Educational services
Carson City	54,742	41.1	\$47,668	Educational services
Churchill County	24,198	29	\$47,415	Trade, transportation
Douglas County	48,020	47.4	\$58,535	Educational services
Lyon County	53,179	40.9	\$47,255	Retail trade
Storey County	4,051	44.5	\$64,832	Manufacturing

#### 4.2.4 Community Rating System (CRS)

The communities of Carson City, Douglas County, and Storey County participate in the CRS program as of October 1, 2017, as shown in Table 6.

Table 6. CRS Rating of participating communities.

Community	CRS Rating
Carson City	6
Douglas County	6
Storey County	8

#### 4.2.5 Flood Control Structures

##### 1. Levees

According to the 2012 Discovery Map, there are 9 levees, located in Carson City and Lyon County, as identified in Table 7. Lyon County levees are not identified on the FIRM panels, and none are certified as USACE levees or accredited by FEMA. According to the Lyon County FIS (2016), approximate analyses of “behind levee” flooding were conducted for all the levees in Table 7 to indicate the extent of the “behind levee” floodplains. The approximate levee analysis was conducted using information from existing hydraulic models (where applicable) and USGS topographic maps.

Table 7. Levees identified on FEMA FIRM panels.

Community	Flood Source	FIRM Panel
Carson City	Eagle Valley Creek	32001C0083F
Carson City	Eagle Valley Creek/Combs Canyon Creek	32001C0084F 32001C0092G
Carson City	H Tributary	32001C0092G
Lyon County	Unnamed Wash at Silver Springs	32019C0211E 32019C0213E
Lyon County	Unnamed Wash at Silver Springs	32019C0214E 32019C0212E
Lyon County	Carson River	32019C0289F
Lyon County	Carson River	32019C0452F
Lyon County	Undetermined	32019C0452F

##### 2. Dams

The 2012 Discovery Report lists the Lahontan Dam and Reservoir in Churchill County, and Eagle Valley Golf Course Dam and the Shenandoah Detention Basin in Carson City. The federal classification of dams of low, significant or high hazard is shown in Table 8. Included in this update are all High and Significant hazard dams located within the Carson River Watershed (Table 9). These and all other dams classified as Low hazard can be found on the Nevada Division of Water Resources (NDWR) website (<http://water.nv.gov/DamsQuery.aspx>) or for those in Alpine county, on the California Department of Water Resources website (<https://www.water.ca.gov/Programs/All-Programs/Division-of-Safety-of-Dams>) High hazard dams indicate potential loss of life and economic damage; significant indicates economic damage.

Table 8. Hazard Potential Classification System for Dams (2004, Federal Guidelines for Dam Safety)

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
<b>Low</b>	None expected	Low and generally limited to owner
<b>Significant</b>	None expected	Yes
<b>High</b>	Probable. One or more expected.	Yes (but not necessary for this classification)

In the State of Nevada, the State Engineer is charged with dam safety pursuant to Nevada Revised Statutes (NRS) 535. The goal of Nevada's dam safety program is to avoid dam failure and thus prevent loss of life and destruction of property. This is accomplished by careful review of new dam applications, on-site inspection of the dams being built, review of as-built drawings and QA/QC reports and finally, through periodic visual inspections of the structures themselves. In each jurisdiction's CRS Annual Report is a section confirming that the State has in fact inspected the dams. While there are 26 dams in Alpine County, only three are within the Carson River Watershed boundary that are considered significant or high hazard. Dams for which an Emergency Action Plan (EAP) is active are also indicated in the table. An EAP is required to be developed and maintained by owners and operators of high hazard dams; these plans are intended to reduce the risk to loss of life and property if the dam fails.

Table 9. Dams located in Carson River Watershed, and hazard potential as classified by the State (See Table 8 for description of High (H), Significant (S) or Low (L) hazard potential).

National ID	State ID	Name	Stream	Owner	Hazard	EAP
<b>Alpine County</b>						
CA01222	1062.003	Harvey Place		South Tahoe PUD	S	
CA00894	1062.000	Indian Creek		South Tahoe PUD	S	
CA00631	1.090	Red Lake		California Dept. of Fish and Wildlife (CDFW)	S	
<b>Carson City</b>						
NV00223	J-228	Carson City Treated Effluent Dam	Carson River-Tr	Carson City	H	Y
NV00231	J-244	Carson City Golf Course Detention Basin	Carson River-Tr	Carson City	S	Y
NV10635		Shenandoah Detention Basin	Eagle Creek-Tr	Carson City	H	Y
<b>Churchill County</b>						
NV10120		Carson River Diversion	Carson River	BOR*	S	Y
NV10123		Lahontan	Carson River	BOR	H	Y
NV00214		Sheckler Dam	Carson River-Os	BOR	S	
<b>Douglas County</b>						
NV10441	XJ-187	Veta Grande Tails Dam	Carson River-Tr	Precious Metal Recovery System	H	
NV10469	XNV10469	Allerman #2 Dam	Carson River-Os	Allerman Upper Virginia Irrigation Co Inc	H	
NV10829	XNV10829	Ruhenstroth Power Dam	Carson River	Hussman, George G.	H	
NV10175	J-229	Sierra Springs	Carson River-Os	Sierra Reflections	S	
NV00092		Allerman #1 Dam	Carson River-Os	Allerman Upper Virginia Irrigation Co Inc	H	Y

National ID	State ID	Name	Stream	Owner	Hazard	EAP
NV00227	J-238	Minden-Gardnerville Sanitation District	Carson River-Os	Minden-Gardnerville Sanitation District	S	Y
NV10166	J-380	Buckeye Creek Lower Effluent Storage Pond	Buckeye Creek-Os	Douglas County Sewer Improvement Dist. #1	H	Y
NV10168	J-350	Indian Hills Effluent Pond #5	Carson River-Os	Indian Hills G. I. D.	S	Y
NV10435	J-411	Indian Hills Effluent Pond #6	Carson River-Os	Indian Hills G. I. D.	S	Y
NV10605	J-551	Bently Reservoir	Buckeye Creek-Tr	Bently Family Limited Partnership	H	Y
NV10665	J-594	North Carson Valley Treated Effluent Storage Dam	Carson River-Os	Douglas County	S	Y
NV10686	J-380	Buckeye Creek Middle Effluent Storage Pond	Buckeye Creek-Os	Douglas County Sewer Improvement Dist. #1	H	Y
NV10687	J-380	Buckeye Creek Upper Effluent Storage Pond	Buckeye Creek-Os	Douglas County Sewer Improvement Dist. #1	H	Y
NV00234	J-257	East Peak Lake	Daggett Creek	Heavenly Valley Limited Partnership	H	Y
NV10439	J-515	Mud Lake	Indian Creek-Os	West Fork Water Company	H	Y
NV10605	J-551	Bently Reservoir	Buckeye Creek-Tr	Bently Family Limited Partnership	H	Y
<b>Lyon County</b>						
NV00150	J-086	Eldorado Canyon Dam	Eldorado Canyon Creek	Wade Development Company Inc	H	Y
NV10313	Xj-264	North Dayton Valley Primary Pond 1	Carson River-Os	Lyon County Utilities	S	
NV10638		Sheep Camp Detention Dam	Carson River-Tr	Chase Property Group, LLC	H	
NV10727	Xj-264	North Dayton Valley Primary Pond 2	Carson River-Os	Lyon County Utilities	S	
NV10728	Xj-264	North Dayton Valley Secondary Pond	Carson River-Os	Lyon County Utilities	S	
NV10729	Xnv10729	North Dayton Valley Storage Pond	Carson River-Os	Lyon County Utilities	S	

\*U.S. Department of the Interior Bureau of Reclamation (BOR)

#### 4.2.6 Floodplain Management/Community Assistance Visits (CAVs)

As the state coordinating agency for the National Flood Insurance Program, the NDWR conducts CAVs as part of their floodplain management programs. A CAV typically consists of a tour of the floodplain to assess any recent construction activities, a review of the local permitting process, and evaluation of the local floodplain ordinance. A meeting with the local floodplain official is held to discuss the NFIP, the local permitting process, any recent flood events, training opportunities, and any program deficiencies. [Table 10](#) lists the communities in the watershed and the date of their latest CAV.

While CRS reviews are conducted annually, staff visits generally only occur every few years.

Table 10. Recent CAVs and CRS visits.

Community	CAV Meeting Date	CRS Meeting Date
Carson City	07/21/2011	2013
Douglas County	02/23/2012	2013
Storey County	9/20/2012	2013

#### 4.2.7 Regulatory Mapping

As part of the CWSD’s ongoing efforts to update the watershed FIRMs, many maps have been updated since the 2012 Discovery. The most recent FIRM updates for the communities in the Carson River Watershed became effective as shown in Table 11. While Churchill County maps are effective 2008, they are based on maps developed in 1977; the maps were digitized in 2008 to create the FIRMs. Please note that some of the map dates and letters may change during the course of the Discovery process.

Table 11. FIRM updates through 2017 Discovery.

<u>Jurisdiction</u>	<u>Effective Date</u>	<u>Description</u>
<b>Alpine County</b>		No changes to FIRMs effective 11/19/1987
<b>Carson City</b>		
3200010083F 3200010084F 3200010091F	2/19/2014	Ash Canyon Creek, Kings Canyon Creek, Vicee Canyon Creek, Combs Canyon Creek, Eagle Valley Creek
3200010092G 3200010094F 3200010111G 3200010113F	12/22/2016	Combs Canyon Creek, Ash Canyon Creek, Kings Canyon Creek, Saliman Road Tributary, Voltaire Canyon Creek, H Tributary, I Tributary
<b>Douglas County</b>		
32005C0070H 32005C0090H 32005C0093H 32005C0232H 32005C0234H 32005C0235H 32005C0251H 32005C0252H 32005C0253H 32005C0254H 32005C0256H 32005C0258H 32005C0259H	6/15/2016	Remapping using detailed methods of 30 streams, five two-dimensional study areas (Airport Tributary Wash, Airport Wash, Buckbrush Wash, Johnson Lane Wash, Sunrise Pass Wash; and redelineations of 5 stream/river segments on the: Carson River, Clear Creek, Pine Nut Road Wash, Rocky Slough, and Smelter Creek
<b>Churchill County</b>		No changes to FIRMs effective 9/28/2008
<b>Lyon County</b>		
32019C0289F 32019C0291F 32019C0292F 32019C0293F 32019C0294F 32019C0311F 32019C0312F	10/20/2016	Floodplain redelineation of the Carson River in Lyon County

<i>Jurisdiction</i>	<i>Effective Date</i>	<i>Description</i>
(Lyon County Continued)		
32019C0316F		
32019C0320F		
32019C0340F		
32019C0345F		
32019C0350F		
32019C0434F		
32019C0451F		
32019C0452F		
32019C0453F		
<b>Storey County</b>		No changes to FIRMs effective 1/16/2009

### 4.3 DISCOVERY MEETINGS

Before and during Discovery meetings the 2012 Discovery Report projects were reviewed for accuracy. Completed projects and projects that were no longer a priority were removed. New projects were identified based on recent flooding or changes in priority by representatives from Carson River Watershed stakeholders.

August 15, 2017 Discovery Meeting:

A Community Questionnaire was used to help jurisdictions identify areas where flood risk data is outdated. The following observations were made:

- Carson City identified numerous watersheds for which an area drainage master plan or flood study needs to be conducted. Many are subject to alluvial fan/flash flooding as a result of summertime cloudburst events.
- Churchill County’s FIRM maps are from the 1970s, and new FIRMs are needed to show modern growth, new plans, and new water spillways (created as a result of the overwhelming 2017 inputs of the Carson River to Lahontan Reservoir).
- Lyon County is subject to flash flood potential and alluvial fan flooding from the surrounding steep hillslopes.
- Douglas County needs detailed flood studies for Pinenut Creek – from Jo Lane to Orchard Road (A flood zone), Sierra Country Estates, and the Ruhenstroth area (Smelter Creek).

October 24, 2017 Meeting:

Individual project staff members worked with each jurisdiction to fine-tune the information contained in the Community Fact Sheets, and potential mitigation projects. Potential projects were derived from the 2012 Discovery list, the 2017 draft Update of the Carson River Watershed plan, and discussions with jurisdiction staff.

### 4.4 DISCOVERY MAP

A Discovery Map (Appendix F) presents the current floodplain mapping extents, LiDAR coverage boundaries, and locations of potential mitigation projects within each jurisdiction. The content was derived by each jurisdiction at the Discovery meetings and follow-up. It is evident that the impacts due to flooding, the need for better or revised floodplain mapping, and the importance of project implementation are at the forefront of each jurisdiction’s priorities. Alluvial fan and wash flash-

flooding are increasingly a concern for jurisdictions. These are recognized by the number of such potential projects in each jurisdiction list.

#### **4.5 MITIGATION PROJECTS**

Community stakeholders identified locations where mitigation projects could reduce the impacts of flooding. Topics of mitigation interest included upstream storage, roads that frequently flood, and recent/future growth or development. Appendix E provides lists of projects Identified for potential mitigation for each community.

## 5 APPENDICES

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### List of Appendices

Appendix A	Project Team Contact Information
Appendix B	Stakeholder Contact Information
Appendix C	Discovery Interviews <ul style="list-style-type: none"><li>• Community Fact Sheets</li><li>• Community Interview Notes</li></ul>
Appendix D	Discovery Meetings <ul style="list-style-type: none"><li><b><u>August 15 Meeting</u></b><ul style="list-style-type: none"><li>a. <u>Notice</u></li><li>b. <u>Agenda</u></li><li>c. <u>Community Questionnaire</u></li><li>d. <u>List of Attendees</u></li><li>e. <u>Risk MAP Presentation</u></li></ul></li><li><b><u>October 24 Meeting</u></b><ul style="list-style-type: none"><li>a. <u>Notice</u></li><li>b. <u>Agenda</u></li><li>c. <u>August Meeting Notes</u></li><li>d. <u>List of Attendees/Sign-in sheet</u></li><li>e. <u>Individual Jurisdiction Maps</u></li></ul></li></ul>
Appendix E	Community Potential Mitigation Projects
Appendix F	Discovery Map Discovery Geodatabase (to be completed)

## APPENDIX A

### PROJECT TEAM CONTACT INFORMATION

AGENCY	NAME	PHONE	EMAIL
Carson Water Subconservancy District	Brenda Hunt	(775) 887-9005	<a href="mailto:brenda@cwsd.org">brenda@cwsd.org</a>
	Debbie Neddenriep	(775) 887-1260	<a href="mailto:debbie@cwsd.org">debbie@cwsd.org</a>
	Ed James	(775) 887-7456	<a href="mailto:edjames@cwsd.org">edjames@cwsd.org</a>
Michael Baker International	Geoff Brownell	(775) 722-4713	<a href="mailto:gbrownell@mbakerintl.com">gbrownell@mbakerintl.com</a>
	Karin Peternel	(775) 412-4605	<a href="mailto:Karin.peternel@mbakerintl.com">Karin.peternel@mbakerintl.com</a>
FEMA	Bob Bezek	(510) 627-7274	<a href="mailto:Robert.Bezek@fema.dhs.gov">Robert.Bezek@fema.dhs.gov</a>

#### Carson Water Subconservancy District

777 E. William Street, Suite 110A

Carson City, NV 89701

#### Michael Baker International

5470 Kietzke Lane, Suite 208

Reno, NV 89511

#### Federal Emergency Management Agency (FEMA)

##### Region 9

1111 Broadway, Suite 1200

Oakland, CA 94607

## APPENDIX B

### STAKEHOLDER CONTACT INFORMATION

JURISDICTION	CONTACT	TITLE	PHONE	EMAIL
Alpine County	Brian Peters		(530) 694-2140 x425	<a href="mailto:bpeters@alpinecountyca.gov">bpeters@alpinecountyca.gov</a>
Carson City	Robb Fellows	Floodplain Manager	(775) 283-7370	<a href="mailto:rfellows@carson.org">rfellows@carson.org</a>
Churchill County	Michael Johnson	Planning Manager	(775) 423-7627	Planning- director@churchillcounty
	Michael Heidemann	Emergency Manager	(775) 423-4188	<a href="mailto:mheidemann@churchillcounty.org">mheidemann@churchillcounty.org</a>
	Preston Denney	GIS Manager	(775) 423-7627	<a href="mailto:Planning-gis@churchillcounty.org">Planning-gis@churchillcounty.org</a>
Nevada Division of Emergency Management	Caleb Cage	Chief – Homeland Security	(775) 687-0300	<a href="mailto:cscage@dps.state.nv.us">cscage@dps.state.nv.us</a>
Nevada Division of Water Resources	Bunny Bishop	State Floodplain Manager	(775) 684-2834	<a href="mailto:bbishop@water.nv.gov">bbishop@water.nv.gov</a>
Dayton Valley Conservation District	Robert Holley	Manager	(775) 246-1999	<a href="mailto:Rholley.dvcd@yahoo.com">Rholley.dvcd@yahoo.com</a>
	Leah Hoover		(775) 246-1999	<a href="mailto:Lkniffen.dvcd@yahoo.com">Lkniffen.dvcd@yahoo.com</a>
Douglas County	Mimi Moss	Floodplain Manager	(775) 782-6230	<a href="mailto:mmoss@douglasnv.us">mmoss@douglasnv.us</a>
	Erik Nilssen	County Engineer	(775) 782-9063	<a href="mailto:enilssen@douglasnv.us">enilssen@douglasnv.us</a>
	Courtney Walker	Stormwater Program Manager	(775) 782-6215	<a href="mailto:cwalker@douglasnv.us">cwalker@douglasnv.us</a>
Fallon	Mike Miller	Public Works Engineer	(775) 423-3040	<a href="mailto:mmiller@fallonnevada.gov">mmiller@fallonnevada.gov</a>
Federal Emergency Management Agency	Bob Bezek			
Lyon County	Rob Pyzel	Planner	(775) 463-6535	<a href="mailto:rpyzel@lyon-county.org">rpyzel@lyon-county.org</a>
	Chuck Reno	County Engineer	(775) 463-6535	<a href="mailto:chuck@farrwestengineering.com">chuck@farrwestengineering.com</a>
Storey County	Austin Osborne	Senior Planner	(775) 847-0968	<a href="mailto:aosborne@storeycounty.org">aosborne@storeycounty.org</a>
Truckee Carson Irrigation District	Kate Rutan		(775) 423-2141	<a href="mailto:kate@tcid.org">kate@tcid.org</a>
U.S. Army Corps of Engineers	Kristine Ceragioli	Senior Project Manager	(775) 784-5304	<a href="mailto:Kristine.s.hansen@usace.army.mil">Kristine.s.hansen@usace.army.mil</a>
U.S. Bureau of Reclamation	Terri Edwards	Area Manager	(775) 884-8353	<a href="mailto:tedwards@usbr.gov">tedwards@usbr.gov</a>
U.S. Geological Survey	Steven Berris	Data Chief	(775) 887-7693	<a href="mailto:snberris@usgs.gov">snberris@usgs.gov</a>

## APPENDIX C

### COMMUNITY INFORMATION

1. **List of Community Fact Sheets:**

Alpine County, California  
Carson City, Nevada  
Churchill County, Nevada  
Douglas County, Nevada  
Fallon, Nevada  
Lyon County, Nevada  
Storey County, Nevada

2. **Community Interview Notes**

3. **Community Reference Maps**

**Region 9 Discovery 2017: Carson River Watershed  
Fact Sheet: Alpine County, California**

<b>CID:</b>	60632	<b>FIS/FIRM</b>	Effective Date	11/19/1987
<b>NFIP Participation Status:</b>	Participating		Level of Study:	Zone D/Undetermined
			Last Community Meeting:	

**LOMCs:** \_\_\_\_\_ **Last CAV/CAC Date:** \_\_\_\_\_

**CRS Status**

Class: \_\_\_\_\_ SFHA Discount: \_\_\_\_\_  
Effective: \_\_\_\_\_ Non-SFHA Discount: \_\_\_\_\_

**Demographics (US 2016 Census Data)**

Population: 1,071  
Median Age: 39.3  
Elderly (65+): 23.2%  
Native: 96.6%

**Social Characteristics**

Non-English Speakers: 14.0%  
High School + Education: 89.5%  
Bachelor's + Education: 27.5%

**Industrial (2015)**

Population in labor force: 49.0%  
Median income: \$52,917  
Top 5 Industries:  
1 Educational services, health care and social assistance  
2 Public Administration  
3 Arts, entertainment, recreation, accomodation and food services  
4 Professional, scientific and management, administrative, waste management  
5 Other services exempt from public administration

**Presidentially-Declared Disasters**

Flood related total: \$119,907  
Recent flood related: 1/5/17 - 1/14/17  
Other hazards: \_\_\_\_\_

**Insurance**

Total Premiums: \_\_\_\_\_ Variances \_\_\_\_\_  
Total Coverage: \_\_\_\_\_ Repetitive Losses: 1 (Bear Valley)  
Total Policies: 98 Total Claims: \_\_\_\_\_  
A Zone Policies: \_\_\_\_\_ BXC Zone claims: \_\_\_\_\_  
BCX Policies: \_\_\_\_\_

**Mitigation Projects and Other Grants**

**Approved Mitigation Projects** Updgraded culvert at wastewater plant in Markleeville **Funding:** \_\_\_\_\_  
**Pending Mitigation Projects** Culvert upgrades in Diamond Valley

**Mitigation Plans:** Alpine County Natural Hazard Mitigation Plan **Effective Date:** 2017

**Other Plans**  
Alpine County General Plan 2009  
Carson River Watershed Regional Floodplain Management Plan 2013  
Floodplain Development Standards Code 2013

**Region 9 Discovery 2017: Carson River Watershed  
Fact Sheet: Carson City, Nevada**

<b>CID:</b>	320001	<b>FIS/FIRM</b>	Effective Date	12/22/2016
<b>NFIP Participation Status:</b>	Participating		Level of Study:	Detailed
			Last Community Meeting:	

<b>LOMCs:</b>	8	<b>Last CAV/CAC Date:</b>	7/21/2011
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**CRS Status**

Class:	6	SFHA Discount:	20%
Effective:	10/1/2009	Non-SFHA Discount:	10%

**Demographics (US 2016 Census Data)**

Population	54,742
Median Age	41.1
Elderly (65+):	20.3%
Native:	88.3%

**Social Characteristics**

Non-English Speakers:	8.2%
High School + Education:	86.8%
Bachelor's + Education	20.7%

**Industrial (2015)**

Population in labor force:	59.7%
Median income:	\$47,668
Top 5 Industries:	<ul style="list-style-type: none"> <li>1 Educational services, health care and social assistance</li> <li>2 Public Administration</li> <li>3 Arts, entertainment, recreation, accomodation and food services</li> <li>4 Retail trade</li> <li>5 Manufacturing</li> </ul>

**Presidentially-Declared Disasters**

Flood related total:	\$4,799,910
Recent flood related:	2/28/1986; 1/3/1997; 2/3/2006; 1/13/2017; 2/17/2017
Other hazards:	8/27/2004      Waterfall Fire

**Insurance**

Total Premiums:	\$301,195	Variances	0
Total Coverage:	\$133,923,700	Repetitive Losses:	1
Total Policies:	638	Total Claims:	\$578,249
A Zone Policies:	451	BXC Zone claims:	
BCX Policies:	187		

**Mitigation Projects and Other Grants**

**Approved Mitigation Projects**

**Funding:**

- Pending Mitigation Projects**
- Eagle Valley Golf Course
  - Shenandoah Basin
  - Silver Oak Golf Course Basins
  - Timberline/Combs Basins
  - Eagle Valley Creek Basins
  - Vicee Canyon Basin

<b><u>Mitigation Plans:</u></b>	Carson City Hazard Mitigation Plan	<b>Effective Date:</b>	2016
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<b><u>Other Plans</u></b>	Carson City Sandbagging Plan	2010
	Carson River Watershed Regional Floodplain Management Plan	2013
	Community Wildfire Protection Plan	2009
	Carson City Master Plan	2006
	Carson City Parks and Recreation Plan	2006
	Carson City Open Space Plan	2000
	Carson River Master Plan	1996

**Region 9 Discovery 2017: Carson River Watershed  
Fact Sheet: Churchill County, Nevada**

<b>CID:</b>	320002, 320030	<b>FIS/FIRM</b>	Effective Date	9/26/2008
<b>NFIP Participation Status:</b>	Participating		Level of Study:	Detailed
			Last Community Meeting:	

**LOMCs:** 4 **Last CAV/CAC Date:**

**CRS Status**

Class: SFHA Discount:  
Effective: Non-SFHA Discount:

**Demographics (US 2016 Census Data)**

Population	24,198	<b>Social Characteristics</b>	
Median Age	29	Non-English Speakers:	11.7%
Elderly (65+):	18.7%	High School + Education:	89.6%
Native:	93.6%	Bachelor's + Education	15.9%

**Industrial (2015)**

Population in labor force:	55.0%	
Median income:	\$47,415	
Top 5 Industries:		1 Trade, transportation (26%)
		2 Education and health services (20.7%)
		3 Leisure and hospitality (12.7%)
		4 Government (9.8%)
		5 Professional services (7.3%)

**Presidentially-Declared Disasters**

Flood related total: \$5,822,208  
Recent flood related: 1/3/1997; February and March, 2017  
Other hazards:

**Insurance**

Total Premiums:	\$262,700	<b>Variances</b>	
Total Coverage:	\$145,569,200	Repetitive Losses:	1
Total Policies:	487	Total Claims:	\$9,850
A Zone Policies:	56	BXC Zone claims:	
BCX Policies:			

**Mitigation Projects and Other Grants**

Approved Mitigation Projects **Funding:**

Pending Mitigation Projects

**Mitigation Plans:** Churchill County and City of Fallon Hazard Mitigation Plan **Effective Date:** 2016

**Other Plans**

Churchill County Master Plan	2015
Carson River Watershed Regional Floodplain Management Plan	2013
Carson River Geographic Response Plan	
Lahontan Dam Tabletop Flood Exercise	2009
Design, Estimating and Construction Review Truckee Canal Risk Assessment	2008

**Region 9 Discovery 2017: Carson River Watershed  
Fact Sheet: Douglas County, Nevada**

<b>CID:</b>	320008	<b>FIS/FIRM</b>	Effective Date	6/15/2016
<b>NFIP Participation Status:</b>	Participating		Level of Study:	Detailed
			Last Community Meeting:	

<b>LOMCs:</b>	43	<b>Last CAV/CAC Date:</b>	2/23/2012
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**CRS Status**

Class:	6	SFHA Discount:	20
Effective:	10/1/2004	Non-SFHA Discount:	10

**Demographics (US 2016 Census Data)**

Population	48,020	Non-English Speakers:	10.2%
Median Age	47.4	High School + Education:	92.8%
Elderly (65+):	26.5%	Bachelor's + Education	25.2%
Native:	92.5%		

**Social Characteristics**

**Industrial (2015)**

Population in labor force:	56.3%		
Median income:	\$58,535		
Top 5 Industries:		1 Educational services, health care and social assistance	
		2 Public Administration	
		3 Arts, entertainment, recreation, accomodation and food services	
		4 Construction	
		5 Manufacturing	

**Presidentially-Declared Disasters**

Flood related total:	\$1,442,170
Recent flood related:	2/28/1986; 1/3/1997; 2/3/2006; 2/15/2008; 1/5-1/14/2017, 2/5-2/22/2017
Other hazards:	

**Insurance**

Total Premiums:	\$771,827	Variances	0
Total Coverage:	\$145,569,200	Repetitive Losses:	4
Total Policies:	1,139	Total Claims:	\$3,644,170
A Zone Policies:	640	BXC Zone claims:	
BCX Policies:	436		

**Mitigation Projects and Other Grants**

<b>Approved Mitigation Projects</b>	US Highway 395 Culvert (Martin Slough)	<b>Funding:</b>	FEMA \$875,916
			Douglas County \$41,972
			NDOT \$250,000
<b>Pending Mitigation Projects</b>	SR 88 Flood Mitigation (Cottonwood Slough)	<b>Funding:</b>	FEMA \$1,605,500

<b>Mitigation Plans:</b>	Douglas County Natural Hazard Mitigation Plan	<b>Effective Date:</b>	2013
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<b>Other Plans</b>	Douglas County Master Plan	2012
	Carson River Watershed Regional Floodplain Management Plan	2013
	Douglas County Open Space and Agricultural Lands Preservation Implementation Plan	2004
	Douglas County Code Title 20 Zoning Ordinance of Douglas County	1996

**Region 9 Discovery 2017: Carson River Watershed  
Fact Sheet: Lyon County, Nevada**

<b>CID:</b>	320016, 320029, 320038	<b>FIS/FIRM</b>	Effective Date	10/20/2016
<b>NFIP Participation Status:</b>	Participating		Level of Study:	Detailed
			Last Community Meeting:	
<b>LOMCs:</b>	13		<b>Last CAV/CAC Date:</b>	10/20/2009
<b>CRS Status</b>				
Class:			SFHA Discount:	
Effective:			Non-SFHA Discount:	
<b>Demographics (US 2016 Census Data)</b>			<b>Social Characteristics</b>	
Population	53,179		Non-English Speakers:	13.6%
Median Age	40.9		High School + Education:	84.9%
Elderly (65+):	21.1%		Bachelor's + Education	16.6%
Native:	92.9%			
<b>Industrial (2015)</b>				
Population in labor force:	56.2%			
Median income:	\$47,255			
Top 5 Industries:		1 Retail trade		
		2 Educational services, healthcare and social assistance		
		3 Manufacturing		
		4 Arts, entertainment, recreation, accomodation and food services		
		5 Construction		
<b>Presidentially-Declared Disasters</b>				
Flood related total:	\$1,044,838	Dates:	2/28/1986; 1/3/1997; 2/3/2006; 2/15/2008	
Recent flood related:	\$92,857 (from 1/5-1/14/2017 event);			
	\$119,907 (Awarded; Work not completed yet)			
<b>Insurance</b>				
Total Premiums:	\$198,143		Variances	
Total Coverage:	\$75,185,300		Repetitive Losses:	
Total Policies:	320		Total Claims:	\$386,144
A Zone Policies:			BXC Zone claims:	
BCX Policies:				
<b>Mitigation Projects and Other Grants</b>				
Approved Mitigation Projects		Funding:		
Pending Mitigation Projects				
<b>Mitigation Plans:</b>	Lyon County Multi-Jurisdictional Hazard Mitigation Plan	<b>Effective Date:</b>	2013*	
	*(HMP will be revised prior to July, 2018)			
<b>Other Plans</b>	Lyon County Comprehensive Master Plan		2010	
	Carson River Watershed Regional Floodplain Management Plan		2013	

**Region 9 Discovery 2017: Carson River Watershed  
Fact Sheet: Storey County, Nevada**

<b>CID:</b>	320033	<b>FIS/FIRM</b>	Effective Date	1/16/2009
<b>NFIP Participation Status:</b>	Participating		Level of Study:	Detailed
			Last Community Meeting:	4/23/2008

<b>LOMCs:</b>	13	<b>Last CAV/CAC Date:</b>	9/6/2007
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**CRS Status**

<b>Class:</b>	8	<b>SFHA Discount:</b>	10%
<b>Effective:</b>	10/1/1999	<b>Non-SFHA Discount:</b>	5%

**Demographics (US 2016 Census Data)**

Population	4,051
Median Age	44.5
Elderly (65+):	30.1%
Native:	97.7%

**Social Characteristics**

Non-English Speakers:	4.3%
High School + Education:	92.4%
Bachelor's + Education	21.4%

**Industrial (2015)**

Population in labor force:	56.2%
Median income:	\$64,832
Top 5 Industries:	<ol style="list-style-type: none"> <li>1 Manufacturing</li> <li>2 Educational services, healthcare and social assistance</li> <li>3 Construction</li> <li>4 Arts, entertainment, recreation, accomodation and food services</li> <li>5 Professional, scientific, management, Administrative and waste management</li> </ol>

**Presidentially-Declared Disasters**

Flood related total:	\$1,171,546	(2012 Discovery Report)
Recent flood related:	2/28/1986; 1/3/1997; 2/3/2006; 2/15/2008	
Other hazards:		

**Insurance**

Total Premiums:	\$107,652	<b>Variances</b>	
Total Coverage:	\$41,354,100	Repetitive Losses:	0
Total Policies:	216	Total Claims:	\$40,962
A Zone Policies:		BXC Zone claims:	
BCX Policies:			

**Mitigation Projects and Other Grants**

<b>Approved Mitigation Projects</b>	<b>Funding:</b>		
<b>Pending Mitigation Projects</b>			
<b>Mitigation Plans:</b>	Storey County Hazard Mitigation Plan	<b>Effective Date:</b>	2015
<b>Other Plans</b>	Emergency Operations Plan		
	Carson River Watershed Regional Floodplain Management Plan		2013

## APPENDIX C

### 2. Community Interview Notes

## ALPINE COUNTY

Discovery Meeting Responses	CWSD FOLLOW-UP ITEMS
<b>Present Potential Flood Risk Projects for Discovery Update</b>	
1 List any existing planned projects (2012 Discovery, 2008/2013 Regional Floodplain Management Plan) no longer being considered	
2 Provide any feedback regarding potential flood risk projects	Are there flood mitigation projects in area affected by Washington Fire?
3 Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas	Mesa ADMP?
4 Discuss areas where flood risk data may be outdated	Do Zone D maps need to be updated?
5 Discuss any new flood risk projects you are considering:	
<b>Flood Risk Reduction</b>	
6 Briefly describe your mitigation capabilities	
7 Briefly describe any hazard risk assessments your community has completed since the last Discovery	Is funding assistance needed to update County's lapsed HMP?
8 Describe any current or future mitigation activities planned in your community	
<b>Data Requests</b>	
9 Do you have any high-water marks or photos from recent flood events?	
10 Will you be providing any storm water or floodplain data generated since the last Discovery?	
11 Has your community acquired any new aerial topography or LiDAR data since the last Discovery?	
12 Who should we contact for any community demographic data?	
13 Has your community recently completed a hazard mitigation plan, and if so whom should we contact?	
14 Do you know of any other flood hazard mitigation data not previously listed?	
<b>Please add any additional comments or concerns relative to your jurisdiction:</b>	

<b>Carson City</b>		
<b>Discovery Meeting Responses (8/15/2017)</b>		<b>CWSD FOLLOW-UP ITEMS</b>
<b>Present Potential Flood Risk Projects for Discovery Update</b>		
<b>1</b>	List any existing planned projects	None – all projects are being considered
<b>2</b>	Provide any feedback regarding potential flood risk projects	What method should be used to add projects to the plan in between the update process
<b>3</b>	Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas	Current growth in the city is on the Schulz, Lompa and Anderson Ranches. These proposed developments are required to analyze and mitigate their flood impacts.  Lompa Ranch development requires the realignment of existing flood channels within the proposed site. The channel design is currently going through the CLOMR process.
<b>4</b>	Discuss areas where flood risk data may be outdated	Data within the Clear Creek watershed including Prison Hill area. Data within the Pinion Hills area from Deer Run bridge south to the city boundary and east of the Carson River.
<b>5</b>	Discuss any new flood risk projects you are considering:	Look at the feasibility to adding flood control facilities to the Goni Canyon watershed as well as Prison Hill, Kings and Ash Canyons per Hazard Mitigation goal 5A.  Look at the feasibility to adding flood control facilities to the Goni Canyon watershed as well as Prison Hill, Kings and Ash Canyons per Hazard Mitigation goal 5A (including maintenance costs). Area Drainage Master Plans for several areas of Carson City: Eagle Valley A & B; Goni Wash; Area Between Goni Wash & Eagle Valley Creek (North of Highway 50, East of Highway 395, West of Goni); Ash Canyon; Kings Canyon; H & I tributary; Prison Hill Area; Pinion Hills Area (East of River & South of Deer Run Road) New projects to be considered which come out of any conducted Area Drainage Master Plan (sediment transport / flood mitigation projects/ costs) Future flood studies in the Clear Creek Watershed area.
<b>Flood Risk Reduction</b>		
<b>6</b>	Briefly describe your mitigation capabilities	Currently the City has over 50% of the SFHA in open space. The City continues to find ways to expand their open space ownership to coincide with the SFHA. The City has developed a city-wide sand bagging plan that provides setup guidance prior to and during a flood event. Also, the City has constructed flood control facilities in different parts of the City.  Detention and retention basins
<b>7</b>	Briefly describe any hazard risk assessments your community has completed since the last Discovery	The City has updated their Hazard Mitigation Plan in 2016. The document addresses all mitigation plans.  Goni Canyon Wash Floodplain study; Eagle Valley Golf Course A&B Drainage/Floodplain Restudy/Remapping
<b>8</b>	Describe any current or future mitigation activities planned in your community	The City's current effort involves feasibility studies for various future detention and sediment basins around the city, then looking for grant funds to construct the basins.  With so much open space in City, are there any studies / plan/ projects needed regarding trail's impacts during flood events? Is there language in policy's / ordinances to ensure trail infrastructure does not create flood hazards?
<b>Data Requests</b>		
<b>9</b>	Do you have any high-water marks or photos from recent flood events?	Public works has flood photos
<b>10</b>	Will you be providing any storm water or floodplain data generated since the last Discovery?	None
<b>11</b>	Has your community acquired any new aerial topography or LiDAR data since the last Discovery?	None
<b>12</b>	Who should we contact for any community demographic data?	Lee Plemel – Planning Director
<b>13</b>	Has your community recently completed a hazard mitigation plan, and if so whom should we contact?	Yes, the document is on the City website at <a href="http://www.carson.org">www.carson.org</a>
<b>14</b>	Do you know of any other flood hazard mitigation data not previously listed?	None known
<b>Please add any additional comments or concerns relative to your jurisdiction:</b>		

## CHURCHILL COUNTY

Discovery Meeting Responses		CWSD FOLLOW-UP ITEMS
<b>Present Potential Flood Risk Projects for Discovery Update</b>		
<b>1</b>	List any existing planned projects	No current projects listed
<b>2</b>	Provide any feedback regarding potential flood risk projects	New projects to be considered are: 1. Revised FIRM study 2. Carson River clearing and snagging program
<b>3</b>	Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas	
<b>4</b>	Discuss areas where flood risk data may be outdated	The old FIRM maps are from the 1970s, we need a revised FIRM to show modern growth, new plans, and new water spillways
<b>5</b>	Discuss any new flood risk projects you are considering:	Consider mapping and providing mitigation for areas at greater risk for flooding. Any plans to identify and maintain floodplain lands as open space or agricultural production? Any plans to elevate/buy back high flood hazard and/or repetitive loss properties within the floodplain?
<b>Flood Risk Reduction</b>		
<b>6</b>	Briefly describe your mitigation capabilities	Precautionary releases in accordance with the BOR Lahontan Dam Emergency Action Plan
<b>7</b>	Briefly describe any hazard risk assessments your community has completed since the last Discovery	None
<b>8</b>	Describe any current or future mitigation activities planned in your community	None  Are any studies/plans/projects to improve Bafford Lane Bridge to reduce flood hazard? Has community considered developing floodplain ordinances which recognize importance of floodplains and implementing flood mitigation ordinances and building standards within the floodplain? Has community considered transfer of development rights (TDRs), conservation easements, or other alternative to preserve floodplain?
<b>Data Requests</b>		
<b>9</b>	Do you have any high-water marks or photos from recent flood events?	Yes, City of Fallon and TCID
<b>10</b>	Will you be providing any storm water or floodplain data generated since the last Discovery?	See TCID and BOR concerning Churchill County
<b>11</b>	Has your community acquired any new aerial topography or LiDAR data since the last Discovery?	Yes, see Preston Denney (GIS Coordinator for Churchill County)
<b>12</b>	Who should we contact for any community demographic data?	Rex Massey is a consultant for Churchill County on demographics
<b>13</b>	Has your community recently completed a hazard mitigation plan, and if so whom should we contact?	Mike Heidemann, updated in 2016/2017.
<b>14</b>	Do you know of any other flood hazard mitigation data not previously listed?	Contact BOR and TCID – they should have more data based upon 2017 events
<b>Please add any additional comments or concerns relative to your jurisdiction:</b>		

Completed projects:

1. Sagouspie Dam Debris/Sediment Removal Flood Control and River Rehabilitation
2. Carson River Lahontan Dam Carson Sink – Debris Removal Flood Control

## DOUGLAS COUNTY

Discovery Meeting Responses (8/15/2017)		CWSD FOLLOW-UP ITEMS
<b>Present Potential Flood Risk Projects for Discovery Update</b>		
<b>1</b>	List any existing planned projects (2012 Discovery, 2008/2013 Regional Floodplain Management Plan) no longer being considered	Stephanie Way Detention Basin (may be included in JLADMP)
		Old Ruhenstroth Dam removal -
<b>2</b>	Provide any feedback regarding potential flood risk projects	Maintenance costs; timeline for building Smelter Creek Detention Basin may be long
<b>3</b>	Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas	**Need to ask Planning or County Engineer
<b>4</b>	Discuss areas where flood risk data may be outdated	Pinenut Creek - from Jo Lane to Orchard is A zone - needs a detailed study. Also Sierra Country Estates, Smelter Creek in Ruhenstroth. South County (south of TRE) low priority as there is not much development, there are a couple of areas between Pinenut and Fish Springs Road
<b>5</b>	Discuss any new flood risk projects you are considering:	Floodplain ordinances update
		Area Drainage Master Plans for other areas of Douglas County
		New projects to be considered will come out of Johnson Lane Area Drainage Master Plan (JLADMP)
<b>Flood Risk Reduction</b>		
<b>6</b>	Briefly describe your mitigation capabilities	Building code is 1' higher than FEMA regulations. Updated maps coming soon for Carson River Floodplain. Limitations for land division in SFHA. No parcels less than 19 acres unless . . . (DC Code)
<b>7</b>	Briefly describe any hazard risk assessments your community has completed since the last Discovery	Floodway is being remapped in Carson River floodplain. East Valley Washes FIRMs updated. LOMRS. Douglas County Flood Management Guide (12/28/2015)
<b>8</b>	Describe any current or future mitigation activities planned in your community	Carson River Floodplain re-mapping in review
		TDRs?
		Johnson Lane ADMP
		Conservation Easements?
		Smelter Creek Detention Basin
		Open Space Plans?
		Alpine View Estates LOMR in review
		Data Requests
		SR88 Culvert expansion at Cottonwood Slough and East Fork of Carson River
<b>Data Requests</b>		
<b>9</b>	Do you have any high-water marks or photos from recent flood events?	Yes, and HDR, weather service do as well
<b>10</b>	Will you be providing any storm water or floodplain data generated since the last Discovery?	Yes, new FIRMs, JLADMP should be completed in mid-2018
<b>11</b>	Has your community acquired any new aerial topography or LiDAR data since the last Discovery?	LiDAR of Johnson Lane area for ADMP; ask GIS when it was last done **
<b>12</b>	Who should we contact for any community demographic data?	GIS? Assessor??
<b>13</b>	Has your community recently completed a hazard mitigation plan, and if so whom should we contact?	Hazard Mitigation Plan is being updated in 2018.
<b>14</b>	Do you know of any other flood hazard mitigation data not previously listed?	
<b>Please add any additional comments or concerns relative to your jurisdiction:</b>		

LYON COUNTY		
Discovery Meeting Responses (8/15/2017)		CWSD FOLLOW-UP ITEMS
<b>Present Potential Flood Risk Projects for Discovery Update</b>		
<b>1</b> List any existing planned projects		
<b>2</b> Provide any feedback regarding potential flood risk projects	USA Parkway impacts to Silver Springs	
<b>3</b> Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas	Silver Springs	Dayton Valley, Moundhouse, & Stagecoach is expected to grow; Suggest listing ADMP projects for 1) Highway 50 Corridor from Moundhouse through Silver Springs for areas of current/planned future growth; and 2) Alluvial Fans South of Carson River in Dayton Valley (eg Eldorado Canyon) in areas of current/planned future growth; 3) Consider listing flood impact studies regarding bridge alternatives in East Dayton Valley; 4) Any flood data needs in relation to water/ wastewater treatment plant?
<b>4</b> Discuss areas where flood risk data may be outdated	Flash flood potential Alluvial fan flooding	
<b>5</b> Discuss any new flood risk projects you are considering:	Ramsay Canyon Study Special Improvement District for Storm Drainage that flows into Carson River along Carson River (design, construct, operate and maintain)	New studies and/or projects which may be identified by Dayton Valley ADMP and future ADMP's within the county to help reduce flood risk to communities within the county
<b>Flood Risk Reduction</b>		
<b>6</b> Briefly describe your mitigation capabilities	Compliance with Title 12 (Flood Control) and work done by Dayton Conservancy District	
<b>7</b> Briefly describe any hazard risk assessments your community has completed since the last Discovery	2012 Ramsey Canyon Study by Manhard Consulting of Highlands/Silver Springs	
<b>8</b> Describe any current or future mitigation activities planned in your community	2017 Ramsay Canyon Study Title 15 – Low Impact Development Standards adoption Carson River Storm Water SID proposal	With so much open space in City, are there any studies / plan/ projects needed regarding trail's impacts during flood events? Is there language in policy's / ordinances to ensure trail infrastructure does not create flood hazards?
<b>Data Requests</b>		
<b>9</b> Do you have any high-water marks or photos from recent flood events?	Yes	Please provide on a flash drive at Discovery Meeting
<b>10</b> Will you be providing any storm water or floodplain data generated since the last Discovery?	Yes	Please provide on a flash drive at Discovery Meeting
<b>11</b> Has your community acquired any new aerial topography or LiDAR data since the last Discovery?	Yes	Yes, new LIDAR flown 9/2017 by USGS; will be available ~5/2018
<b>12</b> Who should we contact for any community demographic data?	Planning department	
<b>13</b> Has your community recently completed a hazard mitigation plan, and if so whom should we contact?	Emergency Manager	
<b>14</b> Do you know of any other flood hazard mitigation data not previously listed?		
<b>Please add any additional comments or concerns relative to your jurisdiction:</b>		

## STOREY COUNTY

Discovery Meeting Responses  
(8/15/2017)

CWSD FOLLOW-UP ITEMS

### Present Potential Flood Risk Projects for Discovery Update

- 1 List any existing planned projects
- 2 Provide any feedback regarding potential flood risk projects
- 3 Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas
- 4 Discuss areas where flood risk data may be outdated
- 5 Discuss any new flood risk projects you are considering:

### Flood Risk Reduction

- 6 Briefly describe your mitigation capabilities
- 7 Briefly describe any hazard risk assessments your community has completed since the last Discovery
- 8 Describe any current or future mitigation activities planned in your community

### Data Requests

- 9 Do you have any high-water marks or photos from recent flood events?
- 10 Will you be providing any storm water or floodplain data generated since the last Discovery?
- 11 Has your community acquired any new aerial topography or LiDAR data since the last Discovery?
- 12 Who should we contact for any community demographic data?
- 13 Has your community recently completed a hazard mitigation plan, and if so whom should we contact?
- 14 Do you know of any other flood hazard mitigation data not previously listed?

**Please add any additional comments or concerns relative to your jurisdiction:**

## CWSD

### Discovery Meeting Responses (8/15/2017)

#### Present Potential Flood Risk Projects for Discovery Update

- |   |                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | List any existing planned projects (2012 Discovery, 2008/2013 Regional Floodplain Management Plan) no longer being considered |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2 | Provide any feedback regarding potential flood risk projects                                                                  | Identifying Alluvial Fans which present flood risks and conducting ADMPs; 2) ID land ownership; 3) Sediment transport study of Carson River (USACE? ); 4) Inventory of Diversion /grade control structures & determine potential locations for modifications to pass fish, sediment, and recreational vessels; 5) ID locations for LID projects in watershed and/or places in communities where CRS credits can be applied for LIDs; 6) Explore ecosystem services funding mechanisms for agriculture / open space / parks / golf courses that provide flood hazard mitigation |
| 3 | Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 4 | Discuss areas where flood risk data may be outdated                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 5 | Discuss any new flood risk projects you are considering:                                                                      | Complete the Regional Floodplain Model through Lyon County; work with USBOR to create flood maps in Churchill County Below Lahontan Reservoir                                                                                                                                                                                                                                                                                                                                                                                                                                  |

#### Flood Risk Reduction

- |   |                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                |
|---|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6 | Briefly describe your mitigation capabilities                                                      |                                                                                                                                                                                                                                                                                                                                                                |
| 7 | Briefly describe any hazard risk assessments your community has completed since the last Discovery |                                                                                                                                                                                                                                                                                                                                                                |
| 8 | Describe any current or future mitigation activities planned in your community                     | Ordinance update for new floodplain maps include mitigation language such as LID and green infrastructure in Arid/cold climates; 2) Assess public infrastructure within SFHA / Adequately insured?; 3) Promote CRS program to Lyon and Churchill counties; 4) Explore regional support of CRS program; 5) Project to mitigate repetitive flood loss properites |

#### Data Requests

- |    |                                                                                                   |                                                                                                     |
|----|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 9  | Do you have any high-water marks or photos from recent flood events?                              |                                                                                                     |
| 10 | Will you be providing any storm water or floodplain data generated since the last Discovery?      |                                                                                                     |
| 11 | Has your community acquired any new aerial topography or LiDAR data since the last Discovery?     | USGS will have new LiDAR for Carson City/Douglas County/Lyon County. Should be completed this fall. |
| 12 | Who should we contact for any community demographic data?                                         |                                                                                                     |
| 13 | Has your community recently completed a hazard mitigation plan, and if so whom should we contact? |                                                                                                     |
| 14 | Do you know of any other flood hazard mitigation data not previously listed?                      |                                                                                                     |

#### Please add any additional comments or concerns relative to your jurisdiction:

## APPENDIX C

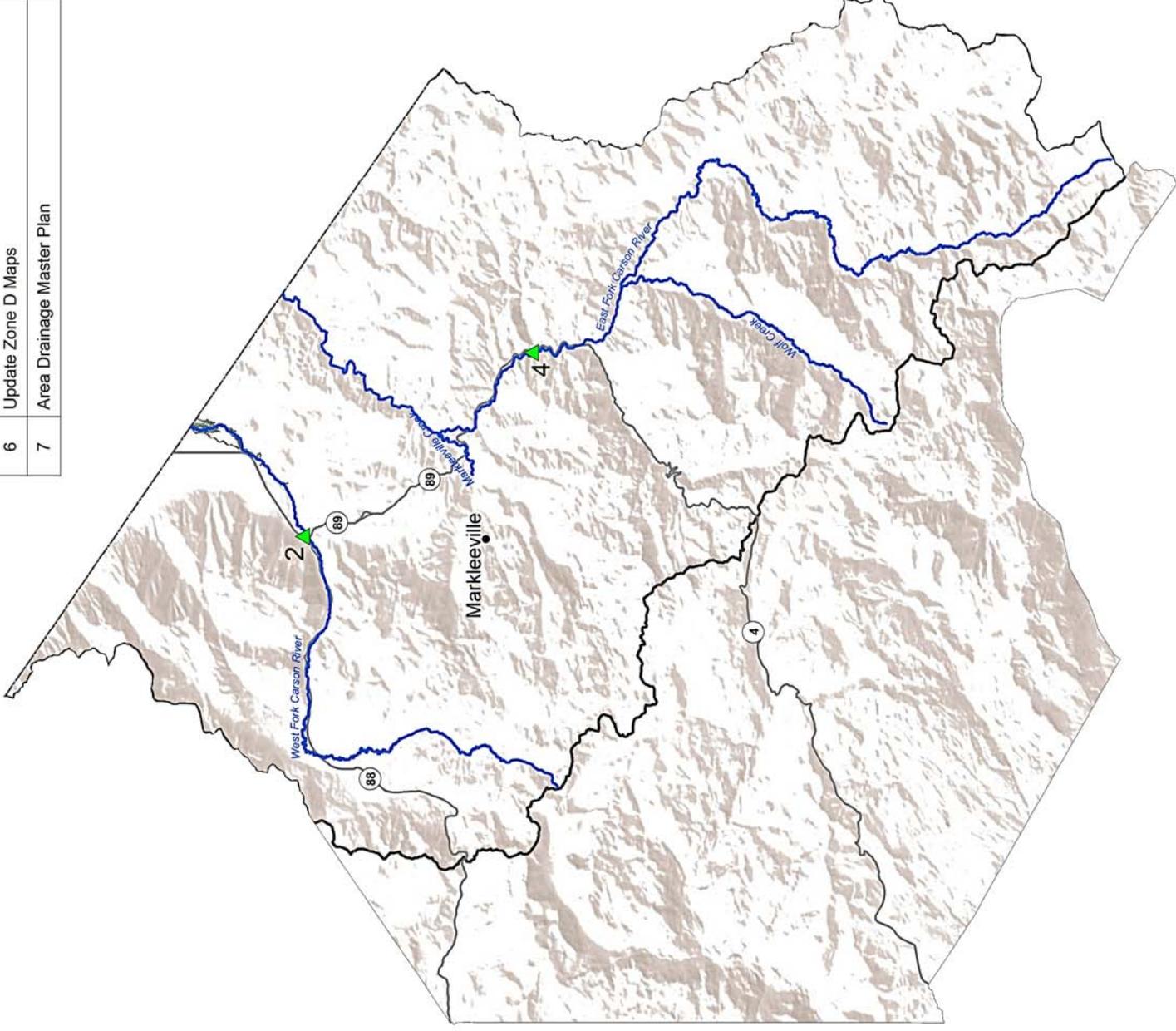
### **3. Community Interview Reference Maps Drafts for October Meeting**



0 4 8 Miles

### Project Locations

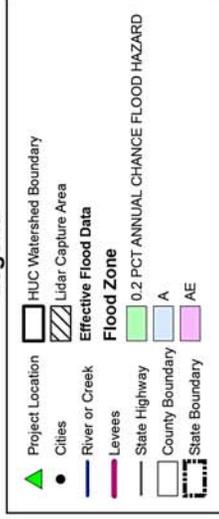
Label	Project
1	Markleeville Creek Floodplain Restoration
2	Woodfords/Highway 88 Bridge
3	Various Mitigation Projects for roads prone to flooding
4	State Highway 89/4 - known flood damage
5	Update Alpine County Hazard Mitigation Plan
6	Update Zone D Maps
7	Area Drainage Master Plan



### Location



### Legend



NATIONAL FLOOD INSURANCE PROGRAM  
**Discovery Map: Flood Risk**

Carson River Watershed

Alpine County

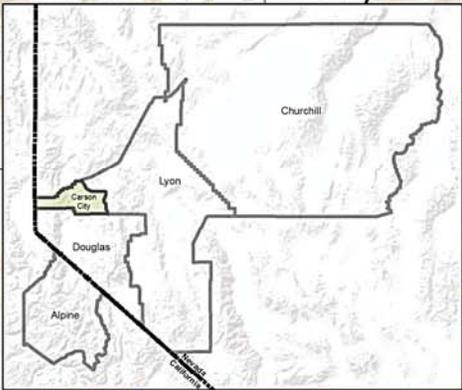


Discovery Report Release Date: 11/17/2017

**Legend**

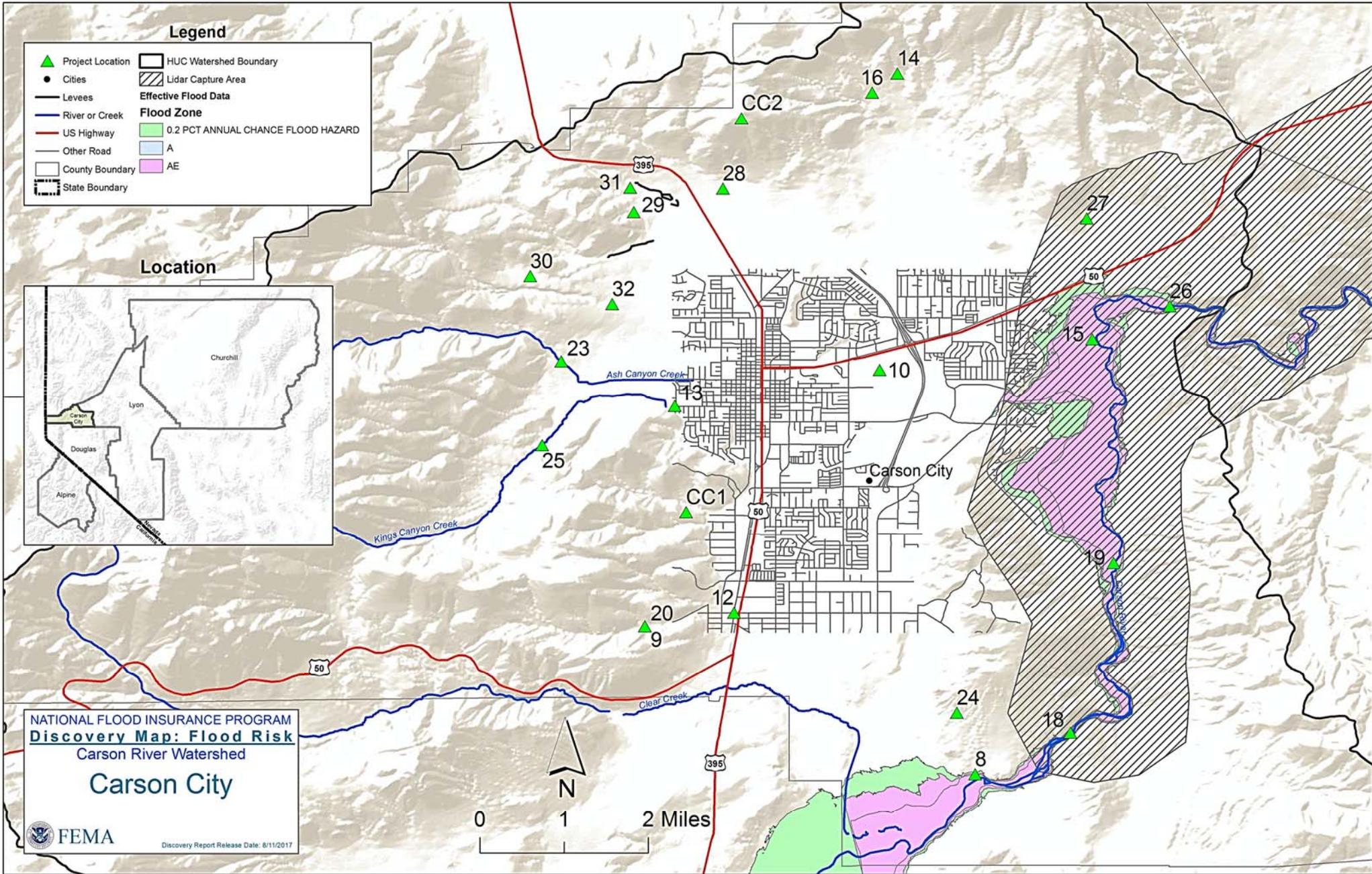
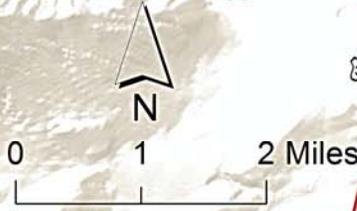
- ▲ Project Location
- Cities
- Levees
- River or Creek
- US Highway
- Other Road
- County Boundary
- ▭ State Boundary
- HUC Watershed Boundary
- ▨ Lidar Capture Area
- Effective Flood Data**
- Flood Zone**
- 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
- A
- AE

**Location**



NATIONAL FLOOD INSURANCE PROGRAM  
**Discovery Map: Flood Risk**  
Carson River Watershed  
**Carson City**

FEMA  
Discovery Report Release Date: 8/11/2017



**Legend**

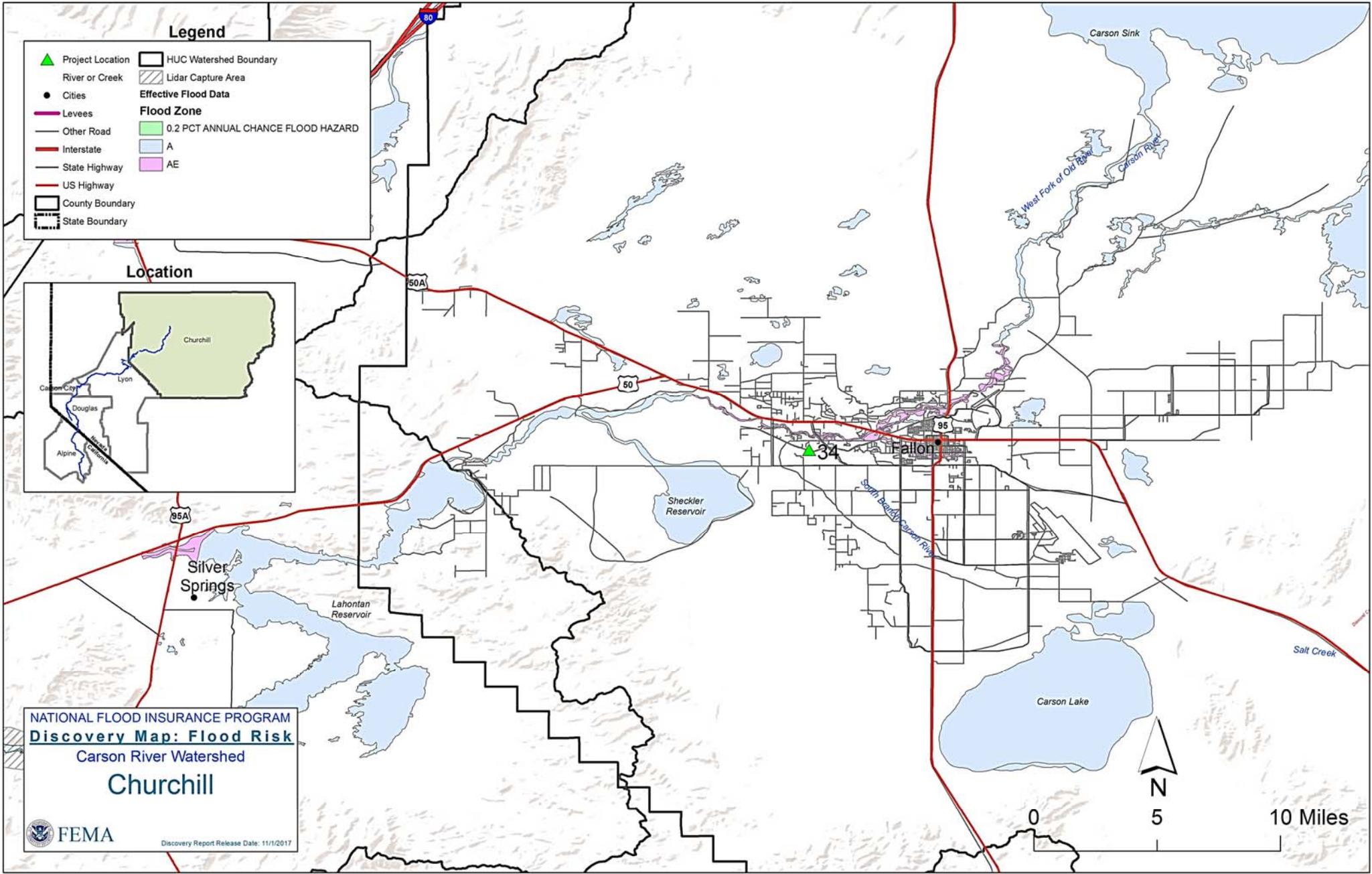
- ▲ Project Location
- River or Creek
- Cities
- Levees
- Other Road
- Interstate
- State Highway
- US Highway
- ▭ County Boundary
- ▭ State Boundary
- ▭ HUC Watershed Boundary
- ▨ Lidar Capture Area
- Effective Flood Data**
- Flood Zone**
- 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
- A
- AE

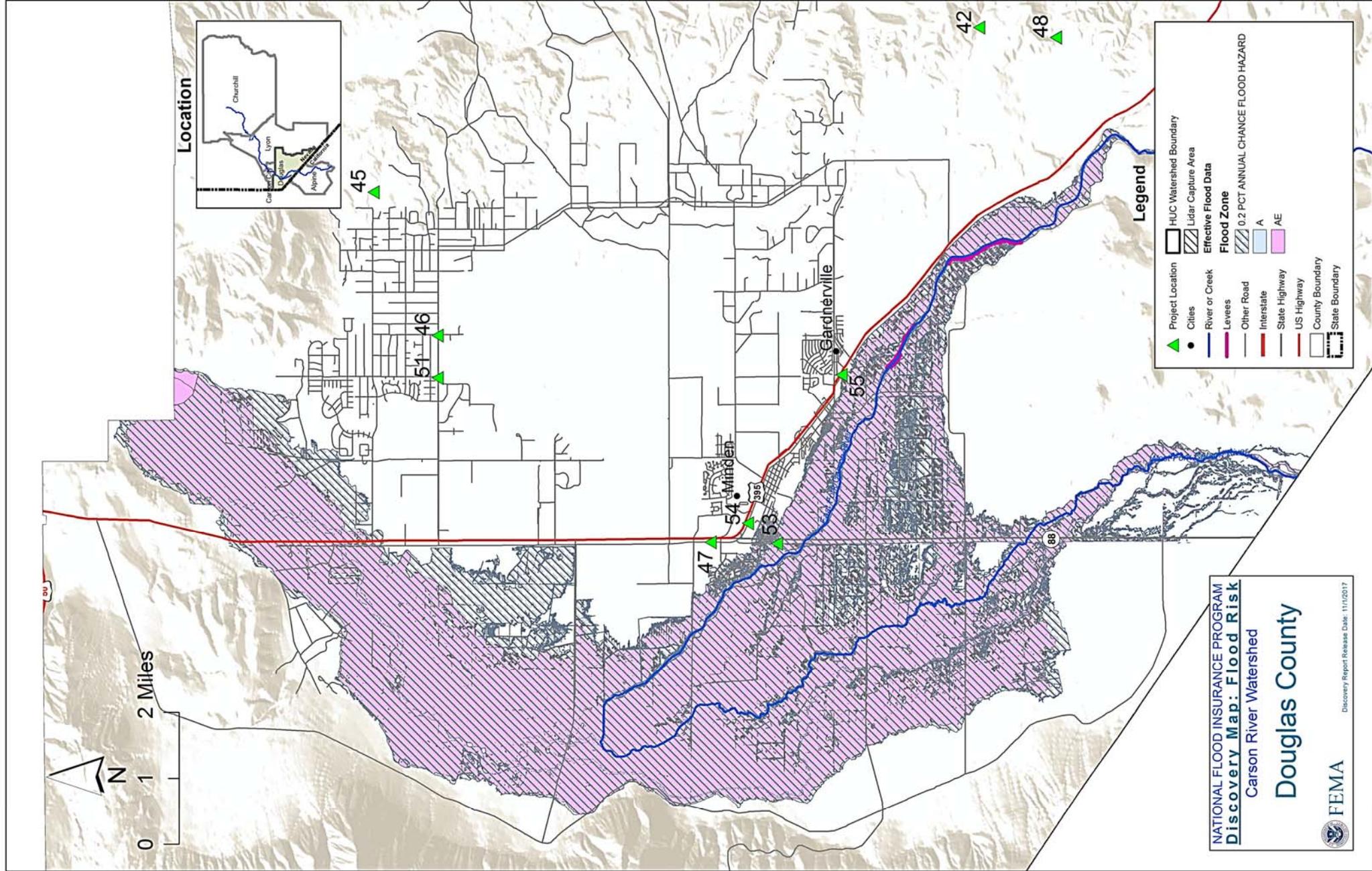
**Location**



NATIONAL FLOOD INSURANCE PROGRAM  
**Discovery Map: Flood Risk**  
Carson River Watershed  
**Churchill**

FEMA  
Discovery Report Release Date: 11/1/2017





**Legend**

	Project Location		HUC Watershed Boundary
	Cities		Lidar Capture Area
	River or Creek		Effective Flood Data
	Levees		Flood Zone
	Other Road		0.2 PCT ANNUAL CHANCE FLOOD HAZARD
	Interstate		A
	State Highway		AE
	US Highway		County Boundary
	County Boundary		State Boundary

NATIONAL FLOOD INSURANCE PROGRAM  
**Discovery Map: Flood Risk**  
 Carson River Watershed

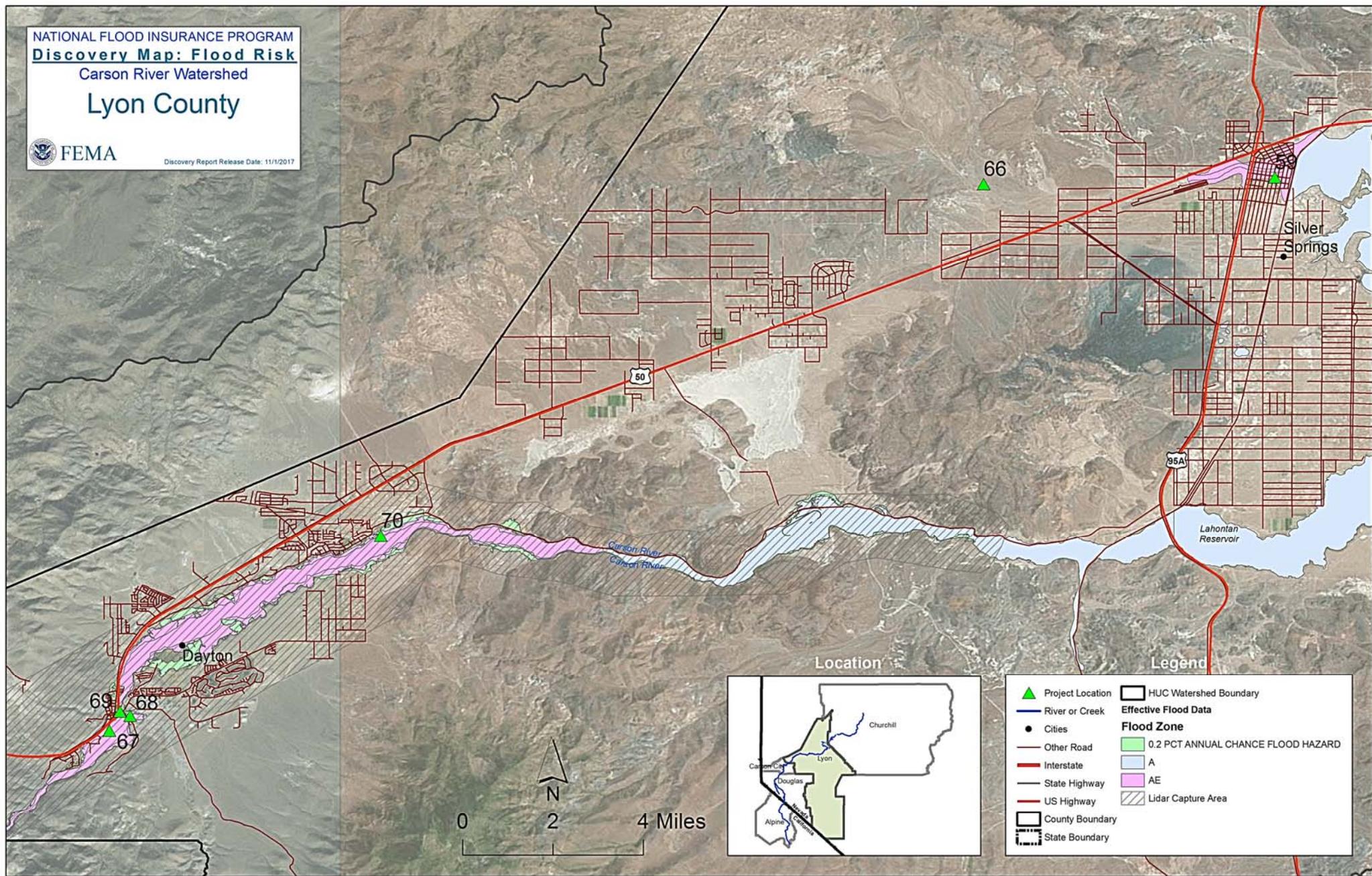
**Douglas County**

FEMA

Discovery Report Release Date: 11/17/2017

NATIONAL FLOOD INSURANCE PROGRAM  
**Discovery Map: Flood Risk**  
 Carson River Watershed  
**Lyon County**

FEMA  
 Discovery Report Release Date: 11/1/2017



**Legend**

Project Location	HUC Watershed Boundary
River or Creek	<b>Effective Flood Data</b>
Cities	<b>Flood Zone</b>
Other Road	0.2 PCT ANNUAL CHANCE FLOOD HAZARD
Interstate	A
State Highway	AE
US Highway	Lidar Capture Area
County Boundary	
State Boundary	

## APPENDIX D

### DISCOVERY MEETINGS

1. August 1 Meeting Notice
2. August15 Meeting Agenda
3. Meeting Handout (Community Questionnaire)
4. List of Attendees
5. Risk MAP Presentation

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## CWSD Meeting Invitation for Carson River FEMA Discovery and Floodplain Management Plan Updates

---



August 1, 2017

Greetings!

The Carson Water Subconservancy District invites you to attend a Carson River Coalition Floodplain and River Management Working Group meeting:

August 15, 2017

1.30 pm to 4.30 pm

Nevada Room at the Governor's Mansion

606 Mountain Street, Carson City, NV 89703

The meeting will cover all areas of the Carson River watershed from Alpine County, California, to Lahontan Reservoir and downstream through Churchill

[Subscribe](#)[Past Issues](#)

The bulk of this meeting, from **1:30 pm – 3:30 pm**, will be focused on a FEMA Discovery and Carson River Floodplain Management Plan Updates to discuss the Risk MAP Discovery process for the Carson River watershed. As part of FEMA's Risk Mapping, Assessment and Planning (Risk MAP) program, CWSD will be working with communities along the Carson River to enhance understanding of flood risk and mitigation efforts. Many of you participated in a similar effort in 2012 and understand the importance of identifying future restudies and projects.

Click this link for the [full invite with data request](#).

Click here for the [draft agenda](#).

Click here for more information on the [FEMA Discovery process](#).

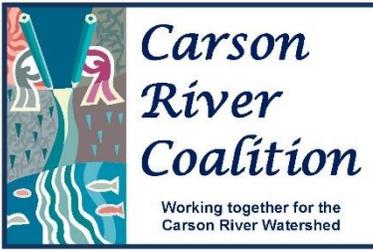
We thank you for supporting this effort and encourage you to attend this important meeting. County officials, floodplain managers, planners, engineers, emergency managers, GIS staff and any other representative you deem appropriate are all invited, and we ask that you pass along a copy of this invitation to whomever should attend this meeting. The partnership between FEMA and all communities is vital to our success in identifying flood risks and needs that may exist. To learn more, please contact Brenda Hunt, our Watershed Program Manager, [brenda@cwsd.org](mailto:brenda@cwsd.org) (775.887.9005). Your continued partnership is critical to the successful completion of these floodplain management planning efforts! We look forward to seeing you at the meeting.

Sincerely,  
Ed James,  
CWSD General Manager  
[edjames@cwsd.org](mailto:edjames@cwsd.org)  
775.887.7450



---

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# Floodplain and River Management Working Group Agenda

Tuesday, August 15, 2017

1:30 PM –4:30 PM

**Location:** ***NOTICE CHANGE OF VENUE and MEETING DURATION!!!***  
**Nevada Room at the Governor's Mansion**  
**606 Mountain Street. Carson City, NV 89703**

**Contact:** Questions? Brenda Hunt, 887-9005, [brenda@cwsd.org](mailto:brenda@cwsd.org)

1. Welcome
2. 1:30 –3:30 pm ***Draft Agenda FEMA Discovery and Floodplain Management Plan Update Meeting***
  - A. Project Overview of Discovery and Floodplain Management Plan Updates
    1. Purpose and Background
    2. Recent Flood Events
    3. Project Timeline
  - B. Present Potential Flood Risk Projects for Discovery Update
    1. Review existing projects
    2. Gather community feedback
    3. Discuss areas of growth;
    4. Discuss areas where flood risk data may be outdated
    5. Discuss potential new projects
  - C. Flood Risk Reduction
    1. Understand local mitigation capabilities, hazard risk assessments, and current or future mitigation activities
  - D. Prepare for Next Meeting
    1. Data request (Discovery Update):
      - i. Photos and high-water marks from recent floods
      - ii. Any storm water or floodplain activities since last Discovery
      - iii. LiDAR and aerial topography acquired since last Discovery
      - iv. Community demographics
      - v. Most recent hazard mitigation plans
      - vi. Any other flood hazard mitigation data
    2. Data request (Floodplain Mgmt. Plan Update)
      - i. TBD
  - E. Next Meeting Date

8/15/2017

FRMWG 1:30 – 4:30PM *Nevada Room* - Governor's Mansion

3. 3:30 -4:30 pm **Last meeting's unfinished business**

A. Floodplain Management Plan Suggested Actions update:

1. SA – 30

- i. Flood Awareness Week Update (Shane/Bunny)
- ii. Floodplains as Community Assets (Debbie) – Please Click the links below to view our four videos:

[Public Service Announcement \(PSA\) - Conserving the Carson River Floodplain as a Community Asset \(:30\)](#)

[Agriculture's a Good Fit for Conserving the Carson River Floodplain as a Community Asset \(4:31\)](#)

[A Case for Developers to Conserve the Carson River Floodplain as a Community Asset \(3:13\)](#)

[Our Officials in Conserving the Carson River Floodplain as a Community Asset \(4:19\)](#)

B. Flood Damage Field Trip (John Coburn)

- 1. Site Selection and Timing (August???)
- 2. Types of damages
  - i. Erosion/Channel Migration
  - ii. Structures
  - iii. Infrastructure/grade controls

C. Finalized Stewardship Plan Submitted (Brenda)

D. Other

4. Schedule Next Meeting

**FEMA Discovery and Floodplain Management Plan Update Meeting – August 15, 2017**  
**Carson River Watershed**  
**Community Questionnaire**

**Community Name:** \_\_\_\_\_

Present Potential Flood Risk Projects for Discovery Update

1. List any existing planned projects (2012 Discovery, 2008/2013 Regional Floodplain Management Plan) no longer being considered: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

2. Provide any feedback regarding potential flood risk projects: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

3. Discuss areas of growth in your community and state whether new flood hazard analyses is warranted for these areas: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

4. Discuss areas where flood risk data may be outdated: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

5. Discuss any new flood risk projects you are considering: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Flood Risk Reduction

6. Briefly describe your mitigation capabilities: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

7. Briefly describe any hazard risk assessments your community has completed since the last Discovery: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

8. Describe any current or future mitigation activities planned in your community: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Data Requests

9. Do you have any high-water marks or photos from recent flood events?  
\_\_\_\_\_

10. Will you be providing any storm water or floodplain data generated since the last Discovery?  
\_\_\_\_\_

11. Has your community acquired any new aerial topography or LiDAR data since the last Discovery? \_\_\_\_\_

12. Who should we contact for any community demographic data?  
\_\_\_\_\_

13. Has your community recently completed a hazard mitigation plan, and if so whom should we contact? \_\_\_\_\_

14. Do you know of any other flood hazard mitigation data not previously listed? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Please note any additional comments or concerns relative to your jurisdiction:

**Thank you!**

**Carson River Watershed Discovery, Floodplain Management Plan Updates**  
**Attendees - August 15, 2017**

FirstName	LastName	Company	Department	Job Title	EmailAddress	BusinessPhone
Jeff	Anderson	Nevada NRCS Snow Survey		Water Supply Specialist	jeff.anderson@nv.usda.gov	775-857-8500 x152
Tim	Bardsley	National Weather Service-Reno		Senior	tim.bardsley@noaa.gov	775-673-8100 x228
Geoff	Brownell	Michael Baker Jr., Inc.			gbrownell@mbakercorp.com	
Craig	Burnside	Carson Valley Conservation District		Watershed Coordinator	<a href="mailto:craig.burnside@nv.nacdnet.net">craig.burnside@nv.nacdnet.net</a>	775-782-9835
Kristine	Ceragioli	Army Corps of Engineers	Reno Regulatory Field Office	Senior Project Manager	Kristine.S.Hansen@usace.army.mil	775-784-5304
Katherine	Clancey	NV Div. of Water Resources		State Floodplain Mapping Coordinator	kclancey@water.nv.gov	775-684-2847
John	Cobourn	University of Nevada Cooperative Extension		Water Resource Specialist	cobournj@UNCE.unr.edu	775-339-0244
Preston	Denny	Churchill County		GIS	planning-gis@churchillcounty.org	
Steven	Endacott	City of Fallon		Emergency Management Director	endacottsteve@charter.net	775-427-5356
Brenda	Hunt	Carson Water Subconservancy District		Watershed Program Manager	brenda@cwsd.org	775-887-9005
Edwin	James	Carson Water Subconservancy District		General Manager	edjames@cwsd.org	775-887-7456
Michael	Johnson	Churchill County		Planning Director	planning-director@churchillcounty.org	775-423-7627
Steve	King			Attorney	kingmont@charter.net	775-427-5821
Steven	Lewis	University of Nevada Cooperative Extension		Extension Educator	lewisst@unce.unr.edu	(775) 782-9960
Debbie	Neddenriep	Carson Water Subconservancy District	Water Resource Specialist 2		debbie@cwsd.org	775-887-1260
Karin	Peternel	Michael Baker International			karin.peternel@mbakerintl.com	
Robert	Pyzel	Lyon County		Planner	rpyzel@lyon-county.org	
James	Shell	US Navy - Fallon NAS	Commanding Officer		James.shell@navy.mil	
Jeanmarie	Stone	NV Div. of Environmental Protection			jstone@ndep.nv.gov	
Mary Kay	Wagner	NV Div. of Environmental Protection	Bureau of Water Quality Planning		mkwagner@ndep.nv.gov	
Courtney	Walker	Douglas County	Public Works	Storm Water Program Manager	cwalker@douglasnv.us	775-782-6215
Zach	Wood	Alpine County			zach@pd.alpinecountyca.com	
Shane	Fryer	Carson Water Subconservancy District		Watershed Program Specialist	shane@cwsd.org	775-887-1260
Bryant	Smith	BLM	Sierra Front	Field Manager	bbsmith@blm.gov	775-885-6172
Barry	Wood	Fallon NAS	Emergency Management	Emergency Management Officer	barry.wood@navy.mil	775-426-3190
Leah	Hoover	DVCD		Administrative Assistant	lkniffen.dvcd@gmail.com	775-246-1999
Lyndsay	Boyer	Carson City	Open Space	Sr. Water Resource Specialist	<a href="mailto:lboyer@carson.org">lboyer@carson.org</a>	775-283-7341
Dan	Stucky	Carson City	Public Works	City Engineer	<a href="mailto:dstucky@carson.org">dstucky@carson.org</a>	
Anne	Knowles	Nevada Appeal		Reporter	<a href="mailto:aknowles@nevadaappeal.com">aknowles@nevadaappeal.com</a>	
Charles	Reno	Farr West Engineering	Lyon County	County Engineer	<a href="mailto:chuck@farrwestengineering.com">chuck@farrwestengineering.com</a>	
Ken	Gray	Lyon County	BOCC		<a href="mailto:kgray@lyon-county.org">kgray@lyon-county.org</a>	
Toni	Leffler	CWSD				



# Discovery and Floodplain Management Plan Updates

## Carson River Watershed

August 15, 2017

**RiskMAP**  
Increasing Resilience Together



## Introductions

- **Project Team**
  - Carson Water Subconservancy District
  - Michael Baker International
- **Local Community partners and officials**
  - Alpine, Churchill, Douglas, Lyon, Storey, Carson City
- **State of Nevada partners and officials**
  - NDEM, NDWR, NDEP,
- **Other Federal Agencies partner representatives**
  - FEMA, USGS, U.S. Navy, National Weather Service
- **Associations**
- **Other Stakeholders**
  - Washoe Tribe, Fallon Tribe,



2



## Agenda

- **A. Project Overview**
  - Discovery Update
  - Floodplain Management Plan Update
- **B. Present Potential Flood Risk Projects for Discovery Update**
- **C. Flood Risk Discussion**
- **D. Prepare for Next Meeting**
  - Data Request – Discovery
  - Data Request – Floodplain Management Plan
- **E. Next Meeting Date**



3



## Project Overview

- **Why are we here today?**
- **Discovery Plan Update**
  - The Discovery of flood hazards and associated flood risk and mitigation activities
    - Data Collection
    - Stakeholder coordination
    - Meetings
- **Floodplain Management Plan Update**
  - Continue to create a long-term vision and strategies for floodplain management to reduce flood damage impacts

### **Understand the needs of communities in the watershed**

- Discuss flood risk
- Balance local needs with FEMA's resources
- Plan for possible flood risk projects



4



## Discovery

- **Discovery helps determine the areas within your watershed where a flood risk study is needed**
- **During Discovery, we work together to:**
  - Review local flood risk and hazards
  - Understand local mitigation capabilities, hazard risk assessments, and current or future mitigation activities
  - Collect information about flooding history, development plans, daily operations, and stormwater and floodplain management activities



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## Purpose and Background

- **Discovery Report (2013)**
  - Developed the framework for dealing with flood risk in the Carson River Watershed. As flood risk projects have been completed over the last several years, the community must re-evaluate the flood risks in the watershed, identify prioritized and sequenced new projects
- **Process:**
  - Evaluate regulatory mapping, risk assessment, mitigation planning technical assistance, and outreach and communications assistance.
- **Six main activities:**
  - Watershed Stakeholder Coordination
  - Data Analysis
  - Discovery Meeting
  - Post-Meeting Coordination
  - Database Updates
  - Project Refinement.
- **Updated Discovery Report Due November, 2017**



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## Purpose and Background

- **Floodplain Management Plan (2008, 2013)**
- In 2008, CWSD and the various counties along the Carson River adopted the Carson River Regional Floodplain Management Plan (Plan).
  - Plan developed a long-term vision and strategies for floodplain management to reduce flood damage impacts, benefitted by a regional approach
- **Suggested Actions**
  - 38 Suggested Actions were reviewed and summarized on a county and watershed-wide basis.
    - Many of the projects and programs have or are being implemented; Continuing work needed to address flooding
- **Recent Events**
  - Alluvial fan and stormwater flooding events, extended snowmelt runoff, available storage capacity issues
- **Updated Draft Plan due August, 2018**



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## Potential Flood Risk Projects for Discovery Update

### GROUP DISCUSSION

- Review existing projects
- Gather community feedback
- Discuss areas of growth
- Discuss areas where flood risk data may be outdated
- Discuss potential new projects



8



## Flood Risk Reduction

### GROUP DISCUSSION TO UNDERSTAND:

- Local mitigation capabilities
- Hazard risk assessments
- Current or future mitigation activities



9



## Next Meeting – Data Request

### DISCUSSION - COMMUNITY QUESTIONNAIRE

- Photos and high water marks from recent floods
- Storm water or floodplain activities since last Discovery (2012)
- LiDAR and aerial topography since last Discovery
- Community demographics
- Flood hazard mitigation plans
  - Alpine County – under revision
  - Carson City Hazard Mitigation Plan – 2016
  - Churchill County/City of Fallon Hazard Mitigation Plan (2012)
  - Douglas County Natural Hazard Mitigation Plan - 2013
  - Lyon County Multi-jurisdictional Hazard Mitigation Plan July 2013
- Any other flood hazard mitigation data



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## **APPENDIX E**

### **POTENTIAL MITIGATION PROJECTS**

## APPENDIX E

### JURISDICTIONAL POTENTIAL MITIGATION PROJECTS

Alpine County					
NO.	PROJECT	COMMENTS	JUR. PRIORITY	HMP MITIGATION GOAL	LOCATION
1	Analysis of post-fire (Washington) flood mitigation; along Highway 89			Sec. 8, Goal	38.592 - 119.752
2	East Fork Carson River LiDAR			Sec. 8, Goal 2C	38.664772, - 119.707487
3	Erosion Zone Analysis	Between Markleeville and Wolf Creek			38.674587, - 119.736088
4	Flooding at Markleeville Creeks blocks Public Works Access to Lift Station; explore flood mitigation options			Sec. 8, Goal 7G?	38.698041, - 119.771424
5	Map Markleeville Creek Drainage			Sec. 8, Goal 2C	38.677836, - 119.794713
6	Markleeville Creek Floodplain Restoration				38.697998, - 119.777715
7	Markleeville Creek LiDAR			Sec. 8, Goal 2C	38.688665, - 119.786605
8	Potential Impact Analysis; Number & Location of residents with flood insurance as way to focus efforts.			Sec. 8, Goal 2A	
9	State Highway 89/4 - known flood damage				38.660574, - 119.726352
10	Update FIRM Panels?				
11	Various Mitigation Projects for roads prone to flooding				
12	Woodfords/Highway 88 Bridge - STPUD C-Line blowout			STPUD HMP Plan: Severe Storms Obj. #2: Minimize storm related damage from all types of severe storms that impact district facilities.	<a href="#">38.778781, - 119.821539</a>

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Carson City					
NO.	PROJECT	COMMENTS	JUR. PRIORITY	HMP MITIGATION GOAL	LOCATION
1	Goni Wash Area Drainage Master Plan (ADMP), drainage system improvements, maintenance costs		H	Sec. 8 Goals 1, 5, 7, 10	39.208362, -119.725276
2	King Street drainage/flood protection improvements and maintenance costs		H	Sec. 8, Goals 5, 7, 9	39.164020, -119.780888
3	Kings Canyon Area Drainage Master Plan (ADMP) and flood control facility		H	Sec. 8, Goals 1, 5, 7, 9	39.157260, -119.803691
4	South Carson Street storm drain system improvements	Associated with South Carson Street Improvements; should be implemented in 2019; will still need some funding so leave in	H	Sec. 8, Goals 5, 9	39.154540, -119.767018
5	South Carson Street/South Curry Street storm drain system improvements	Associated with South Carson Street Improvements; should be implemented in 2019; will still need some funding so leave in	H	Sec. 8, Goal 1	39.141992, -119.768288
6	Voltaire Canyon Channel and Drainage system improvements		H	Section 8, Goals 1,5	39.126091, -119.786021
7	Voltaire Canyon Floodplain Restudy/Remapping	Ongoing	H	Section 8, Goals 1, 5, 7, 9	39.126091, -119.786021
8	Ash Canyon Area Drainage Master Plan (ADMP) and flood control facility and maintenance costs		M	Section 8, Goals 1, 5, 7, 9	39.171675, -119.800376
9	Carson River Channel Clearing and Snagging - Flood Protection	Mainstem Carson River to New Empire	M	Sec. 8, Goal 1?	Ongoing
10	Clear Creek Area Drainage Master Plan, Restudy, maintenance costs	See polygon	M	Sec. 8, Goals 1, 5, 7, 9,	39.112716, -119.760239
11	Eagle Valley Golf Course A&B Area Drainage Master Plan (ADMP) and drainage system improvements	Restudy done; Floodplain just revised; should go into effect 10/26/2017;	M	Sec. 8, Goals 1, 5, 7, 9	39.188645, -119.713521
12	Eagle Valley Golf Course basin and piping improvements	what could mitigate the impacts	M	Sec. 8, Goals 5,7	39.196268, -119.710076
13	Goni Wash Sediment and Detention basins and maintenance costs	make a polygon	M	Sec. 8, Goals 5, 7, 10	39.221218, -119.742620
14	Areas Between Goni Wash & Eagle Valley Creek Area Drainage Master Plan	see polygon	M	Sec. 8, Goals 1, 5, 6?, 7,	39.211756, -119.767808
15	H&I Tributary ADMP and subsequent sediment transport/flood mitigation projects/costs		M	Sec. 8, Goals 1, 5, 7, 9	39.143396, -119.779450
16	New Empire Drainage System Improvement	Substandard drainage system; make polygon	M	Sec. 8, Goals 5, 8	39.178885, -119.724824
17	Prison Hill Area Drainage Master Plan, restudy and remapping, flood control facility		M	Sec. 8, Goals 1, 5, 7, 9	39.131249, -119.741044
18	East Silver Saddle Ranch and Sierra Vista Lane drainage improvements; Pinion Hills from Deer Run Bridge south to City boundary - Study	See Polygon of 19 and 26	L	Sec. 8, Goals 1, 5, 7, 9	39.138384, -119.700372

## APPENDIX E

Carson City					
NO.	PROJECT	COMMENTS	JUR. PRIORITY	HMP MITIGATION GOAL	LOCATION
19	Forest Legacy Project Old Woods Ranch/Schulz Invt. Cons. Easements Project	Clear Creek (Carson River Tributary)	L	Sec. 8, Goals 2, 6?, 7	39.115067, -119.845845
20	Golden Eagle Lane (Flood Protection, Rehabilitation / Stabilization)	Multiple segments of the river on which projects are necessary	L	Sec. 8, Goals 1, 5, 7	39.107734, -119.712887
21	Saliman and Carson High drainage system improvements	Install another pipe south to Robinson will alleviate flooding by High School	L	Sec. 8, Goals 5, 9	39.170173, -119.745684

Churchill County					
NO.	PROJECT	COMMENTS	JUR. PRIORITY	HMP MITIGATION GOAL	LOCATION
1	Revised FIRM study for Churchill County and City of Fallon		L	Sec. 8, 6.1	
3	Study to evaluate the Newlands Project infrastructure to increase flood water diversions to Stillwater NWR	TCID project	H	Sec. 8, 6.1, 6.3	
4	Carson River watershed floodplain model update	City of Fallon	M	Sec. 8, 6.1	
5	Study of potential impacts due to varying high flows in canals and emergency operations or mitigation; Casey and Bottom Roads		M	Sec. 8, 6.1, 6.3	39.469347, -118.853610
6	Inundation maps/stormwater area drainage master plan below Lahontan		L	Sec. 8, 6.1	
7	Flood Water control and mitigation study report from V-line weir to Carson Lake to reduce impact to US Navy Bravo 16	Fallon NAS	M	Sec. 8, 6.4, 6.7	

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Douglas County					
NO.	PROJECT	COMMENTS	JUR. PRIORITY	HMP MITIGATION GOAL	LOCATION
1	Pinenut Wash attenuation study	No progress on this study	H	Sec. 8, Goal 5	38.907443, -119.665535
2	100-year flood access from US HWY395 to Foothill Road	Construction one 100-year flood access from US HWY395 to Foothill Road. Options include Centerville, Mottsville, Muller, or Genoa Lane.	H		
3	Johnson Lane Area Drainage Master Plan	In progress; June 2018	H	Sec. 8, Goal 10	39.026845, -119.733462
4	Martin Slough (NDOT)	Project currently out to bid. Construction to be completed Spring 2018.	H		38.966682, -119.779105
5	Tracking between forks outside of floodway	Procedure for doing this in Douglas County	H		
6	Projects as a result of Johnson Lane ADMP including Stephanie Way Flood Control Facility		H	Sec. 8, Goal 10	39.026887, -119.742770
7	Carson River Floodplain re-mapping	IN FEMA Review	H		
8	SR88 Culvert expansion Cottonwood Slough	In process; acquiring ROW through NDOT.	H	Sec. 8, Goal 6	38.952034, -119.779415
9	Zone A BFE unknown restudies (Carson River PMR – almost complete)		H	Sec. 8, Goal 4	
10	Washoe Tribe Bank Stabilization project	90% Design - needs \$340,000; \$100,000 already received through EPA funding	M		Adjacent to Washoe tribal property;
11	Carson River clearing and snagging projects (Proactive infrastructure/river maintenance and replacement)	Lutheran Bridge and Cradlebaugh Slough Clearing and Snagging to be completed in early 2018	M		
12	Washoe Tribe - Storm water plans/updates		M		
13	LID	Design criteria, procedures, ordinances	M		
14	Smelter Creek Flood Control Facility (detention basin)	CBA recalculated and submitted to FEMA as part of the 2018 PMG and FHMG.	M	Sec. 8, Goal 5	38.890555, -119.667741
15	Floodplain ordinances update	Larger efforts to streamline changes, permits; include protocols/procedures to update model. Dovetail with Rob Loveberg's work	M	Sec. 8, Goal 12~	
16	ADMPs for other areas in the County	Alpine View Estates, Jacks Valley, Indian Hills; wildcat subdivisions where drainage is piecemealed	L	Sec. 8, Goal 4	
17	Countywide Stormwater master plan (Genoa, Minden, Gardnerville)	Add Tribal areas	L	Sec. 8, Goal 4	38.958451, -119.774839
18	Buckeye Creek Wash Study	May be zone A	L	Sec. 8, Goal 3	38.937797, -119.742127
19	Washoe Tribe - 395/Dresslerville - Indian Creek Bridge	Have been funded through BIA to fix/modify infrastructure. Flooding affects Tribal road	L		
20	Studies of other washes and sloughs		L		

## APPENDIX E

LYON COUNTY					
NO.	PROJECT	COMMENTS	JUR. PRIORITY	HMP MITIGATION GOAL	LOCATION
1	River Road Project		M	Sec. 7, Table 7-1, #1	
2	Superfund Site resolution		L		
3	Silver Springs/Ramsay Canyon Remapping	Study sent to FEMA for review; need planning study for improvements, possibly part of NDOT project	H	Sec. 7, Table 7-2 Item 17; Sec. 7, Table 7-1, #1	39.407934, -119.217702
4	TDR, incentivize floodplain protection deer run to New Empire to Lahontan		M	Sec. 7, Table 7-2 Item 3, 15; Sec. 7, Table 7-1, #1	
6	Phase 2 re-vegetation Fort Churchill State Park (Houghman Howard Diversion to Bucklands Station)	follow up	M	Sec. 7, Table 7-2 Item ?	
7	Phase 3 re-vegetation (Bucklands Station to Lahontan Res)	follow up	M	Sec. 7, Table 7-2 Item ?	
8	Title 15 - LID standard adoption		H	Sec. 7, Table 7-2 Item 1?	
9	Special Improvement District for Storm Drainage that flows into Carson River along Carson River (design, construct, operate and maintain); ADMP for Highway 50 Corridor from Moundhouse through Silver Springs (future growth)		H	Sec. 7, Table 7-1, #1	39.405824, -119.310962
10	Alluvial Fan ADMP for areas south of river in Dayton Valley (Eldorado Canyon); future growth		H	Sec. 7, Table 7-1, #1	<a href="#">39.235343, -119.584410</a>
11	Bridge alternatives in East Dayton Valley	Flood impact and alignment study needed as a result of development pressure in area	M	Sec. 7, Table 7-2 Item 3, 15, 17; Sec. 7, Table 7-1, #1	<a href="#">39.236731, -119.587636</a>
12	Wastewater treatment plant - any flood issues?	Pond in floodplain, needs mitigation	L	Sec. 7, Table 7-2 Item 15, 17?; Sec. 7, Table 7-1, #1	<a href="#">39.293079, -119.504058</a>

## APPENDIX E

COMMUNITY-WIDE		
NO.	PROJECT	COMMENTS (10/15/2017)
1	Early warning system to install gages to include a tipping bucket and reverse 911.	System is operational in Carson City with warnings issued by National Weather Service; however, gages are old, may be better systems now. Still very relevant.
2	Floodplain preservation (easements/open areas).	Floodplain and flood hazards should be considered with open space program objectives when selecting acquisition targets and establishing management strategies for open spaces. Still very relevant.
3	Develop Build Wisely! Codes	Implement or enhance county ordinances that include floodplain protection as a purpose, account for the loss of floodplain storage volume, and mitigate losses through a variety of methods. Floodplain ordinance update with Rob Loveberg an ongoing aspect of this.
4	Public awareness (Flood Awareness Week, etc.)	Ongoing, examples of which are as follows: <ul style="list-style-type: none"> <li>• Develop watershed-wide outreach and education program about floodplain importance and flooding hazards.</li> <li>• Brochures should be developed for distribution on a watershed level with consistent messages and information for the general public.</li> <li>• Annual Flood Awareness Week will be established with the objective of providing information about flooding and flood hazards to the general public.</li> <li>• Special Events, River Work Days, and other outreach opportunities should be utilized to help raise awareness of flooding hazards and importance of floodplains.</li> </ul>
5	Elevation Reference Marks (ERM) should be permanent monuments and updated on a regular basis.	ERMs should be in the same datum as base flood elevations on FIRMs or a datum that is readily convertible to FIRM datum. Move towards FEMA recommended NAVD 88 datum. A master list of ERMs should be developed, maintained, and made available to interested parties. A gap analysis may need to be conducted. Douglas County needs updates, other jurisdictions as well. This is especially important since this round of discovery will implement alluvial fan plans, so even more important to understand gaps for those reference marks.
6	DFIRM updated procedure	Updating digital flood maps. Support FEMA's Map Modernization Program and encourage FEMA to update FIRMs with current and future conditions. Significant verification of topography and other variables should be conducted prior to release of draft FIRMs.
7	Flood hazard mitigation procedures and understanding how each community has been developing it.	Establish building set-backs in flood hazard areas, where appropriate, to reduce severe hazards from channel migration.
8	Photo monitoring	Photo-Monitoring program (on-the-ground and aerial) should be developed and coordinated on a watershed level to document flooding and flood hazards in a consistent matter. Important to have on record photos of past floods; pictures to see how system reacts. It will react differently now than it did in 1955 for example, as a result of growth, etc. Consider format or venue to submit anecdotal evidence, pictures. "Report a Flood". Churchill flew lots of aerials during flooding; they have hundreds of pictures in a dropbox. Need a database/procedure to submit pictures.
9	LiDAR and/or aerial photography (on a watershed level) should be conducted on a 5-year basis, or as needed, to provide updated information on channel movement and floodplain condition.	Explore potential for UAS technology of floodplain mapping.

## APPENDIX E

<b>10</b>	Hazard areas - investigate areas for establishment of setbacks and buffer zones in highly hazardous areas.	Retain lands that provide floodplain storage and maintain or restore connection of river with floodplain through land acquisition, conservation easements, local open space programs, TDR and PDR Programs, and other protection methods. This is ongoing with ordinance planning.
<b>11</b>	Infrastructure design/replacement-coordinate with NDOT and local jurisdictions to ensure infrastructure compatible/consistent with RFMP	Ongoing.
<b>12</b>	Groundwater quality impacts - evaluation of groundwater impact due to flooding	Ongoing; still sampling
<b>13</b>	Fluvial geomorphic assessment update (RFMP update 2013)	Very relevant; last done in 1996. New projects: put together a rapid response simulation model. River forecast constantly changing during an event, Following up on that, they found really limited number of forecast sites. Only 3 on Carson River that are reforecasting sites.
<b>14</b>	Sediment transport study	Still relevant. Impacts on water quality; impact flood hazards if changing invert elevation of river. Lateral migration, scour at bridges.
<b>15</b>	Leviathan mine monitoring. There were spills from ponds during winter. Beaver ponds were removed that caused heavy metals build up; water quality issues.	Some misconceptions about the extent of spills. Public outreach to address concerns if necessary.

# **Appendix I**

## **Table of CWSD CTP Projects**

Carson Water Subconservancy District FEMA Mas 1 - 9 Projects

<b>FEMA MAS 1</b>	Project Elements	Grant Performance Period: 9/2009-9/2011; 9/2009 -3/31/2012	Completed	Comments
<b>FEMA Proj. #: EMF-2009-GR-0911</b>	Carson River Remap and Restudy - Lahontan to Dayton Valley & Discovery			3/31/2012 Revision effective 10/16/2016
<b>FEMA MAS 2</b>	Project Elements	Grant Performance Period: 9/26/2011-9/25/2013; 9/26/2014	Completed	Comments
<b>FEMA Proj. #: EMF-2011-GR-1114</b>	Carson River Remap and Restudy - Dayton Valley Carson City		7/30/2014	Submitted & Approved, expect 90-day comment this fall
<b>FEMA MAS 3</b>	Project Elements	Grant Performance Period: 9/21/2012-5/29/2015; 9/21/2012-9/30/2015	Completed	Comments
<b>FEMA Proj. #: EMF-2012-GR-1211</b>	Carson River Remap and Restudy - Carson Valley Phase 1 (H & H for Carson River)		9/30/2015	Amended USACE HEC-RAS 5.0 Delay; Submitted & Approved

Carson Water Subconservancy District FEMA Mas 1 - 9 Projects

FEMA MAS 4	Project Elements	Grant Performance Period: 8/31/2013-9/1/2015; 8/31/2013-12/31/2016	Completed	Comments
FEMA Proj. #: EMF-2013-GR-2010	Carson River Remap and Restudy - Carson Valley Phase 2		12/31/2016	New Flood Map submitted to FEMA to for review
	Community Engagement		12/31/2016	
	<a href="#">Evaluate Floodplain Ordinances based on new map</a>			<a href="http://www.cwsd.org/cwsd-floodplainordreviewimprovement-interviewsummariesdraftords-12-22-2016/">http://www.cwsd.org/cwsd-floodplainordreviewimprovement-interviewsummariesdraftords-12-22-2016/</a>
	<a href="#">Stillwater Report Technical Assistance for Mitigation Actions</a>		9/30/2016	<a href="http://www.cwsd.org/cwsd-flood-mitigation-final/">http://www.cwsd.org/cwsd-flood-mitigation-final/</a>
	<a href="#">Floodplain Model Protocol &amp; Proceures for Updates</a>		12/31/2016	<a href="http://www.cwsd.org/2017-3-29finaldrafthec-ras-modeling-management-protocol-report/">http://www.cwsd.org/2017-3-29finaldrafthec-ras-modeling-management-protocol-report/</a>

Carson Water Subconservancy District FEMA Mas 1 - 9 Projects

FEMA MAS 5	Project Elements	Grant Performance Period: 9/26/2014-9/24/2016; 9/26/2014-12/31/2016	Completed	Comments
FEMA Proj. #: EMW-2014-CA-00170	Douglas County Smelter Creek Identification and Mitigation Project		8/8/2015	<a href="http://www.cwsd.org/smelter-creek-final-report-1-reduced/">http://www.cwsd.org/smelter-creek-final-report-1-reduced/</a>
	Churchill County Water Shunt Identification and Mitigation Project		10/20/2015	<a href="http://www.cwsd.org/0713-005-final_report_w_attaches/">http://www.cwsd.org/0713-005-final_report_w_attaches/</a>
	Public Outreach Flood Awareness Program 2016		12/22/2016	
	Inundation Flood Maps Upper Carson River Watershed Non-Regulatory Product		12/31/2016	<a href="https://water.weather.gov/ahps2/inundation/index.php?gage=stwn2">https://water.weather.gov/ahps2/inundation/index.php?gage=stwn2</a>
	Douglas County Alpine View Estates Restudy and Remapping Project		12/31/2016	LOMR submitted; Effective Date 6/7/2018
		created for use in Flood Awareness program.		<a href="#">Carson River Floodplain Inventory</a>
	Carson City Restudy and Remapping - Eagle Valley Golf Course A & B		12/31/2016	LOMR submitted; Effective Date 12/26/2017

Carson Water Subconservancy District FEMA Mas 1 - 9 Projects

FEMA MAS 6	Project Elements	Grant Performance Period: 9/25/2015-9/24/2017; 9/25/2015-6/30/2019	Completed	Comments
FEMA Proj. #: EMW-2015-CA-00087	<a href="#">Douglas County Stephanie Lane Drainage Identification and Mitigation Project</a>		5/27/2016	<a href="http://www.cwsd.org/0713-008_stephanie_way_flood_control_project_feasibility_engineering_study_report_fnl_wetstamped/">http://www.cwsd.org/0713-008_stephanie_way_flood_control_project_feasibility_engineering_study_report_fnl_wetstamped/</a>
	Public Outreach Flood Awareness Program - PSA Videos			
	<a href="#">Public Service Announcement (PSA) - Conserving the Carson River Floodplain as a Community Asset (:30)</a>		7/31/2017	Completed
	<a href="#">Agriculture's a Good Fit for Conserving the Carson River Floodplain as a Community Asset (4:31)</a>		7/31/2017	Completed
	<a href="#">A Case for Developers to Conserve the Carson River Floodplain as a Community Asset (3:13)</a>		7/31/2017	Completed
	<a href="#">Our Officials in Conserving the Carson River Floodplain as a Community Asset (4:19)</a>		7/31/2017	Completed
	Carson City Inundation Maps			<a href="https://water.weather.gov/ahps2/inundation/index.php?gage=stwn2">https://water.weather.gov/ahps2/inundation/index.php?gage=stwn2</a>
	Carson City Goni Wash Restudy and Remapping Project			
	Lyon County Ramsey Canyon Restudy and Remapping Project			

Carson Water Subconservancy District FEMA Mas 1 - 9 Projects

FEMA MAS 7	Project Elements	Grant Performance Period: 9/19/2016-9/18/2018; extended to 6/30/2019	Completed	Comments
FEMA Proj. #: EMF-2016-CA-00005	Douglas County Johnson Lane Area Drainage Master Plan		8/31/2018	Completed
	Updates to the 2012 Discovery Report and Regional Floodplain Management Plan		8/15/2018	Approved by CWSD board; will take to County Boards for Adoption
	Carson City Voltaire Canyon Restudy and Remapping Project		In Progress	This project was delayed as it required USGS data.
	Northern Nevada Public Outreach Flood Awareness Program		1/15/2018	Completed
FEMA MAS 8	Project Elements	9/1/2017-8/31/2019	Completed	Comments
EMF-2017-CA-00002	(North) Dayton Valley Area Drainage Master Plan		In Progress	
	Floodplain Ordinances Update & Modification		In Progress	
	Northern Nevada Public Outreach Flood Awareness Program		In Progress	

Carson Water Subconservancy District FEMA Mas 1 - 9 Projects

FEMA MAS 9 Application	Project Elements	Tentative: 10/1/2018-9/30/2020	Completed	Comments
EMF-2018-CA-APP-00005	South Dayton Valley Area Drainage Master Plan		Application	
	North Carson City Identification and Mitigation Plan		Application	
	Pine Nut Wash Letter of Map Review (LOMR)		Application	
	Northern Nevada Public Outreach Flood Awareness Program		Application	
Project / Document				
	<a href="http://www.cwsd.org/floodplain-management/">See All Documents on page at http://www.cwsd.org/floodplain-management/</a>			
	<a href="#">Signed CTP Charter</a>		6/6/2005	
	<a href="#">Carson River Watershed Floodplain Management Plan</a>		8/1/2008	
	<a href="#">2013 Update Carson River Watershed Floodplain Management Plan</a>		10/1/2013	
	<a href="#">Discovery 2012</a>		12/12/2012	
	<a href="#">Risk Map Charter</a>		4/26/2012	

## **Appendix J**

### **Floodplain Management Plan Update / Revision Process**

## 2018 Update/Revision Process

Section 5.2 Monitoring and Revision calls for an update of the RFMP to be completed on an as needed basis, not to exceed five years. CWSD worked with stakeholders, including the Floodplain and River Management (Formerly the River Corridor) Working Group and local floodplain administrators to complete this revision. The process outline is as follows:

- A. Work with stakeholders to determine the update format and what revisions/updates are required in the plan.
- B. Interview jurisdictions regarding floodplain management plan and conduct a rapid evaluation of each county.
- C. Complete draft revisions on plan and send out for comment by stakeholders.
- D. Finalize draft revised plan based on input from stakeholders.
- E. Provide final draft revised plan for comments to stakeholders.
- F. Incorporate stakeholder comments and present final draft revisions to CWSD Board, August 15, 2018 for adoption by CWSD.
- G. Present CWSD adopted final revised plan to Counties and other stakeholders for adoption.
- H. Complete Revision Process Appendix L post adoption by CWSD and stakeholders for final.

CWSD staff worked with the CRC Floodplain and River Management Working Group on the types of revisions/updates to be completed and how to format the update. It was decided the 2018 Revision would be a re-write of the plan for the following reasons:

- a. Complete reorganization of format, content, and appendices;
- b. Content of plan significantly changed;
- c. Incorporate the 2013 updates into document and appendices;
- d. Suggested Actions Table is reorganized and reordered;
- e. Revision reflects Physical Map Revision of the Carson River and other studies and projects since the 2008 Floodplain Management Plan;
- f. Appendix A of the USGS Flood Chronology has been put into the main document as a link;
- g. Revision incorporates links to County's updated flood maps within the document rather than including maps in Appendix D; and
- h. Complete revision the Rapid Evaluation.

The draft revised plan revised and updates the original table of contents. Draft revisions were sent out to the CRC Floodplain and River Management Working Group in early July 2018. Comments and updates were incorporated into a second draft and sent to stakeholders in early August 2018.

The CWSD Board adopted the *Carson River Watershed Regional Floodplain Management Plan 2018 Revision* on August 15, 2018. Each of the five counties that previously adopted the Regional Floodplain Management Plan also adopted the supplemental update document as follows:

<b>County</b>	<b>Adoption Date</b>	<b>By Formal motion/ Resolution</b>	<b>Resolution #</b>
Alpine County			
Carson City			
Churchill County			
Douglas County			
Lyon County			
Storey County			

Each County’s formal actions or resolutions adopting the supplemental update are attached to this appendix.

## **Appendix K**

### **Adoption of RFMP**