# CARSON RIVER WATERSHED FLOODPLAIN MANAGEMENT PLAN 2018

***Prepared by:***

Michael Baker INTERNATIONAL

***Prepared for:***

Carson Water Subconservancy District, Alpine County (California), Carson City, Churchill County, Douglas County, Lyon County, Storey County (Nevada).

# TABLE OF CONTENTS


PREFACE ..... 5

EXECUTIVE SUMMARY ..... 6

1.0 INTRODUCTION AND BACKGROUND ..... 8

*1.1 STRATEGIES* ..... 10

*1.2 REGIONAL APPROACH AND PLAN ADOPTION* ..... 11

*1.3 WATERSHED CHARACTERISTICS* ..... 11

*1.4 ECONOMIC IMPACTS* ..... 14

2.0 FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) ..... 17

*2.1 COOPERATING TECHNICAL PARTNER PROGRAM (CTP)* ..... 17

*2.2 COMMUNITY RATING SYSTEM (CRS)* ..... 18

*2.3 FLOODPLAIN 101* ..... 23

3.0 FLOOD HISTORY AND RISK ASSESSMENT ..... 26

*3.2 FEMA REPETITIVE LOSS AREAS* ..... 30

*3.3 RISK ASSESSMENT (HAZUS)* ..... 30

*3.4 PUBLIC AND PRIVATE INFRASTRUCTURE* ..... 31

*3.5 FUTURE CONDITION CONSIDERATION AND IMPACTS TO FLOODPLAIN* ..... 31

4.0 FLOOD RISK REDUCTION AND FLOODPLAIN STRATEGIES ..... 32

*4.1 PROTECT FLOODPLAIN NATURAL FUNCTIONS AND VALUES* ..... 39

4.1.1 Living River Approach ..... 39

4.1.2 Good Neighbor Policy ..... 41

4.1.3 Floodplain Function and Flood Hazards ..... 41

*4.2 HIGHER REGULATORY STANDARDS* ..... 44

4.2.1 Revised Ordinances ..... 44

*4.3 FLOOD DATA INFORMATION AND MAINTENANCE* ..... 46

4.3.1 Up-to-Date and Consistent Data Collection ..... 46

4.3.2 Risk Mapping Assessment and Planning (Risk MAP) ..... 47

4.3.3 Updating and Maintaining DFIRM ..... 47

4.3.4 Elevation Reference Mark Maintenance ..... 47

4.3.5 Floodway Delineation ..... 48

4.3.6 Unsteady-state model for the Carson River ..... 48

4.3.7 Photo Monitoring ..... 49
4.3.8 Rain Gage Network ..... 49
*4.4 CHANNEL MIGRATION AND BANK EROSION MONITORING* ..... 50
*4.5 FLOODPLAIN AND FLOOD HAZARD OUTREACH AND EDUCATION* ..... 53
*4.6 REDUCTION OF INFRASTRUCTURE IMPACTS* ..... 55
*4.7 MAP/STUDY ALLUVIAL FAN FLOOD HAZARDS* ..... 56
*4.8 STORMWATER MITIGATION* ..... 57
5.0 IMPLEMENTATION ..... 59
*5.1 STEPS FOR PLAN IMPLEMENTATION* ..... 59
5.1.1 Summary of Suggested Actions ..... 59
*5.2 MONITORING AND REVISION* ..... 60
*5.3 LINKING REGIONAL FLOODPLAIN MANAGEMENT WITH OTHER PLANS* ..... 60
5.3.1 Hazard Mitigation Plans ..... 60
5.3.2 Carson River Watershed Adaptive Stewardship Plan ..... 61
5.3.3 Carson River Flood Mitigation Plan ..... 61
*5.4 ADDITIONAL REGULATORY AND PERMITTING AGENCY COORDINATION* ..... 62
*5.5 POTENTIAL FUNDING SOURCES* ..... 64
6.0 PLANNING PROCESS ..... 65
7.0 EMERGENCY RESPONSE AND FLOOD WARNING ..... 66
*7.1 FLOOD FORECAST AND WARNING SYSTEMS* ..... 67
8.0 REFERENCES ..... 69

# List of Figures

Figure 1. Carson River Watershed....13
Figure 2. Graph of monthly average flow conditions for 2017 compared to period of record....16
Figure 3. CRS 510 Floodplain Management Planning Checklist....21
Figure 4. Floodplain Components....23
Figure 5. Alluvial fan graphic from Nevada Floods Brochure FS 14-12 created by UNR Cooperative Extension....28
Figure 6. Channel movement from 1906 to 2003 {Courtesy of Randy Pahl and Jean Stone, NDEP)....51

# List of Figures

Table 1. Population growth from 1990 to 2015....12
Table 2. 1997 New Year's flood damage estimates and 2017 damage estimates, Carson and Truckee Rivers*....14
Table 3. Comparison of average monthly flows (cfs) at Carson River near Carson City....16
Table 4. Preliminary damage assessment (PDA) in 2017 for northern Nevada counties....16
Table 5. Mapping activity statement projects completed....18
Table 6. CRS activities outlined in CRS Coordinator's Manual (2017)....19
Table 7. Community Rating System classification and flood insurance premium reductions....20
Table 8. Statistical chances of being flooded during a 30-year mortgage.....25
Table 9. Potential flood impacts related to flood stage for Carson River near Carson City (USGS)....27
Table 10. Repetitive loss areas within CRS communities in Carson River Watershed (2018)....30
Table 11. Summary of strategies and suggested actions (SA) for watershed flood risk reduction....33
Table 12. Additional regulatory and permitting agency coordination....63
Table 13. Federal, state and local funding sources....64
Table 14. Emergency response contact information as of 9/2018....66
Table 15. Flood forecast and warning systems and weather stations in the Carson River Watershed....68

# APPENDICES


| | |
|---|---|
| Appendix A | Floodplain Management Plan Update / Revision Process |
| Appendix B | Rapid Evaluation of the Carson River |
| Appendix C | 2018 Risk MAP Discovery |
| Appendix D | CWSD Project Report Links & FEMA County Flood Insurance Rate Maps Links |
| Appendix E | County Progress Reports |
| Appendix F | Risk MAP Charter & FEMA CTP Agreement |
| Appendix G | Adoption of RFMP |


# ABBREVIATIONS

| | |
|---|---|
| ASFPM | Association of State Floodplain Managers |
| BFE | Base Flood Elevation |
| cfs | cubic feet per second |
| CLOMR | Conditional Letter of Map Revision |
| CRC | Carson River Coalition |
| CRS | Community Rating System |
| CWSD | Carson Water Subconservancy District |
| dFIRM | Digitized Flood Insurance Rate Map |
| ERM | Elevation Reference Mark |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| FMA | Flood Mitigation Assistance |
| LOMR | Letter of Map Revision |
| msl | mean sea level |
| NBMG | Nevada Bureau of Mines and Geology |
| NDEP | Nevada Division of Environmental Protection |
| NDWR | Nevada Division of Water Resources |
| NFIP | National Flood Insurance Program |
| NGO | Non-Government Organization |
| NPS | Non-point Source Pollution |
| NAVD | North American Vertical Datum |
| SFHA | Special Flood Hazard Area |
| RFMP | Regional Floodplain Management Plan |
| UNCE | University of Nevada Cooperative Extension |
| USACE | U.S. Army Corps of Engineers |
| USGS | U.S. Geological Survey |

# PREFACE

The purpose of this Regional Floodplain Management Plan (RFMP) is to create a long-term vision and develop strategies which utilize a Living River Approach for meeting floodplain management objectives to reduce flood damage impacts in the Carson River Watershed. The RFMP revision process reviews regional flood risks and suggests watershed-wide strategies and actions to mitigate and reduce these hazards and risks while maintaining objectives. It also documents regional and local progress on meeting plan objectives.

The RFMP is a living document to guide implementation of suggested actions (Table 11) for regional floodplain management planning which is compatible with each community's planning activity documents and is meant to serve as a quick reference for each identified floodplain management strategy.

The five county boards that reside on the Carson River within the watershed have all adopted the 2008 Plan and the 2013 Update in support of this regional floodplain management approach and have agreed to work together to implement these suggested actions. These suggested actions continue to be supported by local, state, and federal agencies, non-government bodies, and residents, and this revised RFMP will again be presented to each of the counties in the Carson River Watershed for formal adoption (Appendix G).

**Bafford Lane Bridge, Fallon, Nevada**

Acknowledgement:

Thank you to CWSD's board and staff and all the members of the Carson River Coalition Floodplain and River Management Working Group. Your support has been critical. We also want to specifically thank NDEP's Water Quality Planning Division, Lahontan Regional Water Quality Control Board staff and county staff members. The data and input you provided to draft this document are key ingredients to successful regional floodplain management. This RFMP revision was funded through FEMA's Cooperating Technical Partner program.

# EXECUTIVE SUMMARY

Flooding is a regular occurrence in the Carson River Watershed. It is also one of the costliest natural disasters our communities face. Ongoing floodplain management can reduce future flooding by planning for new development, population growth, and mitigating flood hazards. This revised RFMP recognizes the importance of balancing the river's natural floodplain form and function with various land uses to reduce flood damage impacts in the Carson River Watershed.

A primary focus of this Carson River Watershed RFMP is promoting floodplain management and restoration activities which allow the river to access its natural floodplain. This RFMP revision reviews regional flood risks and suggests watershed-wide strategies and actions to reduce and mitigate these hazards and risks while maintaining plan objectives.

This RFMP addresses the Federal Emergency Management Agency (FEMA) requirements for floodplain management planning and delineates potential credit for the National Flood Insurance Program (NFIP) Community Rating System (CRS). The RFMP is a supplemental document to the Carson River Watershed Adaptive Stewardship Plan (2007/2017) and updates the Floodplain Conservation Category, one of seven integrated watershed management categories outlined in that document. The RFMP's strategies for flood mitigation are consistent with the State of Nevada's and each participating county's Multi-Hazard Mitigation Plan (Section 5).

This revision is a collaborative effort guided by Carson Water Subconservancy District (CWSD) and the Carson River Coalition's (CRC) Floodplain and River Management Working Group. The Carson River Coalition is a long-standing group of interested stakeholders made up of local, state, and federal agencies, local non-profits, landowners, and residents. CRC members support addressing the impacts of flooding with a regional approach which considers the health and safety of residents, the river, and the watershed. CRC members developed the long-term vision, *the Living River Approach,* which recognizes the

## STRATEGIES TO MITIGATE FLOOD HAZARDS:

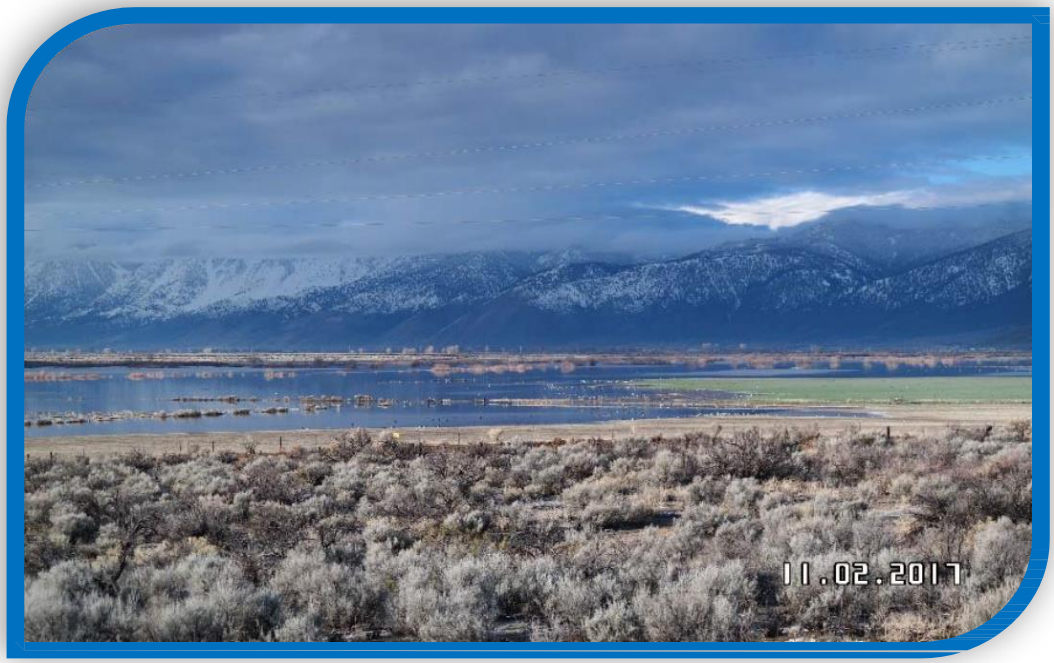
1. Protect Natural Floodplain Function and Values
2. Set Higher Regulatory Standards
3. Collect Flood Data Information and Maintenance
4. Balance Channel Migration and Bank Erosion Monitoring
5. Increase Floodplain and Flood Hazard Outreach and Education
6. Reduce Infrastructure Impact
7. Map/Study Alluvial Fans
8. Minimize Stormwater Impacts

## ACHIEVE STRATEGIES WHILE MAINTAINING OBJECTIVES:

- Manage economic development without sacrificing floodplain and river form and function.
- Ensure public safety upstream and downstream.
- Protect property rights while conserving natural resources.
- Provide river continuity and connectivity - connection of river to its floodplain.
- Protect and improve water quality and wildlife habitat.
- Promote conservation of lands within the river corridor.

importance of balancing the river's natural floodplain form and function with various land uses to reduce flood damage impacts in the Carson River Watershed. This RFMP also recognizes that flooding is a watershed-wide challenge and the actions of one community affect surrounding communities. The 48 suggested actions (see Table 11) are outcomes of CRC collaboration, FEMA requirements, and the application of long-term regional floodplain management principles (see Watershed Guiding Principles and/or Carson River Main Message publication).[1, 2]

**Carson Valley agricultural lands inundated during 2017 flooding**




[1] http://www.cwsd.org/carson-river-coalition/

[2] http://www.unce.unr.edu/publications/files/nr/2004/fs0471.pdf

# 1.0 INTRODUCTION AND BACKGROUND

## STRATEGIES TO MITIGATE FLOOD HAZARDS:

1. Protect Natural Floodplain Function and Values
2. Set Higher Regulatory Standards
3. Collect Flood Data Information and Maintenance
4. Balance Channel Migration and Bank Erosion Monitoring
5. Increase Floodplain and Flood Hazard Outreach and Education
6. Reduce Infrastructure Impact
7. Map/Study Alluvial Fans
8. Minimize Stormwater Impacts

## ACHIEVE STRATEGIES WHILE MAINTAINING OBJECTIVES:

- Manage economic development without sacrificing floodplain and river form and function
- Ensure public safety upstream and downstream
- Protect property rights while conserving natural resources
- Provide river continuity and connectivity - connection of river to its floodplain
- Protect and improve water quality and wildlife habitat
- Promote conservation of lands within the river corridor

The first humans likely entered the Carson River Watershed around 12,000 years ago. Known as the Martis people, they built pit houses along the edges of valleys close to springs and smaller streams. During this period the valley bottoms of the Carson Watershed were seasonally inundated, and wetlands were more abundant. The western pioneers didn't arrive *en masse* until the 1840's looking for opportunities to search for gold through placer mining. The larger incorporated settlements we know today (Genoa, Dayton) began to establish during the 1850's in response to the initial mining boom of the Comstock Era from 1860 to 1920. Agricultural operations grew in response to the new demand for food supplies and other goods desired in the rapidly expanding mining communities. Requiring access to water to support crops and animals, farms and ranches occupied the lands adjacent to the Carson River. Agriculture claimed these tracts and inadvertently preserved the undeveloped floodplains we enjoy today along the Carson River.

This agrarian land use has provided for unique opportunities. Most often communities develop directly adjacent to rivers and encroach upon floodplains. As a result, businesses and residences within the floodplain suffer severe economic loss during flood events. In contrast, floodplain development is minimal in Carson River Watershed communities, and today the open floodplain land along the river offers the best forms of natural flood protection.

This document demonstrates how floodplains provide for public safety during flooding events by storing and slowing down floodwaters. They also enhance our communities and help preserve our natural resources by recharging groundwater, protecting water quality, and providing wildlife habitat.

The Carson River Watershed, like most Eastern Sierra basins, experiences different types of flooding depending on the season and nature of the storm. The most damaging type of flood is a rain-on-snow event.

These storms tend to be infrequent but are large-scale and can cause tremendous damage. The second type of flooding is an extended high-water flow event, often associated with an atmospheric river or the succession of multiple storms. These extended events of tremendous hydraulic pressure lead to bank failure and even the collapse of structures like bridges and roads. Finally, the Carson River Watershed experiences a combination of alluvial fan flooding, flash flooding, and debris flows. These tend to be localized and small-scale but can be very damaging to public infrastructure and the affected property owners. These different types of floods create distinct types of hazards and damages. Proper planning and implementation of floodplain management strategies is essential to build resilient communities prepared for all types of flood scenarios.

According to FEMA statistics, floods cause a greater loss of life and property and devastate more families and communities across the United States than all other natural hazards combined. Floods still occur, and losses rise despite attempts to control damage with costly flood control infrastructure (e.g., levees and dams). Across the United States people and communities are recognizing how protecting the natural resources and functions of floodplains can effectively reduce flood losses. Therefore, FEMA encourages communities to adopt and implement programs which preserve floodplain resources and functions through funding and incentives to reduce flood hazards and risk. FEMA recognizes floodplain management plans that provide a written description of the flood risks and actions a community will take to address how to mitigate those flood hazards. The National Institute of Building Sciences recently reported "mitigation funding can save the nation $6 in future disaster costs, for every $1 spent on hazard mitigation (Natural Hazard Mitigation Saves: 2017 interim Report). [3]

A floodplain management plan assists communities in building resiliency and reducing flood risk. Flood hazards in the Carson River Watershed are primarily due to allowing residences and other structures to be built within the floodplain, river corridor, or on alluvial fans. By placing family residences and businesses in flood prone areas, the potential for considerable damage or loss of life increases.

Since there is little storage to provide flood control in the Carson River's upper watershed, large events can lead to unattenuated downstream flooding. During a major flood event, both Carson Valley and Dayton Valley are typically inundated. Over-bank flows often reach depths of multiple feet. Continued development on open floodplain lands and river and alluvial fan corridors will intensify future flooding events causing inundation in areas that have not previously flooded. Initially elevating building pads, foundations and first floors above the 100-year flood level (base flood elevation) may appear to protect the inhabitants. However, this extra fill reduces a floodplain's natural storage capacity, while increasing flow velocity and can divert flows into new locations.

Regional flooding has been exacerbated in the last decade by highly variable weather conditions. The watershed is subject to extreme drought, forest fires, excessive rain, with minimal snowfall one year and record-breaking amounts of snow the next. In addition to variable weather, there is a significant elevation gradient between the high Sierra and the Carson Sink.

[3] https://www.nibs.org/news/381874/National-Institute-of-Building-Sciences-Issues-New-Report-on-the-Value-of-Mitigation.htm

In the past five years, variable weather has created many diverse types of flood hazards that often catch our communities surprised and unprepared. In 2017, riverine floods caused extensive damage watershed- wide. In 2014, 2015, and 2017, localized alluvial fan floods inundated neighborhoods, clogged drainage infrastructure, and covered roads with sediment and debris. In 2016 and 2017, post-fire flooding caused mudslides and debris flows in multiple locations in the upper watershed.

Presently most of Carson Watershed communities are acutely aware of riverine floods; however as our climate and weather patterns become more variable other types of flooding (alluvial fan/flash flooding, post-fire flooding, and extended high riverine flows) are becoming more frequent. We need to increase awareness to these other flood risks and emphasize the necessity of preparation and mitigation. All of these factors warrant this holistic floodplain management approach to identify and mitigate flood hazards throughout the Watershed.

## *1.1 STRATEGIES*

The purpose of this RFMP revision is to continue support of the adopted *Living River Approach* in river and floodplain management and to reduce flood damage impacts in the Carson River Watershed. The *Living River Approach* recognizes the importance of balancing the river's natural floodplain form and function (fluvial geomorphology) with various land uses. Therefore, the objectives and strategies of this RFMP include:

- Connect floodplain to its riverine channels;
- Provide seasonal continuity of riverine flows;
- Improve water quality;
- Recharge the water supply;
- Mitigate flood hazards;
- Keep structures out of unstable, unsafe areas near river channels;
- Minimize modification of riverine channel and riparian habitat;
- Balance sediment input with sediment transport;
- Convey variable flows which preserve and restore habitat in the floodplain;
- Sustain fish, birds, and other wildlife;
- Enhance aesthetic and recreational qualities which enrich the human environment;
- Minimize Stormwater impacts through various best management practices; and
- Implement Post Disaster mitigation measures.

Minimizing stormwater impacts using methods such as green infrastructure/Low Impact Development and Post-Disaster Mitigation are additional strategies identified to mitigate flood hazards. As effects of actions are felt watershed-wide, communities are key to ensure the long-term objectives are maintained as these strategies are implemented.

## *1.2 REGIONAL APPROACH AND PLAN ADOPTION*

Communities benefit from a regional approach through consistency in planning efforts, programs and projects. Carson Water Subconservancy District (CWSD) coordinates cooperative action between counties and other stakeholders to address river and floodplain and river management so hazards within the region are recognized, prioritized, and addressed. This approach provides a big picture view that helps communities understand the benefit of conserving floodplain lands both within and outside their respective jurisdictions to protect community members from flooding hazards. CWSD coordinates messaging with federal, state and local partners so flood outreach and education to residents, policy makers, and elected officials is consistent. A regional approach reduces duplication of efforts, amplifies messaging and supports community efforts.

***Regional floodplain management benefits:***

- Enhance public safety by reducing flooding risk to all communities;
- Reduce flood damage costs to all communities;
- Enhance awareness of flood danger and risk throughout watershed;
- Provide messaging consistency with resources for local floodplain programs;
- Deliver collaborative support to local floodplain administrators;
- Maximize Community Rating System credit;
- Lower community flood insurance rates; and
- Increase funding leverage and opportunities.

## *1.3 WATERSHED CHARACTERISTICS*

The Carson River Watershed (Watershed) is the land in Nevada and California that captures, stores, and releases rain and snowmelt to the Carson River (Figure 1). It is located east of the Sierra Nevada range and is characterized by partly filled alluvial valleys ranging in elevation from 3,000 to 6,000 feet above mean sea level (msl), surrounded by mountains ranging in elevation from 6,000 to 11,000 feet msl. The area is seismically active with a complex series of faults spanning a large area of Western Nevada. The Genoa Fault Zone is one of the most active faults in the region (Ramelli, et al., 1999).

The watershed consists of 3,966 square miles, with 606 square miles located in California. The Carson River flows approximately 184 miles from its headwaters in Alpine County, California, to the terminus at the Carson Sink in Churchill County, Nevada. The upper watershed in the Sierra Nevada experiences long, very cold winters and short, moderate to warm summers. The upper elevations receive more than 40 inches of precipitation per year, usually as snowfall, decreasing to about four to eight inches in the arid to semi-arid valley floors. Habitats within the watershed range from dry, salt desert scrublands, and sagebrush steppes to lush mountain meadows, forest, and aspen groves. Watershed characteristics and history are comprehensively detailed in Section 3 of the Carson River Watershed Adaptive Stewardship Plan (CWSD 2017).[4]

[4] http://www.cwsd.org/carson-river-watershed-adaptive-stewardship-plan/

Population centers in the watershed include the Minden/Gardnerville area in Douglas County, Carson City, Dayton and Silver Springs in Lyon County, and Fallon in Churchill County. The physical setting of the watershed has somewhat influenced the occurrence and size of population centers. Localized urban and residential areas (often located along or near the river) are separated by larger areas of ranchlands, farmlands, or sagebrush. A significant increase has been seen in population over the last few decades (Table 1), with Lyon and Douglas Counties experiencing the greatest population growth (166% and 74%, respectively). These areas provide the greatest opportunities for continued floodplain protection.

**Table 1. Population growth from 1990 to 2015**

| | 1990 | 2000 | 2015 |
|---|---|---|---|
| Alpine County | 1,113 | 1,113 | 1,071 |
| Douglas County | 27,637 | 41,259 | 48,020 |
| Carson City | 40,443 | 52,457 | 54,742 |
| Lyon County | 20,001 | 34,501 | 53,179 |
| Storey County | 2,526 | 3,399 | 4,051 |
| Churchill County | 17,938 | 23,982 | 24,198 |

Source: US Census Data (www.data.gov)

**Figure 1. Carson River Watershed**

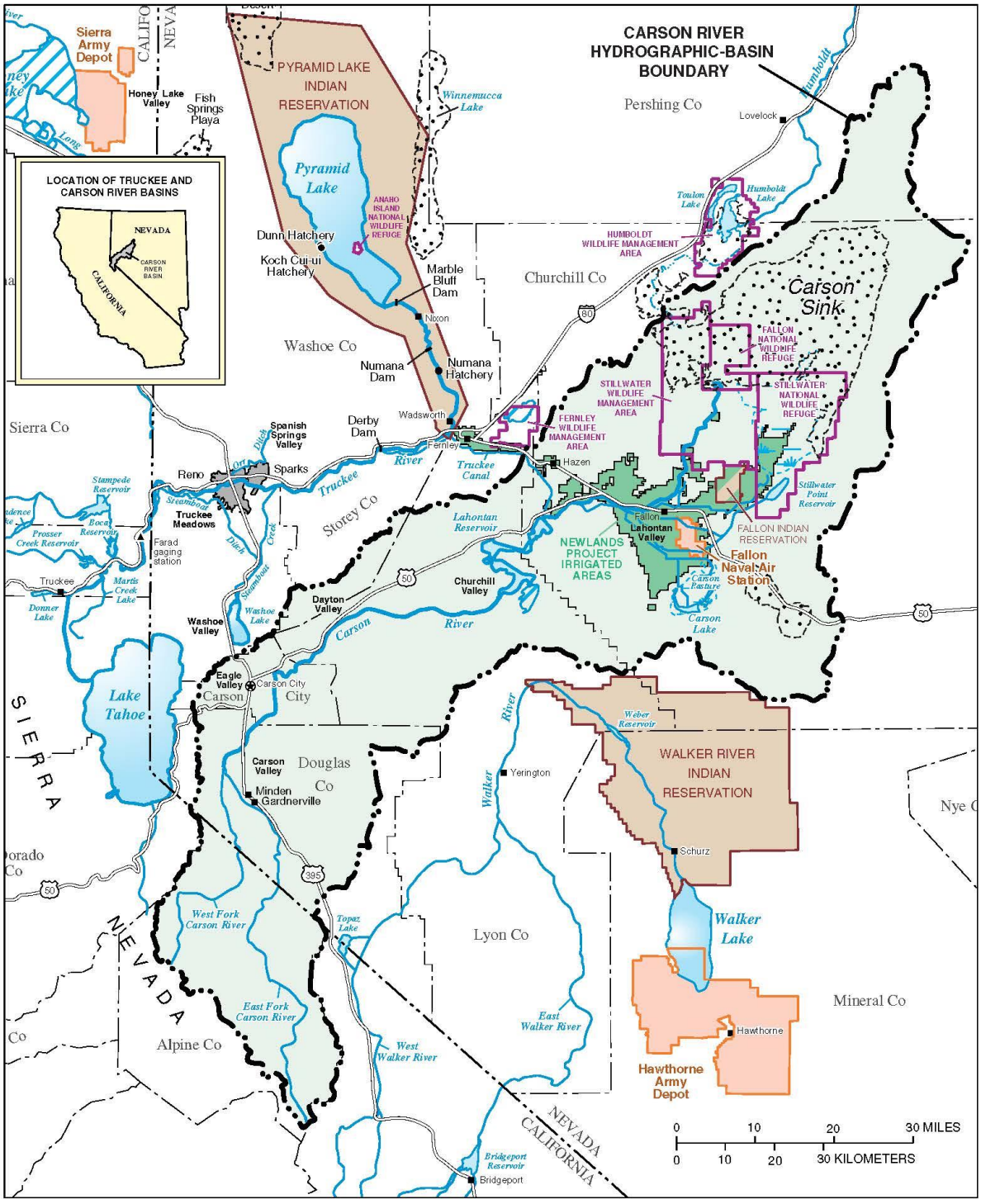



Figure1. USGS hydrologic features map of the Carson River watershed and surroundings.

## *1.4 ECONOMIC IMPACTS*

During the 1997 flood event, economic damages to the communities adjacent to the Carson River were orders of magnitude less than those of adjacent watersheds such as the Truckee River Watershed (Table 2). This difference can largely be attributed to the extent of development on floodplain lands adjacent to the Truckee River in Washoe County, as opposed to the extent of floodplain protection on lands adjacent to the Carson River. The Carson River is surrounded by many areas that have remained agricultural or otherwise undeveloped, thereby retaining floodplain function, and lessening the economic impact when large-scale flooding events occur.

Carson Valley, 1997 Flood

**Table 2. 1997 New Year's flood damage estimates and 2017 damage estimates, Carson and Truckee Rivers***

| | 1997 FLOOD DAMAGE | 2017 FLOOD DAMAGE |
|---|---|---|
| Alpine County[1] | $331,372 | $1,250,003 |
| Douglas County[2] | $13,100,000 | $475,000 |
| Carson City[2] | $5,300,000 | $1,700,000 |
| Lyon County[2] | $10,000,000 | $100,000 |
| Churchill County[2] | $345,000 | $5,800,000 |
| Storey County[4] | | $288,623 |
| *Total Carson River* | $29,076,372 | $9,613,626 |
| *Total Washoe County Only* | $686,000,000 | |

Source: 1) Alpine County Auditor's Office; 2) NBMG 1998; 3) FEMA (https://www.fema.gov/media-library-data/1511811936286-6a8ffe2fd0ff2e7a675025c95704eb79/11-27-2017_Daily_Public_Assistance_Grant_Awards.xlsx)4) Storey County Planner's Office *Cost estimates include entire counties not just the Carson River Watershed and do not represent the actual paid out costs associated with the 1997 flood event.

Many residents have regularly dealt with flooding along the Carson River as the 1997 and 2005 flood events directly affected the floodplain. More recently, summertime cloudburst events on hillslopes or alluvial fans beyond the river corridor have resulted in flash flooding. These flood events have left residents wary and communities in need of money to pay for the cleanup of roads and infrastructure. Record breaking winter snowfall in 2017 led to melt conditions causing high flows and flooding that lingered for months (Table 3). This resulted in saturation of lands and structures adjacent to the river, causing hazardous conditions and continuously eroding the banks and channels. Local ranchers experienced loss of productive lands as portions washed away along the river corridor due to this flooding. Agricultural fields were saturated for months but provided area for the high flows to spread out across the natural floodplain.

With no upstream storage, record snowfall in 2017 also led to record runoff volumes in the Carson River and downstream into Lahontan Reservoir. Lahontan Reservoir was designed to store approximately 300,000 acre-feet of water. However, in 2017, the inflow was three-times this amount. The Carson River alone had its largest cumulative flow volume on record at 920,000 acre-feet (the average is 269,000 acre-feet). Construction of emergency structural improvements to convey the water away from populated areas was accomplished in only a few weeks, as there was significant threat of imminent, widespread, potentially damaging flooding to the communities of Fallon and Churchill County. The actions to release and convey the water from Lahontan Reservoir was at a cost of almost $5.8 million; costs for the Nevada Department of Transportation (NDOT) were approximately $1.5 million for the culverts under Highway 50/95. Monthly average river flow data from 1940 through 2016 (USGS Carson River Gage near Carson City, 10311000) was compared to the monthly flows during 2017, emphasizing the difference between the two periods of record (Table 3, Figure 2). The relentless storms and resultant floods in the first few months of 2017 yielded two Presidential Disaster Declarations in Northern Nevada[5] as summarized in Table 4. While the series of alluvial fan or flash flood events in 2014 and 2015 resulted in damage to residents in some communities, the costs of cleanup did not reach the required minimum to receive a disaster declaration. A lesson learned during those events, however, was that an accumulation of costs by multiple jurisdictions affected could have brought a declaration, potentially allowing for federal funds to help pay for the cleanup and damages.

These data highlight that the communities must maintain an awareness of the different type of flood events and continue to implement management strategies to address these hazards.

[5] DR-4303: PDAs; (Douglas, Lyon, Storey, and Washoe; the independent city of Carson City; and the Pyramid Lake Paiute Tribe, the Reno-Sparks Indian Colony, and the Washoe Tribe of Nevada and California). A total of (Total Public Assistance Grants (PA)), $3,678,371.81 (Emergency Work (Categories A-B)), and $3,936,634.38 (Permanent Work (Categories C-G)).
DR-4307. PDAs: A total of $13,135,370 assessed (Washoe, Storey, Douglas, Carson City, Churchill, Humboldt, Elko); PA grants $8,459,421.78 spent on Emergency Work (Categories A-B)), and $4,990,193.52 (Permanent Work (Categories C-G)).

Table 3. Comparison of average monthly flows (cfs) at Carson River near Carson City

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT |
|---|---|---|---|---|---|---|---|---|---|---|
| 1940 – 2016 | 348 | 363 | 409 | 580 | 1,153 | 921 | 252 | 53 | 42 | 95 |
| 2017 | 1,397 | 2,302 | 1,404 | 1,910 | 3,162 | 3,050 | 1,114 | 235 | 215 | 236 |

Figure 2. Graph of monthly average flow conditions for 2017 compared to period of record

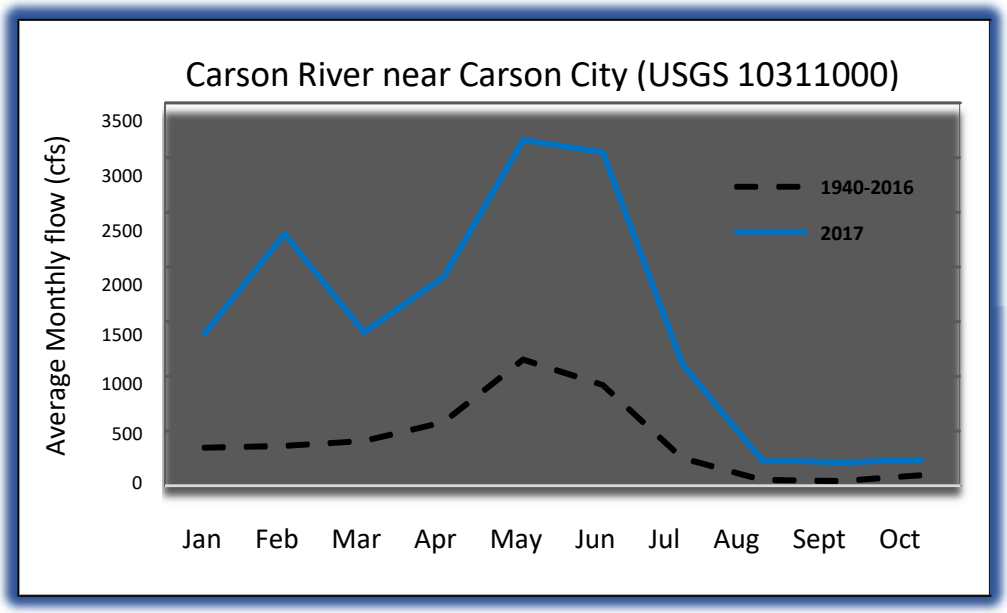



Table 4. Preliminary damage assessment (PDA) in 2017 for northern Nevada counties for which a Presidential disaster was declared

| | DAMAGE ASSESSMENT | COUNTIES AFFECTED |
|---|---|---|
| January 5-14, 2017 DR-4303 | $14,988,043 | Washoe, Storey, Lyon, Douglas, Carson City, |
| Feb. 27-Mar. 3, 2017 DR-4307 | $13,135,370 | Washoe, Storey, Douglas, Carson City, Churchill, Humboldt, Elko |

# 2.0 FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

The Federal Emergency Management Agency (FEMA) coordinates the federal government's response to all domestic disasters, whether natural or man-made. FEMA's suite of disaster actions includes disaster preparation, loss prevention, hazard mitigation, and response and recovery when catastrophes strike. The National Flood Insurance Program (NFIP) was created in 1968 to provide flood insurance to homeowners. The NFIP encourages communities to enact and enforce minimum federal floodplain regulations so residents qualify for flood insurance. Communities that adopt regulations that exceed the NFIP's minimum standards earn premium discounts for residents who purchase flood insurance. This premium discount program is described in depth in section 2.2.

## *2.1 COOPERATING TECHNICAL PARTNER PROGRAM (CTP)*

FEMA carries out some of its flood hazard mitigation activities through the Cooperating Technical Partner (CTP) program. This program provides funding to local communities for actions such as flood hazard map revisions, flood hazard mitigation planning, and outreach and education. Created in 1999 to help FEMA stretch limited mapping dollars and increase local involvement in the creation of floodplain mapping projects, the CTP Program creates partnerships between FEMA and participating NFIP communities, regional agencies, state agencies, tribes, and universities that are interested and capable of being active participants in the FEMA flood hazard mapping program. Each fiscal year, FEMA issues a Notice of Funding Opportunity (NOFO) document to announce the availability of the CTP cooperative agreement funding opportunity. The NOFO describes the available funding, priorities, requirements and process for eligible applicants to request funding for program activities. CWSD has been a CTP since 2005, and through its activities it acquires, administers, and distributes FEMA project funding and oversees all funded projects. Each funding round includes a Mapping Activity Statement (MAS) which identifies the various flood studies and activities that will be accomplished. From 2010 to 2018, CWSD has received approximately $2,800,000 from FEMA, and has provided over $500,000 as in-kind and cash match. Projects resulting from CWSD CTP funding are detailed in Table 5. Listed MAS project funding includes LiDAR or surveying. The CTP agreement is included as Appendix F and the links to CTP projects CWSD has completed is in Appendix D.

**Parks and Open Space are good uses in a floodplain. Morgan Mill River Access, Carson City, 2017**

Table 5. Mapping activity statement projects completed

| MAS | YEAR | CTP PARTNERSHIP PROJECT |
|---|---|---|
| 1 | 2012 | Physical Map Revision (PMR) of the portions of the Carson River through Lyon County. |
| 2 | 2014 | PMR of the portions of the Carson River from Lyon County to Carson City |
| 3 | 2015 | Hydraulic modeling of the Carson River in the Carson Valley |
| 4 | 2016 | Hydraulic modeling of the Carson River in the Carson Valley; Mitigation Plan and Draft Ordinance created |
| 5 | 2016 | Map alluvial fan watersheds in Douglas County and the Eagle Valley Golf Courses A&B Drainages in Carson City; support Northern Nevada Flood Awareness Campaign. |
| 6 | 2017 | Identification and mitigation projects in Douglas County; support Northern Nevada Flood Awareness Campaign; and creation of Carson City Inundation maps |
| 7 | 2018 | Update the Saliman/Voltaire alluvial fan drainages in Carson City; create a Johnson Lane Area Drainage Master Plan in Douglas County; and update the 2012 Discovery Report and 2013 Regional Watershed Floodplain Management Plan; and funded public outreach and education |
| 8 | 2018 | Creation of a Dayton Valley Area Drainage Master Plan in portions of Lyon and Storey Counties; update floodplain ordinances in Alpine County, California, and Douglas, Carson City, and Lyon Counties in Nevada; and work with state and federal partners to continue flood outreach and education. |

## *2.2 COMMUNITY RATING SYSTEM (CRS)*

The Community Rating System (CRS)[6] supports the NFIP by providing a premium discount to policyholders if their communities participate in the program. The CRS program design encourages communities to implement floodplain management programs that go above and beyond the minimum NFIP requirements. Community activities are scored by Public Information Activities; Mapping and Regulatory Activities; Flood Damage Reduction Activities; and Flood Preparedness Activities. These 19 activities are shown in Table 6 and are utilized in formulas that measure the extent a community meets the goals of the CRS program to:

1. Reduce and avoid flood damage to insurable property;
2. Strengthen and support the insurance aspects of the NFIP; and
3. Foster comprehensive floodplain management.

Flood insurance premium discount rates are calculated by a community's CRS classification, which is tabulated as the sum of CRS activity points. There are 10 classes (1 through 10), with a Class 1 Community receiving the greatest flood insurance premium reduction. Table 7 provides a breakdown of the CRS credit points, classification and premium reductions, as well as the status of CRS classification for the counties within the Carson River Watershed.

[6] https://www.fema.gov/media-library-data/1493905477815-d794671adeed5beab6a6304d8ba0b207/633300_2017_CRS_Coordinators_Manual_508.pdf

Table 6. CRS activities outlined in CRS Coordinator's Manual (2017)

| | ACTIVITY | MAXIMUM CRS POINTS |
|---|---|---|
| 300 Public Information Activities | 310 Elevation Certificates | 116 |
| | 320 Map Information | 90 |
| | 330 Outreach Projects | 350 |
| | 340 Hazard Disclosure | 80 |
| | 350 Flood Protection Information | 125 |
| | 360 Flood Protection Assistance | 110 |
| | 370 Flood Insurance Promotion | 110 |
| 400 Mapping and Regulatory Activities | 410 Additional Flood Data | 802 |
| | 420 Open Space Preservation | 2,020 |
| | 430 Higher Regulatory Standards | 2,042 |
| | 440 Flood Data Maintenance | 222 |
| | 450 Stormwater Management | 755 |
| 500 Flood Damage Reduction Activities | 510 Floodplain Management Planning | 622 |
| | 520 Acquisition and Relocation | 2,250 |
| | 530 Flood Protection | 1,600 |
| | 540 Drainage System Maintenance | 570 |
| 600 Flood Preparedness Activities | 610 Flood Warning Program | 395 |
| | 620 Levee Safety | 235 |
| | 630 Dam Safety | 160 |

This regional floodplain management plan addresses activities eligible for CRS credit and provides a significant amount of points for participating communities in the Carson River Watershed (Figure 3). CWSD's integrated watershed management process includes many CRS activities which incorporate:

- Public information activities of Section 300 such as public outreach and flood protection information;
- Mapping and regulations activities in Section 400 such as flood hazard mapping and higher regulatory standards; and
- Flood damage reduction activities of Section 500 through its floodplain management planning, floodplain acquisition, and flood protection.

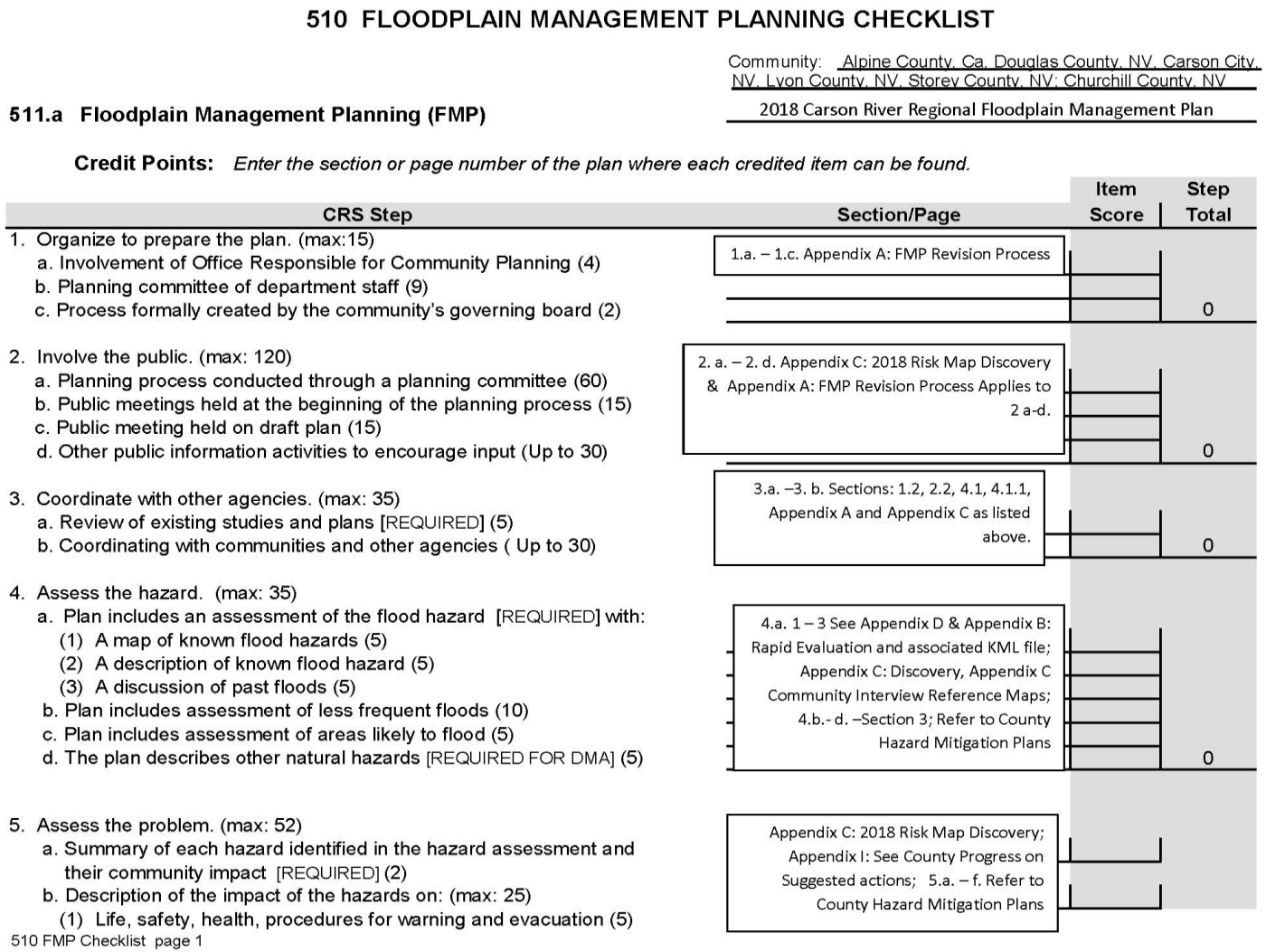
CWSD provides an annual CRS report summarizing these activities to watershed communities who participate in the CRS program. Watershed communities already conduct many of these activities during their regular maintenance and operations; therefore, obtaining the discount is often a matter of documenting those actions. ***A Class 1 community can reduce flood insurance rates for homeowners in special flood hazard areas (SFHA) by 45%.*** Currently, CRS communities in the watershed provide a 10% - 20% flood insurance rate reduction for homeowners in SFHAs as noted in Table 7.

**Table 7. Community Rating System classification and flood insurance premium reductions**

| CREDIT POINTS | CLASS | SFHA | NON-SFHA | JURISDICTION |
|---|---|---|---|---|
| 4,500 and above | 1 | 45% | 10% | |
| 4,000 – 4,999 | 2 | 40% | 10% | |
| 3,500 – 3,999 | 3 | 35% | 10% | |
| 3,000 – 3,499 | 4 | 30% | 10% | |
| 2,500 – 2,999 | 5 | 25% | 10% | |
| 2,000 – 2,499 | 6 | 20% | 10% | Douglas County, Carson City |
| 1,500 – 1,999 | 7 | 15% | 5% | |
| 1,000 – 1,499 | 8 | 10% | 5% | Storey County |
| 500 - 999 | 9 | 5% | 5% | |
| 0 - 499 | 10 | 0 | 0 | Lyon*, Churchill* Alpine County* |

Notes: SFHA – special flood hazard area. *Participates in the NFIP but does not currently participate in the CRS program.

Figure 3. CRS 510 Floodplain Management Planning Checklist



## 510 FLOODPLAIN MANAGEMENT PLANNING CHECKLIST

Community: Alpine County, Ca, Douglas County, NV, Carson City, NV, Lyon County, NV, Storey County, NV; Churchill County, NV

**511.a Floodplain Management Planning (FMP)**

2018 Carson River Regional Floodplain Management Plan

**Credit Points:** *Enter the section or page number of the plan where each credited item can be found.*

| CRS Step | Section/Page | Item Score | Step Total |
|---|---|---|---|
| 1. Organize to prepare the plan. (max:15) | | | |
| a. Involvement of Office Responsible for Community Planning (4) | 1.a. – 1.c. Appendix A: FMP Revision Process | | |
| b. Planning committee of department staff (9) | | | |
| c. Process formally created by the community's governing board (2) | | | 0 |
| 2. Involve the public. (max: 120) | | | |
| a. Planning process conducted through a planning committee (60) | 2. a. – 2. d. Appendix C: 2018 Risk Map Discovery & Appendix A: FMP Revision Process Applies to 2 a-d. | | |
| b. Public meetings held at the beginning of the planning process (15) | | | |
| c. Public meeting held on draft plan (15) | | | |
| d. Other public information activities to encourage input (Up to 30) | | | 0 |
| 3. Coordinate with other agencies. (max: 35) | | | |
| a. Review of existing studies and plans [REQUIRED] (5) | 3.a. –3. b. Sections: 1.2, 2.2, 4.1, 4.1.1, Appendix A and Appendix C as listed above. | | |
| b. Coordinating with communities and other agencies ( Up to 30) | | | 0 |
| 4. Assess the hazard. (max: 35) | | | |
| a. Plan includes an assessment of the flood hazard [REQUIRED] with: | 4.a. 1 – 3 See Appendix D & Appendix B: Rapid Evaluation and associated KML file; Appendix C: Discovery, Appendix C Community Interview Reference Maps; 4.b.- d. –Section 3; Refer to County Hazard Mitigation Plans | | |
| (1) A map of known flood hazards (5) | | | |
| (2) A description of known flood hazard (5) | | | |
| (3) A discussion of past floods (5) | | | |
| b. Plan includes assessment of less frequent floods (10) | | | |
| c. Plan includes assessment of areas likely to flood (5) | | | |
| d. The plan describes other natural hazards [REQUIRED FOR DMA] (5) | | | 0 |
| 5. Assess the problem. (max: 52) | | | |
| a. Summary of each hazard identified in the hazard assessment and their community impact [REQUIRED] (2) | Appendix C: 2018 Risk Map Discovery; Appendix I: See County Progress on Suggested actions; 5.a. – f. Refer to County Hazard Mitigation Plans | | |
| b. Description of the impact of the hazards on: (max: 25) | | | |
| (1) Life, safety, health, procedures for warning and evacuation (5) | | | |

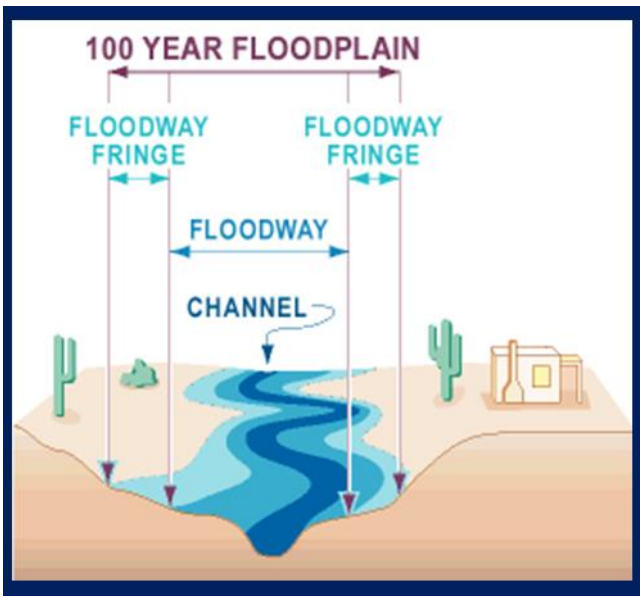
510 FMP Checklist page 1

| | | |
|---|---|---|
| (2) Public health inlcuding health hazards to floodwaters/mold (5)<br>(3) Critical facilities and infrastructure (5)<br>(4) The community's economy and tax base (5)<br>(5) Number and type of affected buildings (5)<br>c. Review of all damaged buildings/flood insurance claims (5)<br>d. Areas the provide natural floodplain functions (5)<br>e. Development/redevelopment/Population Trends (7)<br>f. Impact of future flooding conditions outline in Step 4, item c (5) | Appendix C: 2018 Risk Map Discovery; Appendix E: See County Progress on Suggested actions; 5.a. – f. Refer to County Hazard Mitigation Plans | 0 |
| 6. Set goals. [REQUIRED] (2) | Section 1 and Section 4, Table 11; Appendix C: 2018 Risk Map Discovery; | 0 |
| 7. Review possible activities. (max: 35)<br>a. Preventive activities (5)<br>b. Floodplain Management Regulatory/current & future conditions (5)<br>c. Property protection activities (5)<br>d. Natural resource protection activities (5)<br>e. Emergency services activities (5)<br>f. Structural projects (5)<br>g. Public information activities (5) | Section 4 applies to all sections; specifics called out for each: 7.a. Section 1 & Section 4.3,4.5,4.6, 4.8 & Table 11; 7.b. Section 4.2; 7. c. Sections 4.1, 4.3; 7.d. Section 4.1; 7.e. Section 7; 7.f. Section 4.3 Appendix I; 7.g. Section 4.5 | 0 |
| 8. Draft an action plan. (max: 60)<br>a. Actions must be prioritized [REQUIRED]<br>(1) Recommendations for activities from two of the six categories (10)<br>(2) Recommendations for activities from three of the six categories (20)<br>(3) Recommendations for activities from four of the six categories (30)<br>(4) Recommendations for activities from five of the six categories (45)<br>b. Post-disaster mitigation policies and procedures (10)<br>c. Action items for mitigation of other hazards (5) | 8.a. – 8. c. Conducted by each County<br>Section 4 Suggested Actions is the Action Plan.<br>See Also County Hazard Mitigation Plans | 0 |
| 9. Adopt the plan. (2) | 9. See Appendix G for County Adoption Dates | 0 |
| 10. Implement, evaluate and revise. (max: 26)<br>a. Procedures to monitor and recommend revisions [REQUIRED] (2)<br>b. Same planning committee or successor committee that qualifies under Section 511.a.2 (a) does the evaluation (24) | 10.a. – b. Carson River Coalition Floodplain & River Mgt working groups meets regularly to assess and recommend revisions. Regional FMP is updated every 5 years. Refer to Appendix A | 0 |
| **Maximum Credit for 510 FMP = 382** | **Plan Total:** | **0** |

510 FMP Checklist page 2

## *2.3 FLOODPLAIN 101*

Figure 4. Floodplain Components




This section provides a brief overview of floodplains, how they function, and describes how FEMA regulates floodplains through the National Flood Insurance Program (NFIP).

***The level area bordering a river channel is known as the floodplain; the area that is naturally subject to flooding*** (Figure 4). The river channel meanders through the landscape and over time shapes the surface geology of the landscape and deposits sand, silt, and other material. These deposits are referred to as alluvium.

***The floodway is a critical component of the floodplain*** relative to maintaining the flood carrying capacity of the river. For regulatory purposes, the floodplain is divided into the floodway and the floodway fringe. A "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure that there are no increases (also known as zero rise) in flood elevations. Within the floodway fringe, there must be no more than a 1' rise in flood elevations above base flood elevations.

***Floodplains perform natural and beneficial functions.*** FEMA describes three types of "natural and beneficial functions" that warrant protecting floodplains in their natural state (FEMA 2002).

**FEMA encourages state, local, and private programs that preserve or restore the natural state of floodplains.**

1. **Floodplains** in their natural state have an important positive impact on flooding. Flood waters can spread over a large area in floodplains that have not been encroached upon. This **reduces flood velocities** and provides flood storage to **reduce peak flows downstream**. Vegetation on the floodplain surface stabilizes soils during flooding. Protected floodplains reduce flood energy and, therefore, reduce damage to adjacent properties and areas downstream.
2. **Floodplains** in their natural state provide "ancillary beneficial functions" beyond flood reduction. **Water quality is improved** in areas where natural vegetative cover acts as a filter for runoff and overbank flows. Natural floodplains moderate water temperature, reducing the possibility of damaging impacts to plants and animals.
3. **Floodplains** can act as **recharge** areas for **groundwater**, reduce the frequency of low flow events, and increase minimum flow rates of riverine systems.
4. **Floodplains provide habitat** for diverse species of flora and fauna, some of which can live nowhere else. They are particularly important as breeding and feeding areas for birds and other wildlife.

***Floodplain Economic Value is often not considered.*** Services provided by undeveloped floodplain lands include flood protection, a public safety benefit, improved water quality, flood water retention, and wildlife habitat. These are economic goods even if they are not explicitly bought and sold like other commodities (Lichtenberg 1994). Floodplain managers recognize the costs to landowners of open floodplain lands who provide the benefits of these natural goods and services. Often referred to as **ecosystem services**, it is critical to acknowledge and support landowners who provide these benefits by preserving undeveloped or agricultural floodplain lands.

***Development within floodplains often occurs without consideration of the effects on floodplain function.*** Development increases impermeable surfaces, such as buildings and pavement, as it replaces vegetative cover. Rather than being infiltrated into the ground, water runs off these hard surfaces. Replacing naturally functioning floodplains with impermeable surfaces significantly impacts water quality. This runoff becomes a vector for diffuse "nonpoint sources" (NPS) of pollution, such as lawn fertilizers, leached materials from waste disposal, sediment from excessive erosion, and chemicals from automobiles, to name a few. As NPS pollution accumulates in runoff, it threatens water quality. Natural floodplains and vegetated buffers along waterways can help significantly to mitigate this NPS pollution, also known as polluted runoff.

***Land use that allows and encourages native vegetation to flourish is highly suitable for floodplains.*** Well-placed parks, trails, or other recreational areas that include native vegetation are ideal for flood storage capacity. They support the floodplain's natural and beneficial functions that protect water quality and sustain wildlife habitat. In the Carson River Watershed, agricultural lands provide a sizable portion of open lands that maintain flood storage capacity. These compatible land use choices are critical to naturally reduce flood hazard risks associated with a more developed floodplain.

**A 100-year flood does not only occur once every hundred years; it can occur anytime since there's a 1% chance it could occur in any given year.**

***Floods are frequently defined in probability terms of occurring in a given year***. Floods are classified according to their frequency and depth. For instance, there are 10-year, 25-year, 50-year, 100-year, and 500-year floods. A 100-year flood is less frequent than a 10-year flood but is deeper and far more destructive. The 100-year flood is commonly referred to as the "base flood." However, floodplain managers are moving away from calling it a 100-year flood since many people underestimate their risk. Instead, they are referring to the base flood as a flood which has a 1% chance of occurring in any given year. The 1% annual chance (or 100-year) floodplain and the floodway makes up the Special Flood Hazard Area (SFHA). Buildings located within the SFHA are required to have flood insurance as a condition of receiving a federally-backed mortgage loan or a home equity loan. Given that most mortgages have a 30- year repayment period, there is a 26% chance that the building located within a higher risk flood area will experience flooding during the life of the loan (Table 8). The occurrence of a flood does not affect the probability of a flood to occur again in the same or next year. Flood frequency values adjust either up or down as more data is collected and the flood frequency is recalculated. Bank full discharge is predicted to occur for most alluvial streams, like the Carson River, once every 1.5 years on average (Leopold 1994). Out-of-bank flooding occurs once every 2.3 years on average, with a 40% chance of occurring in a given year. Inappropriate development on vulnerable floodplain lands can cause an increase in the risk and frequency of flood-related damages to property and infrastructure. It is important to encourage

homeowners in areas adjacent to or in potentially susceptible areas to purchase flood insurance. As many residents learned during the 2014-2015 alluvial fan/flash flood events, residents everywhere must be aware of potential flood risks and hazards and be prepared accordingly.

**Table 8. Statistical chances of being flooded during a 30-year mortgage.**
**Percentages represent the probability of the flood occurring in any given year.**

| PERIOD OF TIME | 10-YR FLOOD | 25-YEAR FLOOD | 50-YEAR FLOOD | 100-YEAR FLOOD |
|---|---|---|---|---|
| 1 year* | 10% | 4% | 2% | 1% |
| 10 years | 65% | 34% | 18% | 10% |
| 20 years | 88% | 56% | 33% | 18% |
| 30 years | 96% | 71% | 45% | 26% |
| 50 years | 99% | 87% | 64% | 39% |

Source: Morgan, 2003

***Floodways and flood zones are denoted on a FEMA flood insurance rate map (FIRM).*** FIRM maps delineate the flood hazard areas and divide the mapped areas into zones according to flood hazard factors. They are prepared for insurance rating, land use regulations, and for lenders in determining areas where flood insurance must be purchased. These are the maps that local governments typically use for determining locations of SFHAs. SFHAs have a high risk of flooding and are delineated by FEMA as flood Zones A and V (V refers to coastal flooding). Appendix C: 2018 Risk MAP Discovery Report shows the FEMA flood zones and links to FEMA DFIRMS provided in Appendix D. Because of activities coordinated by CWSD (see Table 5), FIRMs for many jurisdictions in the watershed have been and continue to be updated (Douglas, Carson, Lyon). In the remaining jurisdictions where FIRMs are outdated, the current watershed conditions may not be correctly represented; however, those jurisdictions are considering updating their county's FIRMS.

# 3.0 FLOOD HISTORY AND RISK ASSESSMENT

Repeated incidents of flooding in the Carson River Watershed are detailed on the U.S. Geological Survey (USGS) website, "Flood Chronology of the Carson River Basin." While rain-on-snow, high-intensity and short-duration flood events continue to occur, other flood events have raised awareness to the distinct types of flood hazards. These events include alluvial fan flooding; post-fire debris floods; extended periods of high river flows; and consistent rain which overwhelm stormwater systems. Incidents of these types of floods are described in detail in section 3.1.

The National Oceanographic and Atmospheric Administration (NOAA) National Weather Service (NWS) website[7]provides information on flood levels and associated potential flood impacts. Table 9 provides risk assessment information from NWS for the Carson River near Carson City. As evidenced in the table, 9,800 cfs begins to cause significant impacts to communities from flooding. If future conditions result in more frequent and more intense flooding events, ***a flood greater than the 22,000 cfs event experienced in 1997, is not unrealistic***. For reference, in 2017, peak flow reached 10,500 cfs during the February runoff period. Sustained flows of 1,500 to over 3,000 cfs continued from March through October.

**USGS Flood Chronology of the Carson River Basin available online at: https://nevada.usgs.gov/crfld/Carson/floodevents.htm**

**Flooding in Dayton Valley area 2017 (Courtesy NWS)**

[7] https://water.weather.gov/ahps2/hydrograph.php?wfo=rev&gage=stwn2

Table 9. Potential flood impacts related to flood stage for Carson River near Carson City (USGS)
(Source: NOAA National Weather Service, Advanced Hydrologic Prediction Service: Reno: Carson River near Carson City)

| LEVEL (FT) | FLOW (CFS) | POTENTIAL FLOOD IMPACTS |
|---|---|---|
| 19.0 | 38,000 | Incredible flood with damage previously unknown from Carson Valley to Fort Churchill including Empire and Dayton areas. USGS estimated 100 yr. flood. |
| 17.0 | 29,600 | Record flooding. All towns cut off…bridges and roads destroyed. |
| 16.0 | 25,800 | Near record flooding with massive destruction throughout reach. Most towns isolated with transportation nearly impossible. |
| 15.0 | 22,200 | Major flood disaster with widespread destruction throughout reach from Genoa to Weeks. Transportation extremely difficult. |
| 13.5 | 17,400 | Flood disaster throughout reach. Transportation very difficult. Large number of structures affected and infrastructure damage (roads, bridges, power, water). |
| 12.0 | 13,300 | Extensive flooding with major damage. Most roads in valley areas flooded making transportation difficult. Massive erosion with large agricultural losses and cattle drownings. |
| 11.0 | 10,900 | Major flooding. Many roads and highways flooded. Transportation becoming difficult…US Hwy 395 closes. Massive bank erosion with the ability to wash away buildings…cars…roads. River channel begins to move around laterally. |
| 10.5 | 9,800 | Moderate flooding through reach. Damage to roads, bridges, crops, irrigation systems, and buildings in lower areas. Transportation begins to be affected. |
| 10.0 | 8,800 | Flood stage. Minor to moderate lowland flooding with several homes having flood problems in Genoa, Carson Valley, Stewart, and Dayton. Minor to moderate damage to agriculture. |
| 9.5 | 7,800 | Minor flood impacts in lower portions of reach. |
| 9.0 | 6,900 | Minor lowland flooding through reach in lower flood prone areas. |
| 8.5 | 6,000 | Minimal lowland flooding through reach. |
| 8.0 | 5,200 | Monitoring stage. Flood threat and localized overbank flows begin in lowest areas. |

## *3.1 TYPES OF FLOOD HAZARDS*

Flooding, whether localized or basin-wide, is a common occurrence in the watershed. The three main types of flooding that occur are described by USGS (2006) as the following:

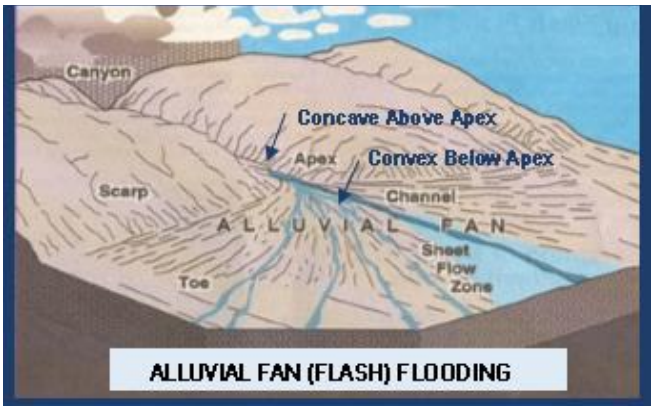
Main Channel (Riverine Flooding): Main-channel floods result from rain on the mountain snowpack which contributes to rapid snowmelt. As flows in the Carson River increase due to the rapid snowmelt, the channel overflows and floods adjacent areas or floodplains. More recently, these types of floods have occurred due to unusually long runoff events due to heavy winter precipitation. Such floods emphasize the importance of maintaining the floodplain in a condition where it can take on the

**Lloyd's Bridge in Carson City; maximum depth measurements and known flow rates should be coordinated at such locations**

additional flow without harm to life or property. Documented footage of the 1997 flood is available and useful for public outreach and education.[8]

The most significant recorded flooding event in the watershed occurred on New Year's 1997, when flows of up to 22,800 cfs ravaged Carson, Eagle, and Dayton Valleys. A decade later, on New Year's 2006, another flood (~12,000 cfs) reminded our communities that flooding regularly occurs on the Carson River. Some residents and natural resource managers reported flooding in areas during this relatively small event which had not previously flooded. Several potential causes of increased river flooding in areas previously considered safe during moderate to moderately high-volume water flows have been hypothesized as follows; however, more study is needed to verify why lower river flows are causing more damage:

**Figure 5. Alluvial fan graphic from Nevada Floods Brochure FS 14-12 created by UNR Cooperative Extension**




- Increase of floodplain development may be changing the flood routes and increasing velocities;
- Increased debris and sediment in the river are displacing water, bridges plugged with debris and sediment are causing water to back up.

Alluvial Fan Flooding: Also known as flash flooding, alluvial fan flooding results from intense rainfall during summer thunderstorms on alluvial fan surfaces (gently sloping, fan-shaped landforms common just below mountain canyons – Figure 5). Flash flooding is characterized by high-velocity flows, sediment and bedload transport, erosion and deposition, and unpredictable flow paths. The risks from this type of flooding increase if development occurs on alluvial fans.

In the summer of 2014, the Johnson Lane area of Douglas County was damaged from three intense flash flood events (July 20, July 30 and August 6). The Nevada Division of Emergency Management (NDEM) conducted a damage assessment and estimated that 101 properties were damaged with a total cost to private homeowners of $1.5 million. Damage to public infrastructure was estimated at $927,205. In the summer of 2015, the Johnson Lane area of Douglas County was inundated from flash floods on July 8 and 9. A damage assessment conducted by NDEM estimated that 162 properties were damaged, and $2.2 million was required to restore damaged public infrastructure.

In Lyon County and Storey County, the residential and commercial areas of Dayton Valley experienced several alluvial fan floods during the summers of 2014, 2015, and 2016. In 2017, alluvial fans in these counties received considerable damage from severe winter flooding. Damage to public infrastructures in the Carson River Watershed portions of Lyon County and Storey County has been estimated to be over $5 million.

[8] https://carsonvalleytimes.wordpress.com/2017/01/02/video-footage-from-the-new-years-flood-of-1997-20-years-ago/

Debris Flows: Debris flows are the result of water from intense rainfall or rapid snowmelt mixing with sediment and bedload to become a slurry like wet concrete. In steep canyon (for example, the east slope of the Carson Range), debris flows can reach high velocities, transport large boulders, and cause catastrophic damage from impact or burial. Debris flows usually originate in post-fire burn areas. Alpine County experienced debris flows in January and February 2017 after the Washington Fire. The East Fork of the Carson River next to Wolf Creek Road was filled with debris and there were many landslides on Highway 89 adjacent to the East Fork of the Carson River.

Debris Flow in Alpine County, 2017

Extended Periods of High Flows: In years when there is an uncharacteristically high snow pack, the duration of spring runoff is prolonged. These conditions can cause flooding below Lahontan Reservoir when the reservoir is near or at its storage capacity, creating a unique set of challenges. For instance, in 2017, record snowfall and subsequent snowmelt runoff led to the threat of flooding along the Carson River into the City of Fallon.

CWSD, in partnership with the River Corridor and Floodplain Management Working Group, conducted a Carson River Regional Flood Management Workshop on March 8, 2017, to discuss best options for mitigating flood risk from the high runoff expected. Stakeholders, including the U.S. Bureau of Reclamation (USBR), Truckee Carson Irrigation District (TCID), Churchill County and City of Fallon agricultural producers, and residents, discussed ideas on how to control the forecasted runoff volume, with ideas such as inter-basin transfer, groundwater injection, and revisiting former dam sites. However, to solve the immediate hazard within the timeframe required, downstream structural solutions were sought. An emergency task force convened including the TCID, Churchill County, USBR, and the Nevada Department of Transportation. The task force worked together to gather funding, approve designs, and install emergency weirs and ditches that released flows from Lahontan Reservoir and its irrigation ditches into the desert and onto Bravo 16, a Navy training range, and then east under new culverts placed on both U.S. Hwy. 95 and U.S. Hwy. 50. The water filled Carson Lake (generally a dry playa) and the construction of the "Big Dig" (a deep, wide channel) then carried the water under U.S. Hwy. 50 north of Grimes Point toward the Stillwater National Refuge and Carson Sink.

This creative solution averted severe damages to Churchill County and City of Fallon residential and commercial properties developed within the historic floodplain. These communities and local entities continue to work together to determine if this is the best permanent solution and consider any maintenance or follow-up mitigation measures to alleviate unforeseen impacts from the construction (e.g., dust, water quality, and invasive species).

## 3.2 FEMA REPETITIVE LOSS AREAS

According to FEMA, a Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978.

The history of the loss includes all flood claims paid on the property, regardless of any change(s) in ownership since the building's construction, or back to 1978. It is important to know about such areas as they affect the credits awarded under the CRS. The repetitive loss properties recorded by the CRS communities In the Carson River Watershed are listed in Table 10. Lyon County and Storey County do not participate in the CRS program.

**Table 10. Repetitive loss areas within CRS communities in Carson River Watershed (2018)**

| JURISDICTION | REPETITIVE LOSS PROPERTIES: |
|---|---|
| Alpine County | The only repetitive loss property is in Bear Valley, which is not in the Carson River Watershed. |
| Carson City | 3 repetitive loss properties |
| Churchill County | 1 repetitive loss property |
| Lyon County | 0 repetitive loss properties |
| Douglas County | Within Douglas County, there are 2 repetitive loss properties in Genoa, 2 repetitive loss properties in Gardnerville, and 5 repetitive loss properties in Minden. |
| Storey County | 0 repetitive loss properties |

## 3.3 RISK ASSESSMENT (HAZUS)

HAZUS is a nationally applicable standardized methodology that contains models for estimating potential economic losses from disasters such as floods, earthquakes, and hurricanes. HAZUS uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. It graphically illustrates the limits of identified high-risk locations, and users can then visualize the spatial relationships between populations and other more permanently fixed geographic assets or resources for the specific hazard being modeled, a crucial function in the pre-disaster planning process.

At the current time, there is one HAZUS analysis done along the Carson River in Carson Valley, but it will be superseded when the Physical Map Revision currently under FEMA review becomes effective. This tool can provide valuable economic loss data to help guide floodplain management decision making, gauge the effects of future changes, and provide input into a community's capital improvement projects on a much broader basis. HAZUS data can be used in conjunction with the two-dimensional hydraulic modeling to generate baseline economic loss data. With much of the watershed studied using 2D modeling, communities should take advantage of these existing data sets and HAZUS to fully understand the potential impacts of future flood events. An analysis of potential economic losses from multiple return interval flood events could be either a FEMA or community funded effort. It could provide local agencies with an understanding of the cost versus benefit of capital improvements and the overall cost of flooding. New data and statistics would improve analysis focused on urban areas rather than that provided in past analysis (impacts on wilderness).

## *3.4 PUBLIC AND PRIVATE INFRASTRUCTURE*

The Carson River Watershed is typical of many irrigated watersheds in the western United States. The watershed is a large land mass traversed by the river, providing a water supply from which the local economy is largely based, and where agricultural needs are primarily served through a series of irrigation canals. Over the years many of the developed areas discharge their stormwater into irrigation canals. This results in an array of infrastructure owned by public and private entities. Local entities periodically conduct routine maintenance to ensure conveyance capacities. Jurisdictions generally have a stormwater inventory, inspection, and maintenance of such facilities which is included in their CRS (540) responsibilities. While public infrastructure may have some funding associated with maintenance costs, private irrigation infrastructure may not. However, it is equally important to maintain the private infrastructure, as it is usually the secondary receiver of the floodwaters. If not functioning or clogged, flood flows may back up onto adjoining properties or infrastructure, leading to risk or potential harm.

Future updates to this plan may start to inventory, categorize, and house public and private drainage and flood control infrastructure in the Carson River Watershed. An inventory of these facilities can provide stakeholders and end users a database of conveyance features to begin prioritizing maintenance and improvements and identify deficiencies in the system.

## *3.5 FUTURE CONDITION CONSIDERATION AND IMPACTS TO FLOODPLAIN*

There is ongoing discussion at working group and technical advisory group meetings about the importance of outreach and education to residents outside of the federally regulated SFHAs within the 100-year floodplain SFHA. There is concern that critical infrastructure (hospitals, schools, fire stations) should be designed to be protected from the 500-year event. This should be concurrent with relating flood risk to residents to ensure they understand flood hazards exist beyond the 100-year floodplain. Flood insurance in the 500-year floodplain is prudent and is much less expensive than the 100-year floodplain. In addition, climate change impacts may result in changing storm patterns, rainfall amounts, and snow levels, adding uncertainty to future conditions. Sound floodplain management in the Carson River Watershed should include a margin of error in all decisions that accounts for this uncertainty.

**Photograph of construction during the 2017 "Big Dig" in Churchill County**

# 4.0 FLOOD RISK REDUCTION AND FLOODPLAIN STRATEGIES

As stated in Section 1, the long-term vision and strategies for regional floodplain management are categorized as follows:

1. Protect Natural Floodplain Function and Values
2. Set Higher Regulatory Standards
3. Collect Flood Data Information and Maintenance
4. Balance Channel Migration and Bank Erosion Monitoring
5. Increase Floodplain and Flood Hazard Outreach and Education
6. Reduce Infrastructure Impact
7. Map/Study Alluvial Fans
8. Minimize Stormwater Mitigation

Table 11 provides a summary of the suggested actions for each strategy presented in this section. Since this floodplain management plan and its suggested actions are elements of the Carson River Watershed Stewardship Plan, the correlation between the two documents is indicated. The table also includes suggested responsible parties and potential sources of funding for specific actions and correlates suggested actions to FEMA Community Rating System (CRS). Refer to Table 6 for a description of each CRS activity, defined objective, and listed activity elements.

Suggested actions are desirable actions to be completed within staffing and budgetary limitations to further local jurisdiction and Carson River Watershed Regional Floodplain Management Plan goals. The suggested actions updated from the 2008 RFMP are included in Table 11. As part of this update each jurisdiction reviewed the suggested actions to assess progress made, prioritize, and identify any new hazards or strategies for which additional suggested actions should be implemented. During the RFMP update process, and in conjunction with other watershed plans (Stewardship Plan, Table 8.8), additional strategies and suggested actions were recommended. These include recognition of alluvial fans and associated hazards, stormwater, and Low-Impact Development considerations.

Table 11. Summary of strategies and suggested actions (SA) for watershed flood risk reduction

| | SA # | CRS | SUGGESTED ACTION | Responsible Party | Existing or Potential Funding Partner |
|---|---|---|---|---|---|
| PROTECT FLOODPLAIN NATURAL FUNCTION AND VALUE (1-8) | 1 | 320<br>420<br>510 | Maintain Living River approach to retain river system in a more natural state that allows the river to access its floodplain. Recognize that not all areas of the river system can be allowed to migrate freely due to special designation (i.e., Superfund area) and/or existing infrastructure. | All entities | N/A |
| | 2 | 350<br>410 | Develop, support and implement a good neighbor floodplain management policy that recognizes cumulative impacts and actions by one property owner can impact upstream, adjacent and downstream property owners. | All entities | N/A |
| | 3 | 420 | Investigate, identify, and implement areas where stream zone buffers would provide multi-objective benefits for river system and downstream communities. (Previously SA # 4) | Local and tribal governments | NDWR Clearing and Snagging Fund; FEMA; State Lands; NDEP |
| | 4 | 310<br>410<br>530 | Manage development in special flood hazard areas and other flood hazard areas (those known flood hazard areas not included on most current FIRMs) to provide public safety and protect the natural functions and benefits of floodplain lands. (Previously SA # 6) | Local and tribal governments; CWSD | Local Governments |
| | 5 | 320<br>450 | Promote and utilize best management practices as a means of protecting riparian habitat. (Previously SA #10) | All entities | NDEP, FEMA, USBR, Local Governments |
| | ECOSYSTEM SERVICES IMPORTANT to MAINTAINING LIVING RIVER APPROACH | | | | |
| | 6 | 350<br>420 | Consider Floodplain and flood hazards ecosystem service objectives which preserve open floodplain lands when selecting acquisition targets and establishing management strategies for open spaces. (Previously SA #3) | Local and tribal governments, NGOs, CWSD | FEMA, Local Governments, NDEP |
| | 7 | 520 | Identify and promote options for landowner incentive programs, such as floodplain leasing program and conservation easements that provide compensation to landowners providing ecosystem services and seek funding mechanisms. (Previously SA# 9) | Local & tribal governments, NGOs, CWSD, CRC, landowners | Federal, State and local sources, , Question 1, SNPLMA |
| | 8 | 420<br>520 | Retain lands that preserve floodplain storage which maintain and/or restore connection of river with floodplain through land acquisition, conservation easements, local open space programs, TDR and PDR Programs, and other protection methods. Pursue protection of additional acreage in flood prone areas (See UNCE 2015, Floodplain Protection Inventory for the Carson River). (Previously SA #7) | Local and tribal governments, NGOs, landowners | Question 1; SNPLMA; NGOs; local governments |

| SA # | | CRS | SUGGESTED ACTION | Responsible Party | Existing or Potential Funding Partner |
|---|---|---|---|---|---|
| | | | **HIGHER REGULATORY STANDARDS (9-11)** | | |
| HIGHER REGULATORY STANDARDS (9-11) | 9 | 430 | Periodically review 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. (Previously SA # 11) | Local governments | FEMA, Local Governments |
| | 10 | 430 | Investigate, promote, and implement of additional flood protection measures that go beyond minimum FEMA requirements, such as improving community rating system. (Previously SA # 12) | Local governments | Local Governments |
| | 11 | 430 | Development and adoption of consistent floodplain management ordinance language and consistent use of hydraulic model of Carson River system. (Previously SA # 13) | CWSD, CRC, local governments | FEMA, CWSD, Local Governments |
| | | | **FLOOD DATA INFORMATION AND MAINTENANCE (12-21)** | | |
| FLOOD DATA INFORMATION AND MAINTENANCE (12-21) | 12 | 410<br>440 | Establish and adopt funding source, and protocol / procedures to consistently update watershed-wide unsteady state modeling to identify flood water storage requirements and to look at the cumulative effects of watershed development. (Previously SA #14) | Local & state governments, CWSD | FEMA, CWSD, NDEP, other local & state entities |
| | 13 | 440 | 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. (Previously # SA 15) | Local governments, FEMA, CWSD | FEMA, CWSD, Local Governments |
| | 14 | | Participate in FEMA's Cooperating Technical Partner Program. (Previously SA#16) | CWSD, FEMA | CWSD |
| | 15 | 410<br>440 | Collect and Maintain up-to-date and consistent data collection which includes updating flood studies as needed and conducting new studies for significant water courses and alluvial fan areas. This data should be used to update FEMA maps and/or fill local data gaps. Complete delineation of the floodway throughout river system and incorporate into FIRMs. (Previously SA #17) | Local governments, CWSD, FEMA | All Federal, state and local funding sources |
| | 16 | 410<br>440 | Update flood studies and maps after significant flooding events. (Previously SA #18) | Local governments | FEMA, CWSD, Local Governments |
| | 17 | 410<br>440 | Update and Maintain Elevation Reference Marks (ERM) as- permanent monuments using NAVD88 Datum which matches base flood elevations on FEMA FIRMs. (Previously SA #19& 20) | Local governments | All Federal, state and local funding sources |
| | 18 | 410<br>440 | Develop and maintain master list of ERMs provide-to interested parties. (Previously SA #21) | Local governments, CWSD | All Federal, state and local funding sources |

| SA # | | CRS | SUGGESTED ACTION | Responsible Party | Existing or Potential Funding Partner |
|---|---|---|---|---|---|
| **FLOOD DATA INFORMATION AND MAINTENANCE (12-21)** | | | | | |
| FLOOD DATA INFORMATION AND MAINTENANCE (19-21) | 19 | 350<br>410<br>440 | Develop and coordinate photo-monitoring program (on-the-ground and aerial) on a watershed level to consistently document flooding and flood hazards. (Previously SA #22) | CWSD | All Federal, state and local funding sources |
| | 20 | 350<br>410<br>440 | Establish and maintain rain gage data network in each local jurisdiction. | Federal, State and Local governments, CWSD | All Federal, state and local funding sources |
| | 21 | | Evaluate potential impacts due to climate variability which could include changing storm patterns, rainfall amounts, and snow levels, adding uncertainty to future conditions. | Federal, State and Local governments, CWSD | All Federal, state and local funding sources |
| **CHANNEL MIGRATION AND BANK EROSION MONITORING (22-29)** | | | | | |
| CHANNEL MIGRATION AND BANK EROSION MONITORING (22-29) | 22 | 410 | Document/map and update known and projected hazard areas including channel migration hazards and incorporated into planning processes. (Previously SA #23) | Conservation Districts, CWSD, NDEP, FEMA, local & tribal governments | FEMA, CWSD, NDEP, NDWR, BIA, Conservation Districts, local & tribal governments |
| | 23 | 440 | Conduct LiDAR and/or aerial photography (on a watershed level) on a 5-year basis, or as needed, to provide updated information on channel movement and floodplain condition. (Previously SA #24) | CWSD, NDEP, CVCD, DVCD, NGOs, BOR, local governments | All Federal, state and local funding sources |
| | 24 | 430 | Conduct research and establish appropriate building set-backs in flood hazard areas to reduce severe hazards from channel migration. (Previously SA #25) | Local and state entities, CWSD | All Federal, state and local funding sources |
| | 25 | 410<br>440 | Conduct and document channel cross-sectional surveys to track long term changes in river channel. (Previously SA #26) | CWSD, conservation districts | All Federal, state and local funding sources |
| | 26 | 410<br>440 | Identify unstable stream banks and areas with high potential for erosion. (Previously SA #27) | Conservation districts, NDEP, CWSD | All Federal, state and local funding sources |
| | 27 | 510 | Promote the use of non-structural, bio-engineering (soft-engineering utilizing natural materials) techniques in river restoration projects in combination with other proven methods. (Previously SA #28) | All entities | FEMA, NDEP, CWSD |
| | 28 | 440<br>510 | Update the 1996 Fluvial Geomorphic Assessment and create a sediment transport model of the Carson River. (Previously SA #29) | CWSD, NDEP, conservation districts | FEMA Pre-Disaster Mitigation grants; USACE: UNR Graduate Grants; DRI; NSF |
| | 29 | 440<br>510 | Create a baseline study that informs management and project decisions regarding flood risks, damages, and ecosystem impacts. | CWSD, NDEP, conservation districts | FEMA Pre-Disaster Mitigation grants; USACE: UNR Graduate Grants; DRI; NSF |

| SA # | | CRS | SUGGESTED ACTION | Responsible Party | Existing or Potential Funding Partner |
|---|---|---|---|---|---|
| **FLOODPLAIN AND FLOOD HAZARD OUTREACH AND EDUCATION (30-34)** | | | | | |
| FLOODPLAIN AND FLOOD HAZARD OUTREACH AND EDUCATION (30-34) | 30 | 330 | Continued implementation of watershed-wide outreach and education program about floodplain importance and flooding hazards. | FAW Working group which includes CWSD, Federal, State and Local Jurisdictions | FEMA; NDWR, and Federal, state and local partners |
| | 31 | 330 | Promote and participate in Annual Flood Awareness Week (FAW) and events throughout the year with the objective of providing information about protection of floodplains, flooding and flood hazards to the general public. | FAW Working group which includes CWSD, Federal, State and Local Jurisdictions | All Federal, state and local funding sources |
| | 32 | 330 | Develop and update media in conjunction with FAW working group (social media, videos, brochures, web content, press releases etc.) for distribution throughout watershed with consistent messages and information for the general public. | FAW Working group which includes CWSD, Federal, State and Local Jurisdictions | CWSD, NDWR, USACE |
| | 33 | 330 | Promote FAW partner websites (e.g., NevadaFloods.org, National Weather Service, CWSD, and county websites) which provide information on the Regional Floodplain Management Plan, floodplain protection, flood risk, emergency preparedness, and emergency contact information. Link to one another's websites and social media sites to amplify message. | In conjunction with Flood Awareness Campaign led by NDWR, CWSD, NOAA -NWS Reno specifically address flood risk and local jurisdictions have websites as well which also link to these websites. | CWSD, NDWR, NOAA -NWS Reno |
| | 34 | 330 | Utilize special Events, River Work Days, and other outreach opportunities in conjunction with FAW working group to raise awareness of flooding hazards and importance of floodplains. | FAW Working group which includes CWSD, Federal, State and Local Jurisdictions | All Federal, state and local funding sources |
| **REDUCE INFRASTRUCTURE IMPACTS (35-39)** | | | | | |
| REDUCE INFRASTRUCTURE IMPACTS (35-39) | 35 | 510<br>540 | Investigate opportunities and implement actions when feasible to remove existing restrictions, such as berms or uncertified levees, to allow flood waters to access floodplain. | Local & tribal government organizations, landowners | All Federal, state and local funding sources |
| | 36 | 510 | Limit the use of future management measures such as dams, levees, and floodwalls. | Local & tribal government organizations, landowners | All Federal, state and local funding sources |
| | 37 | 540 | Design future bridges and roads to protect floodplain and accommodate rather than restrict river course changes, and minimize back up of flood water. | NDOT, local governments | All Federal, state and local funding sources |
| | 38 | | Investigate opportunities to enhance grade control structures. | Local governments, CWSD | FEMA, NDEP, CWSD, and local governments |
| | 39 | | Inventory, categorize, and house data regarding public and private drainage and flood control infrastructure in the Carson River Watershed. | Local governments, CWSD | FEMA, NDEP, CWSD, and local governments |

| SA # | | CRS | SUGGESTED ACTION | Responsible Party | Existing or Potential Funding Partner |
|---|---|---|---|---|---|
| **ALLUVIAL FAN HAZARD REDUCTION (40-43)** | | | | | |
| ALLUVIAL FAN HAZARD REDUCTION (40-43) | 40 | 440 | Investigate extent of potential alluvial fan flood damage and include on maps. | Local governments, CWSD | FEMA, USACE, CWSD, and all other Federal, state, and local funding sources |
| | 41 | 440 | Conduct Area Drainage Master Plans for alluvial fans which examines infrastructure, land use, sediment transport & identify alternative to mitigate and/or reduce risk. | Local governments, CWSD | FEMA, CWSD, and all other Federal, state, and local funding sources |
| | 42 | 440<br>530 | Implement studies to inform and motivate land use planning & development which protects high risk areas, and/or allows flood waters and debris flows to safely move through fan flood zones; | CWSD, Local governments | FEMA, CWSD, and all other Federal, state, and local funding sources |
| | 43 | | Define and implement means to protect existing open alluvial fans, implement recommendations associated with SA#'s 38-40 to limit further development and/or alleviate hazards in high risk areas. | CWSD, Local governments | FEMA, CWSD, and all other Federal, state, and local funding sources |
| **MINIMIZE STORMWATER IMPACTS (44-48)** | | | | | |
| MINIMIZE STORMWATER IMPACTS (44-48) | 44 | 450 | Promote stormwater infiltration rather than direct outflow to urban infrastructure, ditches, creeks, rivers to capture groundwater, improve water quality, and reduce flood risk. | State, CWSD, Local Governments | FEMA, CWSD, and all other Federal, state, and local funding sources |
| | 45 | 450 | Plan for and mitigate cumulative effects of watershed urbanization, including stormwater runoff, to reduce flood hazards. (Previously SA #5) | All entities | FEMA, Local Governments, NDEP |
| | 46 | 450 | Encourage and incorporate low impact development (LIDs) principles into all development proposals to decrease stormwater run-off, improve water quality, and promote groundwater recharge. (Edited from Former SA #8) | Local governments | Incentives to Development (fee waivers, credits?; |
| | 47 | 450 | Encourage adoption of model LID ordinances created for Watershed. | CWSD/Local governments | Local Governments/CWSD |
| | 48 | 320<br>450 | Promote and utilize best management practices to reduce urban runoff (Refer to SA #5) | All entities | NDEP, FEMA, USBR, Local Governments |

THIS PAGE INTENTIONALLY LEFT BLANK

## *4.1 PROTECT FLOODPLAIN NATURAL FUNCTIONS AND VALUES*

The Carson River system is fortunate in that there are still large areas of undeveloped floodplain that that provide ecosystem services to our communities. Agricultural land and areas of open space adjacent to the river allow flood waters to spread out, slow down, and sink in; flood velocities are reduced; emergency managers are given more time to respond; and cumulative impacts of flooding in the river system and adjacent communities are lowered. By allowing the river to access its floodplain, adjacent communities upstream and downstream reap these benefits. This approach acknowledges the open floodplain itself is the best floodplain protection. The following sections summarize the watershed-wide progress accomplished through protecting natural floodplain function and values.

The CRC Guiding Principles (2000) and the original 2008 Carson River Regional Floodplain Management Plan, each adopted by the five counties that the river runs through, promote the protection of natural open floodplain and land uses that are compatible with floodplain form and function. FEMA and the Association of State Floodplain Managers (ASFPM) are now recommending the protection of the natural functions and values of a floodplain as a priority in floodplain management. The CRS has increased the amount of credit that is available for communities implementing these types of strategies. As stated in Natural Hazard Mitigation Saves: 2017 interim Report, "mitigation funding can save the nation $6 in future disaster costs, for every $1 spent on hazard mitigation."[9]

### 4.1.1 Living River Approach

This approach of keeping land adjacent to a river system in a natural state is often referred to as a "***Living River" approach***. For 20 years, the CRC and watershed stakeholders have promoted and actively implemented this approach.

### SUGGESTED ACTIONS 1-8:

1. Maintain Living River approach to retain river system in a more natural state that allows the river to access its floodplain. Recognize that not all areas of the river system can be allowed to migrate freely due to special designation (i.e., Superfund area) and/or existing infrastructure.
2. Develop, support and implement a good neighbor floodplain management policy that recognizes that actions by one property owner can impact adjacent and downstream property owners.
3. Investigate, identify, and implement areas where stream zone buffers would provide multi-objective benefits for river system and downstream communities.
4. Manage development in special flood hazard areas and other flood hazard areas (those known flood hazard areas not included on most current FIRMs) to provide public safety and protect the natural functions and benefits of floodplain lands.
5. Promote and utilize best management practices as a means of protecting riparian habitat.
6. Consider floodplain and flood hazards ecosystem service objectives when selecting acquisition targets and establishing management strategies for open spaces.
7. Identify and promote options for landowner incentive programs, such as floodplain leasing program and conservation easements that provide compensation to landowners providing ecosystem services and seek funding mechanisms.
8. 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.

[9] https://www.nibs.org/news/381874/National-Institute-of-Building-Sciences-Issues-New-Report-on-the-Value-of-Mitigation.htm

The “living river” approach is an effort to achieve a more natural riverine state, an equilibrium between an undisturbed, protected channel and a channelized river in a concrete ditch.

There is an understanding that development will occur, but with a focus on maintaining a river that functions as naturally as possible given the existing constraints. This approach provides numerous benefits including:

- Continuity (un-impeded flow conditions)
- Connectivity (connection of the river to its floodplain)
- Minimizes disruption and alteration of the river and riparian habitat
- Conveys variable flows
- Preserves and restores habitat in the floodplain
- Balances sediment input with sediment transport
- Provides fish and wildlife habitat
- Enhances water quality and supply
- Maintains aesthetic and recreational qualities
- Enhances the human environment

Allowing development to occur in natural areas increases flooding and the potential for detrimental impacts, which increases public expenditures to manage and repair flood damage. No other water quality improvement practice can equal the benefits of retaining undisturbed natural areas adjacent to waterways. Communities that adopt policies that retain the open floodplain and support the living river concept save money in the long term by protecting the lives and property of their residents. The policies include limiting growth in the floodplain and/or clustering growth outside the floodplain, implementing low impact development (LID) practices, incentivizing conservation easements or floodplain leasing, and adopting a Good Neighbor Policy.

**"Building on the floodplain is like setting up your tent on a freeway when no cars are coming."**

**Dr. Vicki Martin, University of Montana**

Morgan Mill Park, Carson City, 2017

### 4.1.2 Good Neighbor Policy

A "Good Neighbor Policy" for floodplain management recognizes that actions by one property owner can impact adjacent and downstream property owners and communities. Adoption of this RFMP includes a good neighbor floodplain management policy as one of its main goals. Efforts to accomplish mitigation of cumulative effects of watershed urbanization include the development and participation in the watershed model and ordinance, which demonstrates that actions in one section of the floodplain or watershed have consequences in others, sometimes adverse. Negative impacts can be measured by an increase in flood stage, flood velocity, peak flows, the potential for erosion and sedimentation, degradation of water quality, and/or increased cost of public services. Through FEMA CTP funding, an unsteady-state HEC-RAS hydraulic model has been developed that can be used to assess impacts of potential watershed urbanization, track the hydraulic and hydrologic impacts of land use changes, and evaluate civil drainage projects and development throughout the entire Carson River Corridor.

Ordinance language is being updated to support a physical map revision and accompanying hydraulic model of the Carson River upstream of Lahontan Reservoir to Alpine County and will be presented to county boards for adoption in early 2019. This ordinance revision will require the use of this model to incorporate changes and assess hydraulic impact for all areas within the newly established SFHAs. 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. The watershed model also enables management of development in Special Flood Hazard Areas and other flood hazard areas (those known flood hazard areas that are not represented on current FIRMs) to provide public safety, protect the natural functions and benefits of floodplain lands, and minimize the loss of floodplain storage capacity. This model, in coordination with updated floodplain ordinances, will enable jurisdictions to make informed decisions as to the extent of development that should be allowed without adverse impacts to adjacent and downstream properties and communities.

### 4.1.3 Floodplain Function and Flood Hazards

As described throughout this document, there are ways that the floodplain can be used to protect residents and structures from flood hazards. Agricultural production is the primary use of much of the floodplains. These fields act as natural flood storage, serving to distribute and slow the flow across the floodplain. Natural floodplain function also enhances groundwater recharge and water quality. Open space program objectives are integral to this strategy. Efforts must continue to retain the lands that provide floodplain storage and maintain or restore connection of the river with the floodplain through land acquisition, conservation easements, local open-space programs, and transfer of development rights (TDR). Jurisdictional implementation of these activities has been ongoing, as seen in the Rapid Assessment of the River System (Appendix B) and summarized herein.

**Agricultural and ranch lands are consistent with the living river approach and are appropriate for critical floodplain lands. Providing ways to protect and sustain these lands remains a top priority.**

Jurisdictions actively promote floodplain protection mechanisms including conservation easements, transfer of development rights (TDR) programs, and local and federal land protection initiatives including land purchases, as follows:

*Conservation Easements*

"Conservation easements are legal agreements between property owners and another entity, usually a land trust or a government body. The easement restricts land uses to allow for protection of an array of conservation values. The land remains in the property owner's possession and they can continue to use it, sell it, or pass it onto their family/heirs. Flexible in nature, conservation easements can be negotiated to limit development on all or a portion of the property. They do not necessarily provide for public access and often prefer the continuation of the existing land use, such as farming or other open space uses. The holder of the easement is responsible for ensuring the terms of the agreement are followed." (Land Trust Alliance website 2013)

*Transfer of Development Rights (TDR) Programs*

According to the Center for Land Use Education, "the Transfer of Development Rights (TDR) is a voluntary, incentive-based program that allows landowners to sell development rights from their land to a developer or other interested party who then can use these rights to increase the density of development at another designated location." (Miskowiak and Stoll 2006) The landowner who sold the development right maintains ownership of the property and generally a conservation easement or other restrictive covenant is placed on the property to limit or prevent development. TDR programs are useful to protect land uses and land areas such as farmlands, open spaces, floodplains, habitat areas and/or places of historical significance. The program is an equitable market-based program that protects natural/historical values while providing incentives to both the seller and the buyer.

*State Question No. 1*

Monies have been awarded to fund projects in the communities to help mitigate flood risks. These included plans to preserve acreage adjacent to the Martin Slough in Douglas County through purchase of private lands, construction of a trench, and creation of a floodway. These activities have been ongoing since the early 2000's.

*Carson City Question 18 Quality of Life Initiative*

In 1996, Carson City voters approved the Quality of Life Initiative that provided a ¼ cent sales tax increase to acquire and maintain open space (40%), develop community park facilities and trails (40%), and maintain and operate the park facilities developed through Quality of Life Initiative (Q18) (20%). (CCPRMP 2006)

*Carson City Open Space Plan*

The Open Space Plan, which is an element of the Carson City Master Plan, identifies resident surveys reflecting the number one priority as preserving open space in the river corridor and the importance of open space to public health and safety (e.g., watersheds, drainage ways, flooding). Since its inception, Carson City's Open Space program has significantly contributed to the protection of lands in the Carson River Corridor. Along the Carson River corridor through Carson City, there are only about three acres of lands that have been identified for potential purchase that has yet to be acquired.

*The Douglas County Economic Development and Conservation Act of 2018*

This Bill has been introduced to Congress but has yet to be enacted. It will allow for (1) the disposal of certain excess and difficult to manage federal lands, ensuring that the sales proceeds are used to acquire conservation easements in the floodplain from willing landowners in Douglas County; (2) transfer of federally-owned flood control management areas and important water resource infrastructure parcels to Douglas County; (3) transfer of

important federally-owned cultural sites to the Washoe Tribe; (4) dedication of the Burbank Canyons Wilderness Area while maintaining vehicular use of historic and existing roads; and (5) improved management of certain federally-owned public recreation parcels. (Etchegoyhen 2013).

Based on the UNCE's **Floodplain Protection Inventory for the Carson River** published in 2015 (UNCE 2015) which only looked at Douglas and Lyon Counties, and Carson City, we have protected 31% or 12,315 acres. With continued partner collaboration to implement this plan and suggested actions, protected floodplain acreage should increase over the next 10 years.

**January 2006 Flood, Dayton, Nevada**

## *4.2 HIGHER REGULATORY STANDARDS*

FEMA has established minimum regulatory standards for communities that participate in the NFIP, including the adoption of a floodplain ordinance that meets minimum federal requirements. While this provides the community an adequate level of protection, damage can still occur. One of the best tools to provide increased public safety is to enhance and/or implement regulatory standards that go beyond the FEMA minimum standards. A higher standard would include the adoption of an ordinance that is more specific to the actual flooding hazards of the community and include good neighbor language that protects adjacent and downstream properties.

SUGGESTED ACTIONS 9-11:

9. **Periodically review 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.**
10. **Investigate feasibility and implementation of additional measures that go beyond minimum FEMA requirements.**
11. **Develop model watershed floodplain management ordinance language that can be adopted by counties to provide watershed-wide consistency.**

**Aftermath of debris flow in Douglas County**

### 4.2.1 Revised Ordinances

As long as development is allowed to occur within the identified SFHAs, construction of buildings must be regulated to provide for increased flood protection. Local jurisdictions support actions that go beyond the minimum requirements and provide additional protection to residents and to the natural resources. In support of this, FEMA CTP funding has been acquired for the development of a "model" floodplain ordinance that includes Alpine County, California and Carson City, Douglas, Lyon and Churchill counties in Nevada. Storey County is also conducting a comprehensive floodplain ordinance update which is consistent and in concert with CWSD's regional effort. This model ordinance language can be adopted by counties to provide watershed-wide consistency yet is customized to enhance each jurisdiction's existing ordinances. In the Carson River Watershed, it is recommended that county ordinances should be implemented or enhanced to:

- Include protection of floodplain function as a purpose of the ordinance;
- Be based on a good neighbor policy;
- Require mitigation for the loss of floodplain storage capacity; and
- Account for the cumulative impacts associated with floodplain development.

To develop and implement the model ordinance, CWSD is working collaboratively with county planners and floodplain managers to update local flood regulations. The first phase was a Floodplain Ordinance Review and Improvement Project (2016), which consisted of a multi-jurisdictional effort led by the CWSD to prepare for the adoption of new Flood Insurance Rate Maps (FIRMs), considered implementation of the Carson River Hydraulic Model and improvement of floodplain management programs and regulations. Floodplain ordinances were preliminarily drafted which align with the needs and opportunities identified within each jurisdiction. The model ordinance project assisted each jurisdiction in the review and future amendment of their floodplain ordinances. The model ordinance will incorporate the Carson River Hydraulic Model and the Model Management, Distribution, and Update Guide to accommodate the new regional floodplain mapping and Flood Insurance Rate Maps (FIRMs). These comprehensive ordinances would provide consistency across the jurisdictions for building and construction standards and must include enforcement by a regulatory agency such as each community's building or zoning department. This model ordinance updates will need to be incorporated/adopted by each community. Ordinance implementation is expected in 2019. To support implementation of the model ordinance, local government staff will be trained to implement the hydraulic model and its update protocols. They will also be provided tips to assist residents in understanding the impacts of the new FIRMs and how the development community will apply the Carson River Hydraulic Model. The 2016 Floodplain Ordinance Draft Report and Mitigation Plan Table can be accessed in Appendix D in the CWSD projects table, MAS 4 section.

## *4.3 FLOOD DATA INFORMATION AND MAINTENANCE*

Technical information that can be used for flood risk analyses and risk reduction is critical data for local jurisdiction planning and management. This information includes hydrologic and hydraulic studies, floodplain and channel migration zone maps, LiDAR surveys, geologic studies, geographic information system (GIS) land use data, habitat studies, risk assessments, flood hazard management maps, and FIRMs. To the extent possible, flood data and other related information should be updated and managed in a manner that provides the most current information to all users in a timely and useful manner. CWSD continues to coordinate with FEMA and all watershed jurisdictions to identify, prioritize, and mitigate flood risk reduction projects. This partnership motivates strong inter-jurisdictional partnerships and leverages and maximizes federal, state, and local funding opportunities to complete new or revised FEMA FIRMs and other priority projects. A major accomplishment was the development of one Carson River Hydraulic Model through four watershed counties upstream of Lahontan Reservoir.

The following programs are encouraged by FEMA to ensure consistent maintenance of data and are incorporated into CWSD's everyday implementation activities for the Mapping Activity Statements (MAS).

### 4.3.1 Up-to-Date and Consistent Data Collection

It is essential to maintain current data and information to properly manage our floodplains and any development that may occur. A lack of reliable data upon which to base and defend decisions can be a significant deficiency. For example, the location of the river and floodplain initially delineated over 30 years ago may not be representative of today's conditions. Unreliable data can leave local governments in the position of having to use inaccurate maps for planning purposes and may leave potential hazard areas unidentified. Over the last decade, CWSD, through CTP funding, has conducted numerous technical data updates useful for flood studies and FIRMs. Additional studies are planned, such as customizable Area Drainage Master Plans (ADMPs). These plans address relatively small areas that have experienced flooding, such as summertime cloudburst flash floods or alluvial fan floods, and can be used throughout the watershed.

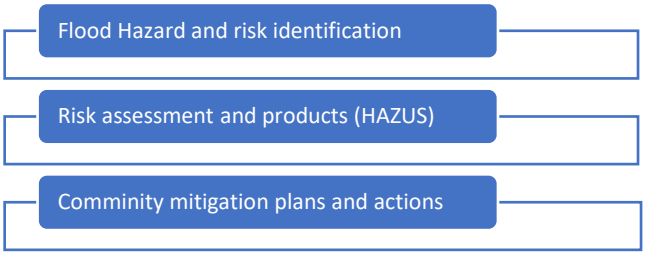
### SUGGESTED ACTIONS 12-20:

12. Establish and adopt funding source, and protocol / procedures to consistently update watershed-wide unsteady state modeling to identify flood water storage requirements and to look at the cumulative effects of watershed development.
13. 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.
14. Participate in FEMA's Cooperating Technical Partner Program.
15. Collect and Maintain up-to-date and consistent data collection which includes updating flood studies as needed and conducting new studies for significant water courses and alluvial fan areas. This data should be used to update FEMA maps and/or fill local data gaps. Complete delineation of the floodway throughout river system and incorporate into FIRMs.
16. Update flood studies and maps after significant flooding events.
17. Update and Maintain Elevation Reference Marks (ERM) as permanent monuments using NAVD88 Datum which matches base flood elevations on FEMA FIRMs.
18. Develop and maintain master list of ERMs and provide to interested parties.
19. Develop and coordinate photo-Monitoring program (on-the-ground and aerial) on a watershed level to consistently document flooding and flood hazards.
20. Establish and maintain a rain gage data network in each local jurisdiction.
21. Evaluate potential impacts due to climate variability which could include changing storm patterns, rainfall amounts, and snow levels, adding uncertainty to future conditions.

ADMPs can be used as tools to help identify priority areas for data collection or improvements. CWSD plans to continue to work with communities to find solutions and to identify data gaps, maintain and collect up-to-date data, and seek funding to help reduce flood risk and community hazards.

### 4.3.2 Risk Mapping Assessment and Planning (Risk MAP)

The FEMA Risk MAP (Risk MAP) Program provides communities with flood information and tools they can use to enhance their mitigation plans and act to better protect their citizens. Through Risk MAP, FEMA is engaging communities to accurately map, communicate, and mitigate flood risk. The Risk MAP program focuses on providing flood prone communities across the nation with tools and data that can be used to mitigate the risk and impact from flooding and communicate with residents and businesses about that risk.[10] Those tools include flood hazard mapping studies and risk identification products and risk assessment tools (e.g., HAZUS – a FEMA GIS tool to estimate economic losses) so communities can make informed decisions about reducing flood risk.




This program assists communities in hazard mitigation planning, education, and outreach about flood risk, flood insurance, and flood hazards. The flood risk information can be used to enhance hazard mitigation plans, make informed decisions to improve resiliency after flooding, protect the beneficial functions of floodplains, and raise awareness about local flood risks. This program encourages a watershed-wide approach as a strategy.

FEMA's Risk MAP Charter (Appendix F) with CWSD in 2011/2012 was the first to be signed in FEMA Region IX. The agreement formalized the collaborative flood management efforts between CWSD; Alpine County in California; Douglas, Carson City, Lyon, and Churchill Counties in Nevada; 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); National Flood Insurance Program (NFIP) Coordinator; State Hazard Mitigation Office; and other partners. Storey County joined the Charter in 2016. The Charter outlines the process to identify, assess, communicate, and plan for flood risk within the Carson River Watershed. All Counties are members of this Risk MAP Charter. CWSD actively pursues CTP projects and programs that are consistent with and meet the suggested actions under the collection and maintenance of flood data information category.

### 4.3.3 Updating and Maintaining DFIRM

In order to fully utilize FEMA programs, a process was developed to provide procedures for coordinating with FEMA on how county GIS, planning and engineering departments, and floodplain administrators can best utilize and update DFIRMs. A common challenge faced by the counties is that base maps change much faster than the FEMA process. A consistent watershed-wide process is beneficial and allows for easier data sharing and up-to-date map maintenance.

### 4.3.4 Elevation Reference Mark Maintenance

Elevation reference marks (ERMs) provide a baseline for ground elevation reference. This is important for surveyors when determining specific site information such as building elevations, cross sections, or topography, and

[10] https://www.fema.gov/risk-map-program-information-community-officials

is critical to determine lowest floor elevations in flood-prone areas. ERM datum should be collected in NAVD88 format, so it is consistent with FIRMs. Some counties (e.g., Carson City) have ERMs publicly available, while others have yet to complete this suggested action.

### 4.3.5 Floodway Delineation

The floodway is the area with the greatest danger during flood events. A floodway is determined with a computer program that "squeezes" the floodplain toward the channel and causes the flood level to rise. At the point where the water level is a maximum of one foot above the base flood elevation the floodway boundaries are drawn. Some states and communities use a more restrictive standard for delineating floodways. Some require less than one-foot rise (e.g., 0.5'); this results in a wider floodway and less area in the flood fringe. This approach provides the community with a higher level of protection during flood events. FEMA suggests that development not be allowed in delineated floodways due to their hazardous nature. However, development in floodways may be permitted if it can be demonstrated that no rise in base flood elevation will occur.

As part of the FEMA Risk MAP Program, floodway delineations were successfully incorporated in 2016 on the Carson River for portions of Douglas County, Carson City, Lyon County, and on a number of tributaries to the Carson River (Clear Creek, Goni Canyon Creek, Kings Canyon Creek). Floodway delineation continues to be a priority in the remaining sections and should incorporate appropriate data verification and address any inconsistencies.

### 4.3.6 Unsteady-state model for the Carson River

The development of an unsteady-state hydraulic model for the Carson River under FEMA MAS 1-4 was a major accomplishment in attempts to identify flood water storage requirements, and to look at cumulative effects of watershed development to the floodplain corridor. One of the main modeling objectives was to track the hydraulic and hydrologic impacts of land use changes, civil drainage projects, and development throughout the entire Carson River Corridor. Floodplain ordinance revisions are underway and will require the use of this model to incorporate changes and assess hydraulic impact for all areas within the newly established Special Flood Hazard Areas. Ordinance revisions are anticipated to be completed in 2019 and will include all Zones A, AE, AH, AO, and Floodways. 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. This model will represent a single tool to help water resource practitioners in the public and private sectors comply with NFIP guidelines and regulations, as well as meet local floodplain management objectives for the multiple communities that are impacted by flooding events on the Carson River. The following documents have been prepared to supplement the use of this model and are linked Appendix D, CWSD project report table, MAS 4 section.

- Hydraulic Modeling and Floodplain Mapping Guidelines (2011): These guidelines 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 technical information specifically tailored to the unique hydrologic and hydraulic characteristics of the Carson River Watershed. Practitioners' use of this consistent set of criteria will result in uniform modeling practices throughout the watershed, across jurisdictional boundaries, and potentially reduce conflict between regulatory agencies and the land development community. The Guidelines only apply to the floodplains and floodways associated with the East Fork, West Fork, and mainstem of the Carson River. It is not intended to provide modeling direction for tributaries or alluvial fans associated with the Carson River.

- ❖ Model Update Protocols: The Model Management, Distribution, and Update Guide (2017) has been prepared to set up standard protocols for updating the model as new development occurs in the floodplain.

### 4.3.7 Photo Monitoring

Photographs of flooding are an invaluable tool for monitoring the impacts of flooding events, as well as verification of model predictions. The development of a photo-monitoring program with individuals and/or organizations assigned as photo-monitors during events would provide historical documentation and data for tracking flooding trends. The need for consistent photo-monitoring continues to be discussed, including a systematic plan to track flood events at specific sites.

### 4.3.8 Rain Gage Network

In 2018, the CRC Floodplain and River Management Working Group identified the need for rain gage data. All of the counties need to know precipitation levels which could cause flooding in localized areas of the river or above/within alluvial fans. Rain gage data can be used to predict flooding, inform response, and help communities mitigate hazards for watershed residents.

**Lloyd's Bridge in Carson City. Maximum depth measurements and known flow rates should be coordinated at such locations.**

## *4.4 CHANNEL MIGRATION AND BANK EROSION MONITORING*

The Carson River tends to change course or move laterally in places during flood events due to the wide, flat, almost unrestricted floodplain. Areas with high potential for channel migration (movement) are extremely hazardous areas for development. Long-term monitoring of the river system can help to identify areas with high potential for excessive erosion and migration. In some areas building set-backs or buffer zones may be appropriate in order to provide public safety in these hazardous areas.

The flooding history of the Carson River indicates that floods have been altering channel alignments and stability every five to twenty-five years since the turn of the 20th century. Channel movement that has occurred in Carson Valley from 1907 to 2003 is shown in Figure 6. It is important to continue to consider this potential for channel migration when allowing for development to occur. While a flood may not have affected an area 10 or even 50 years ago, changes in the river course, as well as upstream development or impacts, can have an impact downstream. Carson River gages are monitored by the USGS and data is available on their website (West Fork Carson River near Woodfords, East Fork Carson River below Markleeville Creek near Markleeville, Carson River near Carson City).

**Flooding at Minor Ranch, 2017, showing extent of bank erosion**

### SUGGESTED ACTIONS 22-29:

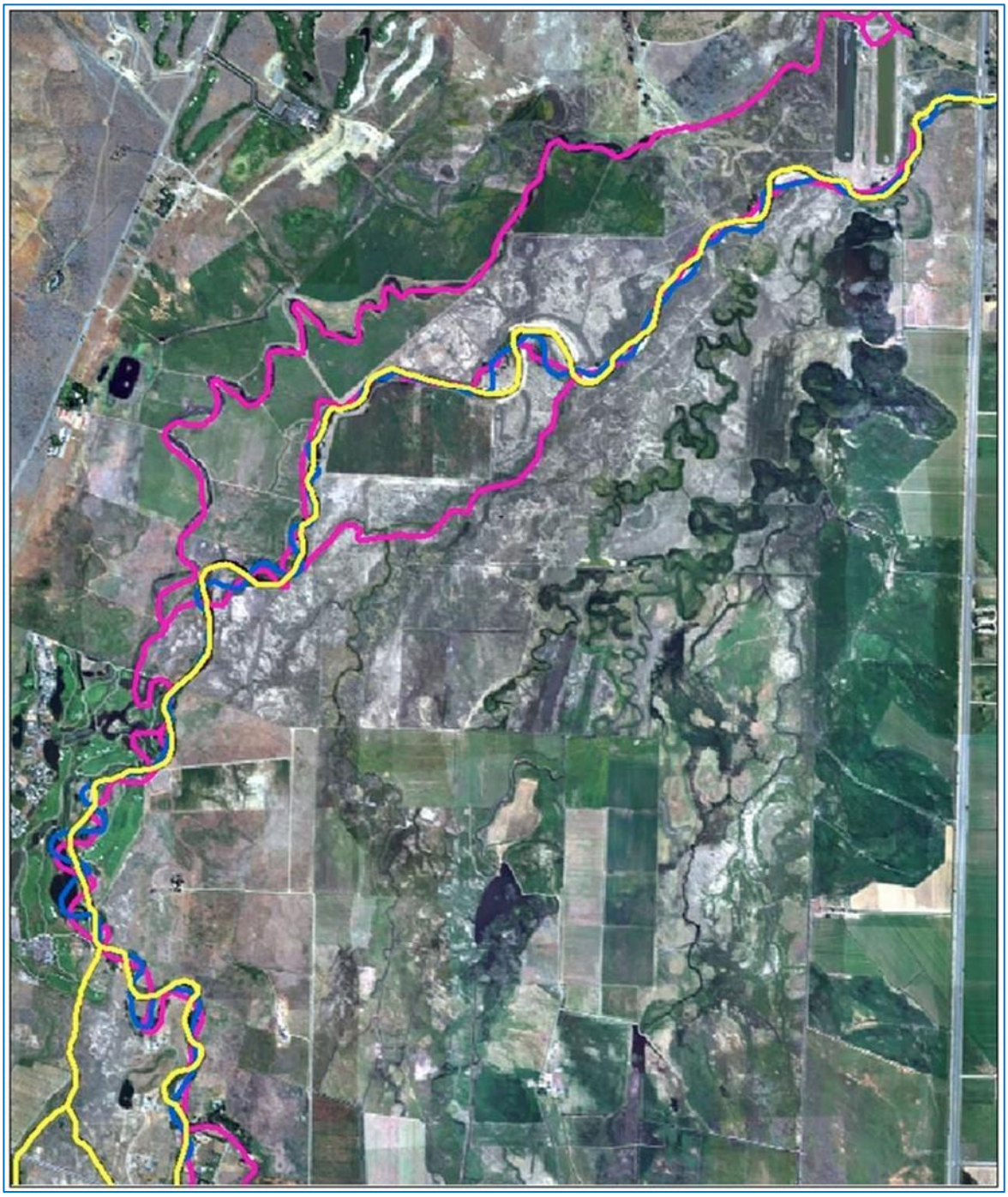
22. Document and update known and projected hazard areas including channel migration hazards and incorporated into planning processes.
23. Conduct LiDAR and/or aerial photography (on a watershed level) on a 5-year basis, or as needed, to provide updated information on channel movement and floodplain condition.
24. Establish building set-backs in flood hazard areas, where appropriate, to reduce severe hazards from channel migration.
25. Conduct and document channel cross-sectional surveys to track long term changes in river channel.
26. Identify unstable stream banks and areas with high potential for erosion.
27. Promote the use of non-structural, bio- engineering (soft-engineering utilizing natural materials) techniques in river restoration projects in combination with other proven methods.
28. Update the 1996 Fluvial Geomorphic Assessment and create a sediment transport model of the Carson River.
29. Create a baseline study that informs management and project decisions regarding flood risks, damages, and ecosystem impacts.

Channel migration risks are at least twofold in the Carson River valleys. Incised rivers are known to widen their gullies, and valley bottom rivers tend to meander. During floods the river will erode the outer banks of bends, and these bends will also migrate downstream. While this happens especially during extreme flood events, it can also happen during long-term (months-long) high flow events, where the banks are saturated and weakened over time, and collapse or erosion occurs. This unexpected erosion and channel migration further validate the need to keep the floodplain free from development.

Figure 6. Channel movement from 1906 to 2003 {Courtesy of Randy Pahl and Jean Stone, NDEP)

Genoa Lane to Cradlebaugh Bridge,
Carson River, Carson Valley, NV
1:24,000 scale

2003 Carson River
1938 Carson River
1900 Carson River



Floodplain managers throughout the nation are urging jurisdictions to consider the risks of allowing urban and residential development near meandering channels. Keeping such areas in agricultural or other open space uses is ideal in terms of avoiding economic losses for property owners and the community as a whole. Carson City has purchased almost all of the riverine floodplain lands in Carson City, allowing for the land to retain its floodplain storage capacity and reducing potential risk to life and property. The photo of Ambrose Natural Area (below) shows an example of the open space purchased by Carson City where floodwaters are allowed to overflow the banks without causing harm to residents.

Ongoing progress in the watershed includes continued funding by CWSD to the local conservation districts (Carson Valley Conservation District, Dayton Valley Conservation District, Lahontan and Stillwater Conservation Districts) to conduct bank stabilization projects that reduce erosion and reduce impacts to water quality and habitat values. These stabilization efforts may also limit loss of agricultural lands adjacent to the river. $250,000 from the State Clearing and Snagging Fund is available for the conservation districts to undertake clearing and snagging projects throughout the watershed to assist hazard removal. Additional funds to the conservation districts are used to promote the use of bioengineering and non-structural solutions for river restoration and rehabilitation; Friends of Hope Valley and the Alpine Watershed Group actively work to restore and rehabilitate river function in Alpine County. All of these actions are important in maintaining the waterway in a condition to ensure unimpeded flows during high events.

**Carson City lands purchased for use as open space; Ambrose Natural Area serves as flood storage areas during the flood**

## *4.5 FLOODPLAIN AND FLOOD HAZARD OUTREACH AND EDUCATION*

Outreach and education are critical and low-cost tools that can be used to increase public safety, reduce flood risks, and raise awareness of the importance of functioning floodplains. CWSD and its partnering agencies and jurisdictions continue to conduct watershed-wide outreach programs to assist local programs and reinforce the flood hazard message in a consistent format. These activities are numerous, continuous, ongoing, and dynamic. A flagship event is the annual Flood Awareness Week, an outreach and education event held since 2014 across northern Nevada. Additional actions include development of watershed-based outreach and educational maps and brochures[11] including the University of Nevada Cooperative Extension (UNCE) brochure *The Importance of Floodplains in Our Communities and Floodplain Protection* for use throughout the watershed.[12] CWSD also debuted its "Floodplains as a Community Asset" video series. There are four videos prepared in this series listed below (website addresses and links are provided as footnotes). The videos support CWSD's overarching objective of informing watershed residents, policy makers, and developers on the importance of conserving the Carson River Floodplain and will be utilized in flood awareness outreach and education efforts throughout the watershed.

1. Public Service Announcement (PSA) – Conserving the Carson River Floodplain as a Community Asset[13]
2. Agriculture's a Good Fit in the Floodplain[14]
3. A Case for Developers to Conserve the Carson River Floodplain as a Community Asset[15]
4. Our Officials' Role in Conserving the Carson River Floodplain as a Community Asset[16]

Information about the floodplain and flood hazard outreach and education is posted on CWSD and Nevada Floods Websites[17],

### SUGGESTED ACTIONS 30-34:

30. Continued implementation of watershed- wide outreach and education program about floodplain importance and flooding hazards.
31. Promote and participate in Annual Flood Awareness Week (FAW) and events throughout the year with the objective of providing information about flooding and flood hazards to the general public.
32. Develop and update media in conjunction with FAW working group (social media, videos, brochures, web content, press releases, etc.) for distribution throughout watershed with consistent messages and information for the general public.
33. Promote FAW partner websites (e.g., NevadaFloods.org, National Weather Service, CWSD, and county websites) which provide information on the Regional Floodplain Management Plan, flood risk, emergency preparedness, and emergency contact information. Link to one another's websites and social media sites to amplify message.
34. Utilize special events, River Work Days, and other outreach opportunities in conjunction with FAW working group to raise awareness of flooding hazards and importance of floodplains.

[11] Carson River Watershed Map: http://www.cwsd.org/wp-content/uploads/2014/07/USGS-Watershed-Map- 836x1024.jpg
[12] University of Nevada Cooperative Extension Floodplain Protection Inventory: https://www.unce.unr.edu/publications/files/nr/2015/sp1505.pdf; The Importance of Floodplain Lands to our Communities: https://www.unce.unr.edu/publications/files/nr/2012/fs1206.pdf
[13] https://www.youtube.com/watch?v=OzkvVBD43is&feature=youtu.be
[14] https://www.youtube.com/watch?v=2TTYIS3oxC0&feature=youtu.be
[15] https://www.youtube.com/watch?v=aR9aaecjmbA&feature=youtu.be
[16] https://www.youtube.com/watch?v=ZGco3s6K_AY

[17] www.nevadafloods.org; www.cwsd.org

as well as local jurisdiction websites. Continuing education and outreach are vital to keep residents and communities aware of the flood hazards faced in the community, how to prevent or reduce damage, and what to do in case of such an emergency. CWSD provides annual reports to the jurisdictions that participate in the CRS program outlining outreach and education efforts. These include detailed descriptions of the activities conducted each year in satisfaction of CRS crediting requirements (Section 3.5 of the annual report). It is important for each jurisdiction to have a watershed-wide message regardless of differing flooding hazards. "Turn around, don't drown" and the Flood Awareness Week are campaigns that improve awareness for the public everywhere. Individual communities may also require additional or specific outreach and education. Activities include monitoring of river channels and restoration projects, river clean-ups, and elementary school curriculum. It is important to maintain the frequency of these events to keep flood awareness on residents' minds. Other non-profit groups, such as River Wranglers, Sierra Nevada Journeys, and The Nature Conservancy, provide invaluable education and community outreach that assists in maintaining river function and while reducing flood risk.

**Flood Awareness Week activities include using the flood model to promote awareness of changes to the floodplain due to upstream changes.**

## *4.6 REDUCTION OF INFRASTRUCTURE IMPACTS*

Restrictions to the movement of flood waters due to existing infrastructure include:

- Raised roadways and driveways that do not have appropriate drainage to pass flood waters. This can result in a back-up of floodwaters affecting not only the landowner but adjacent properties.
- Work conducted in the 1960's by various governmental organizations resulted in berms along portions of the Carson River that restrict access of the river to its floodplain. This results in faster, more erosive flows impacting downstream communities.
- Many of the bridges crossing the Carson River have low capacity during flood events and act as constrictions to the passage of flood flows. This can result in increased flood damages and excess streambank erosion.
- Grade control structures in the river are frequently damaged during flood events. Repairs to the structures after flooding events has historically returned them to the same pre-flood condition per FEMA requirements. This can result in similar damages to the structures in future flooding events, thereby requiring the same types of repairs. Seeking opportunities to upgrade/redesign these structures to not only meet the needs of the water right user but be beneficial to other integrated watershed management objectives is important.

### SUGGESTED ACTIONS 35-39:

35. Investigate opportunities and implement actions when feasible to remove existing restrictions, such as berms, to allow flood waters to access floodplain.
36. Limit the use of future management measures such as dams, levees, and floodwalls.
37. Design future bridges and roads to protect floodplain, accommodate and not restrict changing river course, and minimize back up of flood water.
38. Investigate opportunities to enhance grade control structures.
39. Inventory, categorize, and house data regarding public and private drainage and flood control infrastructure in the Carson River Watershed.

Culverts and other drainage infrastructure often fill with sediments and debris after flow events, thereby restricting the amount of flood waters that can flow through them and in many cases backing up flow. Often, lack of county resources limits ongoing maintenance which keep these structures operating as constructed. There are opportunities throughout the watershed for the enhancement and/or design of roads, culverts, grade controls, and bridges to accommodate floodwaters better, protect floodplains, and decrease bank erosion. New opportunities are evident after each large flood event, and such opportunities were identified during the "Rapid Evaluation of the River System" described previously. Such identification will lead to funding opportunities to address the known impacts. Rebuilding damaged infrastructure so that it will be more resilient to flooding is a good investment and is promoted by FEMA.

Funding has been secured for minor stormwater conveyance and culvert upsizing for specific locations that were identified after flood events. Current and planned area drainage master plans, such as the Johnson Lane Area Drainage Master Plan in Douglas County, will likely serve to identify locations in need of such improvements. While these studies are generally in upland areas that are tributary to the Carson River, some improvements have been identified along the Carson River itself. The Martin Slough irrigation ditch has been expanded and the Cottonwood Slough ditch will be completed in 2019, both to prevent water from backing up upstream into communities and causing flooding and closing major highway routes.

## *4.7 MAP/STUDY ALLUVIAL FAN FLOOD HAZARDS*

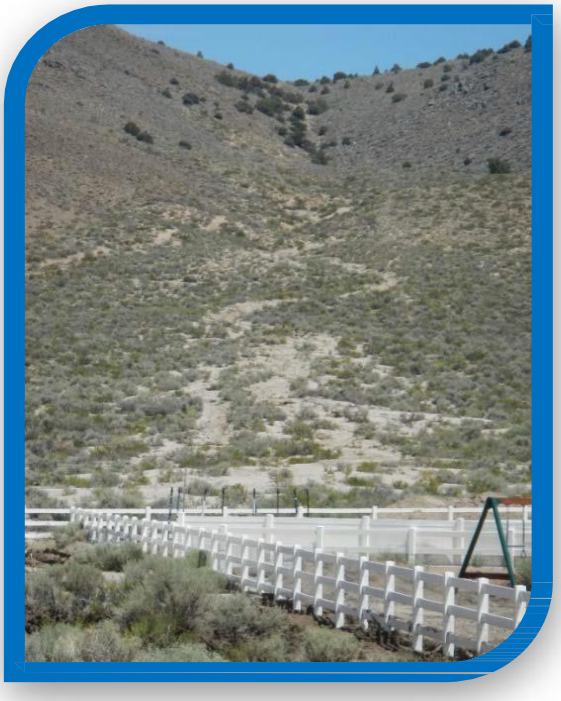
Recently, flood damage has resulted from alluvial fan flooding throughout the watershed. Such flooding presents unique problems to federal and state planners in terms of quantifying flood hazards, predicting the magnitude at which those hazards can be expected at a particular location, and devising reliable mitigation strategies. Existing and future development on alluvial fans and other areas subject to flash floods or debris flows is of great concern.

In an effort to identify risk of alluvial fan flooding, the USACE (December 2017) prepared an initial alluvial fan classification in the watershed. Alluvial fans were delineated based on aerial imagery, soil, and geological maps, then ranked by relative risk using specified criteria. These criteria can be altered to assess more specific local or regional risk based on each alluvial fan. The mapping results provided by USACE are not intended to be used for community or planning purposes or for informing emergency response decisions.

### SUGGESTED ACTIONS 40-43:

40. Investigate extent of potential alluvial fan flood damage and include on maps.
41. Conduct Area Drainage Master Plans for alluvial fans which examine infrastructure, land use, sediment transport, and identify alternative to mitigate and/or reduce risk.
42. Implement studies to inform and motivate land use planning and development which protects high risk areas and/or allows flood waters and debris flows to safely move through fan flood zones.
43. Define and implement means to protect existing open alluvial fans from development and where development exists, implement recommendations associated with SA #'s 40-42 to limit further development and/or alleviate hazards in high risk areas.

**Douglas County alluvial fan**



Future work to improve the accuracy of this study could include field verification of alluvial fan extents, inclusion of a future development risk factor, weighting risk factors based on the intended application, inclusion of LiDAR data, replacing visual estimations from maps with geo-processes for some risk factors, and adding risk factors such as mining impacts, grazing, slope, and precipitation where applicable. Jurisdictions are encouraged to use the accompanying pilot project maps to identify alluvial fans as flood hazards, develop mitigation strategies, and recommend further studies be conducted to more accurately assess fan hazards based on areal and geographic factors specific to the Carson River Watershed.[18]

[18] The mapping results provided by USACE are not intended to be used for community or planning purposes, or for informing emergency response decisions.

As part of the planning process, several of the counties are developing area drainage master plans to identify the flood hazards and which proposed methods are most effective to alleviate these hazards and reduce risk. These methods include maintaining open channels, locating detention basin sites, and improving infrastructure.

The 2017 USACE Alluvial Fan Mapping Methodology can be found online at: http://www.cwsd.org/wp-content/uploads/2018/08/Methology-for-Carson-River-Alluvial-Fan-Study-Final.pdf [18]

**Culvert in Douglas County was upgraded to convey higher flow events**

## *4.8 STORMWATER MITIGATION*

Low impact development (LID) practices are beneficial because they can decrease the amount of pollutants and volume of water delivered directly to waterways by infiltrating the water on site. Incorporation of LID principles into development plans to decrease generation of runoff are encouraged by CWSD, FEMA and the EPA. LID practices reduce development and redevelopment stormwater control costs, improve water quality, enhance neighborhood beauty, reduce the severity of costly flooding events, and improve groundwater recharge.

Through funding provided by the Nevada Division of Environmental Protection's (NDEP) Clean Water Act Sec. 208 planning funds, CWSD partnered with Resource Concepts Inc. (RCI, CWSD 2015) to research, document, and enhance LID implementation in the various counties. The document was aimed at county officials and staff with the goal of eliminating existing road blocks to LID implementation by providing clear

### SUGGESTED ACTIONS 44-48:

44. Promote stormwater infiltration rather than direct outflow to urban infrastructure, ditches, creeks, rivers to capture groundwater, improve water quality, and reduce flood risk.
45. Plan for and mitigate cumulative effects of watershed urbanization, including stormwater runoff, to reduce flood hazards.
46. Encourage and incorporate low impact development (LIDs) principles into all development proposals to decrease stormwater run-off, improve water quality, and promote groundwater recharge.
47. Encourage adoption of model LID ordinances created for Watershed.
48. Promote and utilize best management practices to reduce urban runoff.

practices and steps to implement LID practices in the Carson River Watershed.[19]

The document recommended training workshops in partnership with local and state authorities, as well as local builders, developers, and landscapers to promote the benefits of LID and how to implement the practices. Currently, funding is available to complete LID ordinances, and to conduct a review and audit of existing ordinances to ensure there is no inconsistencies that limit LID use in existing code. LID practices are often straightforward and should be incorporated into the fabric of the planning process to ensure effective implementation and long-term maintenance. Community outreach and involvement is an important aspect for LID implementation. Every community has different types of impacts, water quality or flooding issues, MS4 system requirements, and existing regulations, so working together to incorporate LID ordinances and practices into local jurisdictions repertoire is important.

[19] http://www.cwsd.org/wp-content/uploads/2015/07/2015-04-07-LID-Carson-Watershed.pdf

# 5.0 IMPLEMENTATION

As evidenced herein, significant progress has been made watershed-wide to identify existing and new flood risks and implement various types of actions to prevent or mitigate flood hazards. This variety of strategies will require continued progress involving coordination of the stakeholders and, as always, is dependent upon available funding and staffing resources.

## *5.1 STEPS FOR PLAN IMPLEMENTATION*

Regional Floodplain Management Plan implementation has been successful to date through the activities of CWSD, the CRC and the Floodplain and River Working Group, local jurisdictions, and the continued actions and support of technical advisory groups. All these partners have worked to proactively direct research, funding, and improvements in the watershed. Success is evident within every jurisdiction. There are many new areas of protected floodplain (See UNCE 2015), and floodway and floodplain maps have been revised and/or created identifying new flood hazards. All the jurisdictions update their hazard mitigation plans when required to ensure they are not only in step with FEMA and State requirements, but meet the needs of their respective communities. Seeking alternative funding sources is ongoing to support community efforts to address local challenges as FEMA contends with catastrophic national disasters such as hurricanes, floods, fires, and earthquakes.

### 5.1.1 Summary of Suggested Actions

While suggested actions discussed in this section broadly apply to all jurisdictions and are intended to detail the extent of management actions that have taken place in the watershed, each jurisdiction has accomplished different actions based on their specific needs. Table 11 includes the progress and continued suggested actions to address flood hazard and mitigation within each jurisdiction. The activities of CWSD as a FEMA CTP to be able to continuously secure and prioritize funding and projects is of great benefit to the stakeholders. Appendix E includes county progress toward implementing suggested actions.

Other Implementation Measures:

Establish coordination procedures for county floodplain administrators and the CWSD to ensure regional coordination as well as local. CWSD has developed a comparison of this plan with the Community Rating System and works with the counties to submit proper documentation to allow the counties to receive credit for this regional plan and associated activities. This credit is important to potentially lowering flood insurance rates for community members and to document cooperative activities.

CWSD will continue to meet with the CRC, the Floodplain and River Management Working Group, floodplain administrators, and other stakeholders to coordinate implementation of the suggested actions and implementation of this plan at the local level. CWSD is dedicated to planning, coordinating, and seeking funds to increase awareness relating to this plan. It also focuses on strengthening and expanding the on-the-ground implementation efforts of our local jurisdiction partners to fulfill the floodplain management goals and suggested actions stated in this plan.

## *5.2 MONITORING AND REVISION*

As described previously, an annual CRS report evaluating progress towards implementing the suggested actions is coordinated and prepared by CWSD and provided to the county floodplain administrators and other interested parties. Annual reports for the jurisdictions are included in Appendix D, Project Documents section.

The floodplain management plan and suggested actions will continue to be reviewed and updated on an as-needed basis, not to exceed a five-year time frame. CWSD will work with stakeholders, including the working group and local floodplain administrators, to complete any revisions and updates. All change will be digitally distributed and presentations to stakeholder boards or staff can be requested at any time.

Success and improvements in the effectiveness of the completed suggested actions and the regional approach to floodplain management can be measured by factors such as: reduction in flood damage, enhancement of sediment transport capabilities, protection of additional floodplain acreage, enhancement of water quality, and general awareness of flooding issues by the public.

## *5.3 LINKING REGIONAL FLOODPLAIN MANAGEMENT WITH OTHER PLANS*

This Plan is consistent with the following documents and demonstrates how they link to this plan and complement each entity's floodplain management and hazard mitigation efforts.

### 5.3.1 Hazard Mitigation Plans

A FEMA-approved hazard mitigation plan is a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects. Ultimately, hazard mitigation planning enables actions to reduce loss of life and property, lessening the impact of disasters. It is most effective when implemented under a comprehensive, long-term mitigation plan. State, tribal, and local governments engage in hazard mitigation planning to identify risks and vulnerabilities associated with natural disasters. The plans outline long-term strategies for protecting people and property from future hazard events and are key to breaking the cycle of disaster damage, reconstruction, and repeat damage.

Developing hazard mitigation plans enables state, tribal, and local governments to:

- Increase education and awareness around threats, hazards, and vulnerabilities;
- Build partnerships for risk reduction involving government, organizations, businesses, and the public;
- Identify long-term, broadly-supported strategies for risk reduction;
- Align risk reduction with other state, tribal, or community objectives;
- Identify implementation methods that focus resources on the greatest risks and vulnerabilities; and
- Communicate priorities to potential sources of funding.

Local jurisdictions have received FEMA funding to update their hazard mitigation plans. Each plan has a section with a goal to reduce the possibility of damage and losses due to flooding. Alpine County has additional language on landslides and severe weather; both of which are related to flooding.

### 5.3.2 Carson River Watershed Adaptive Stewardship Plan

CWSD's Board adopted the original Carson River Watershed Adaptive Stewardship Plan (Plan) in 2007, and an update was adopted in 2017. The main purposes of the Plan are to:

A. provide an overview of the watershed and its challenges;
B. identify potential sources of nonpoint source pollution;
C. discuss short and long-term strategies and actions to address these potential sources;
D. provide a tracking mechanism for projects and programs;
E. identify future project and program opportunities; and,
F. address the nine criteria elements of the Clean Water Act (CWA) Section 319 Program. These criteria elements are provided on page II, Section 1.1 of the 2007 plan.

Many organizations throughout the Carson River Watershed rely upon CWA 319 funding for projects and programs. It is the desire of the Environmental Protection Agency (EPA) and the Nevada Division of Environmental Protection (NDEP) that all watershed-based plans meet the EPA's nine criteria elements. EPA and NDEP determined that both the 2007 Plan and 2017 Plan update meet the EPA criteria to be considered a watershed-based plan in the Nevada portion of the watershed. All projects and programs implemented within the watershed utilizing NDEP/EPA CWA 319 funds are expected to be consistent with this plan.

For organizational purposes, the Plan focuses on seven project categories. One of the goals of the Plan is to present a comprehensive list of projects that fall within these categories to illustrate how the projects and programs are moving in a purposeful and solution-based direction. The seven major project categories as listed in the 2007 Plan are:

1. Floodplain Management
2. Water Quality
3. Regional Water Supply
4. River Rehabilitation/Stabilization/Habitat Enhancement
5. Invasive Species
6. Outreach and Education
7. Recreation Use and Management

The Plan lists multiple projects under each project category. Projects associated with Floodplain Management and River Rehabilitation/Stabilization have close links to implementation of the goals and suggested actions in the Regional Floodplain Management Plan. Links with other project categories may be less obvious such as water quality, invasive species, and outreach and education. However, stormwater and LID/Green infrastructure projects reduce flooding while improving water quality. Flooding impacts river rehabilitation and bank stabilization processes and becomes a potent vector of invasive species. Flood awareness activities are critical component of CWSD's multi-objective outreach and education efforts.

### 5.3.3 Carson River Flood Mitigation Plan

As new Flood Insurance Rate Maps (FIRMs) are being generated for the Carson River Watershed, they will establish Special Flood Hazard Areas along the entire Carson River. This Flood Mitigation Plan is a multi- jurisdictional

effort led by the Carson Water Subconservancy District to prioritize mitigation measures implemented by each jurisdiction in conjunction with the new FIRMs. Affected jurisdictions include Alpine County, Carson City, Douglas County, and Lyon County. New FIRMs benefit the Carson River area by identifying flood hazards so that the community can better improve public safety and property protection during future flood events.

New flood maps also bring flood insurance requirements and limitations on uses of property. This plan recommends mitigation measures from a variety of flood management activities listed in existing hazard mitigation plans, comprehensive plans, and floodplain management plans from local communities within the Carson River watershed. These mitigation measures are prioritized according to the effectiveness of each activity based on the individual needs of each jurisdiction.

This plan recommends the most cost-effective and beneficial activities to be implemented as mitigation measures by each jurisdiction in three implementation phases. Mitigation measures are separated into three categories: ordinances, programs, and projects. Ordinances are regulations to be adopted by each jurisdiction, mostly related to development and land use. Programs are community-led endeavors to improve each jurisdiction's floodplain management program through targeted use of finances and staff resources. Projects are construction-based solutions that are recommended to mitigate flood hazards. This plan provides a convenient action plan that each jurisdiction can use to implement mitigation measures to improve public awareness, enhance public safety, and prevent loss of life and property.

## *5.4 ADDITIONAL REGULATORY AND PERMITTING AGENCY COORDINATION*

Local jurisdictions often have their own Floodplain Ordinances. Updated model ordinances are in the process of being developed specifically for the Carson River Watershed entities that have updated FIRMS and are using the new hydraulic model (See Section 4.2.1 Revised Ordinances). In addition to these local ordinances, the following Federal, State, and local permitting requirements are associated with floodplain management and need to be considered when implementing suggested actions (Table 12):

**Table 12. Additional regulatory and permitting agency coordination**

| ORDER/ACT | PERMITTING REQUIREMENTS |
|---|---|
| Clean Water Act of 1972 | Section 303: Authorizes States and Tribal governments to establish water quality standards for navigable waterways to protect and enhance water quality.<br>Section 311: Addresses pollution from oil and hazardous substances.<br>Section 401: Provides that no Federal permit or license is issued for activities that might result in a discharge to navigable waters unless a 401 certification is issued.<br>Section 402: The National Pollutant Discharge Elimination System (NPDES) is a permitting system established to regulate point source discharges of pollutants and is under the purview of the U.S. EPA.<br>Section 404: Establishes permitting systems to regulate the placement of dredged or fill materials into waters (including wetlands) under the U.S. Army Corp of Engineers' purview. |
| U.S. Fish and Wildlife Service Endangered Species Act of 1973 | Consultations are required under Sections 7 and 10 of this Act if development is proposed in an endangered/protected species habitat. |
| U.S. Coast Guard | Project may require a permit if the proposed development includes a bridge or causeway that may affect navigation. |
| U.S. Army Corps of Engineers | All projects within a navigable waterway require permits. |
| State Permits | • Construction in floodways or other designated areas<br>• Stream crossings or projects that affect navigable rivers<br>• Installation of septic systems<br>• Subdivision standards of subdivision plat or lot filling requirements<br>• Manufactured housing (mobile home) park or tie down requirements<br>• Public health facilities, such as hospitals and nursing homes<br>• Operating a landfill or hazardous materials storage facility |
| Executive Order 11988 was rescinded by the Trump administration in 2017. However, it is recommended for community implementation by the Association of State Floodplain Managers and Floodplain Management Association as a best management practice for floodplain management. | • Requires Federal agencies to first assess whether a property will be located within the SFHA or 500-year floodplain, and, if so, to follow an eight-step process to assure all alternatives and guidelines are met before proceeding with the project.<br>• Enacted to "Avoid to the extent possible the long- and short-term adverse impacts associated with occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative." |

## *5.5 POTENTIAL FUNDING SOURCES*

There are many sources of available funding, as detailed in Table 13. Federal and other funding often requires cash and/or in-kind match. Eligibility for funding sometimes requires being named/listed in state or regional plans.

**Table 13. Federal, state and local funding sources**

| ENTITY | SOURCE |
|---|---|
| **FEDERAL** | U.S. Environmental Protection Agency |
| | Federal Emergency Management Agency (FEMA) |
| | Natural Resources Conservation Service |
| | Farm Service Agency |
| | U.S. Bureau of Reclamation |
| | U.S. Army Corps of Engineers |
| | U.S. Bureau of Land Management |
| | U.S. Fish and Wildlife Service |
| | U.S. Forest Service |
| STATE | California State Water Resources Control Board Lahontan Region |
| | Nevada Division of State Lands - Question One Funds |
| | Nevada Division of Environmental Protection |
| | Nevada Division of Water Resources |
| | Nevada Division of Forestry |
| | Nevada Division of Conservation Districts |
| LOCAL | Carson-Truckee Conservancy District |
| | Carson Water Subconservancy District |
| | Carson City Question 18 Funds |
| | Private and Non-Profit Organizations |

# 6.0 PLANNING PROCESS

Oversight and administration of this Regional Floodplain Management Plan Revision was provided by CWSD and the CRC Floodplain and River Management Working Group. Information to help update this plan was obtained from September 2017 through June 2018 in working group meetings and through jurisdiction interviews. Appendix A describes this process in detail. Further guidance was provided by the CWSD Board of Directors and Floodplain Administrators from all six counties along the Carson River and within alluvial fan areas.

The CWSD Board of Directors (Board) provided feedback and input throughout the plan development process. This step was critical as the Board is comprised of elected officials from most six counties along the Carson River Watershed. At each step of development, the Board was provided presentations and discussion opportunities about the Plan. This Board will also approve for the Final Plan to be presented to County Boards of Supervisors or Commissioners for their possible adoption.

# 7.0 EMERGENCY RESPONSE AND FLOOD WARNING

Each county has an emergency response plan on file, but according to the Nevada Attorney General's ruling which cites NRS 239c, these plans are no longer deemed public documents due to homeland security concerns. First responders in appropriate agencies will receive a copy of a given county's or city's emergency response plan.

The following individuals are responsible for emergency response in the event of a flood. Information is also available on the CWSD website at www.cwsd.org and at www.floodsmart.gov.

**Table 14. Emergency response contact information as of 9/2018**

| JURISDICTION | CONTACT | INFORMATION |
|---|---|---|
| Alpine County, California | Emergency Response Officer: Spencer Case | (530) 694-2231 |
| | Sandbag Materials Location | Woodfords Fire Station |
| | | 50 Diamond Valley Road<br>Markleeville, California |
| | | (530) 694-2922 |
| | | Markleeville Fire Station #92 |
| | | 860 Hot Springs Road<br>Markleeville, California |
| | | (530) 694-2223 |
| Carson City, Nevada | Emergency Manager: Sean Slamon | (775) 283-7722 |
| | Sandbag Materials Location | City Corporate Yard |
| | | 3303 Butti Way<br>Carson City, NV 89701 |
| | | (775) 887-2355 |
| Churchill County, Nevada | Emergency Manager: Mike Heidemann | 1175 Wood Dr.<br>Fallon, NV 89406<br>(775) 423-4188 |
| | Floodplain Manager: Michael Johnson (Planning Director) | 155 N. Taylor<br>Fallon, NV 89406<br>(775) 423-7627 |
| | Cliff Van Woert (Building Official) | (775) 428-0264 |
| | Sandbag Materials Location | County Road Department Yard |
| | | 330 N. Broadway<br>Fallon, NV |
| | | (775) 423-4133 |
| Douglas County, Nevada | Emergency Communications Manager:<br>Todd Carlini, East Fork Fire Chief | 1694 County Road, Minden, NV 89423. |
| | | (775) 782-9040 |
| | Floodplain Manager: Mimi Moss | (775) 782-6201 |
| | Sandbag Materials Locations | All Fire Departments in County |

| JURISDICTION | CONTACT | INFORMATION |
|---|---|---|
| Lyon County, Nevada | Emergency Manager: Jeffrey Page | 27 S. Main Street<br>Yerington, NV 89447 |
| | | (775) 463-6531 |
| | | 24-Hour Dispatch: (775) 463-6620 |
| | Floodplain Manager: Chuck Reno | (775) 463-6535 |
| | Sandbag Materials Locations | Dayton Utilities Yard, |
| | | 34 Lakes Road<br>Dayton NV 89403<br>(775) 246-6220 |
| | | 18 Highway 95A<br>Yerington NV 89447 |
| | | (775) 463-6551 |
| Storey County, Nevada | Emergency Management: Joe Curtis (Director)<br>OR Cherie Nevin (Deputy Director) | P.O. Box 7<br>Virginia City, NV 89440 |
| | | (775) 847-0454 |
| | Floodplain Manager: Kathy Canfield | P.O. Box 176<br>Virginia City, NV 89440 |
| | | (775) 847-1144 |
| | Sandbag Materials Locations | Virginia City Public Works |
| | | 110 Toll Road<br>Virginia City, NV 89440 |
| | | Mark Twain Community Center |
| | | 500 Sam Clemens Avenue<br>Dayton, NV 89403 |
| Washoe Tribe of Nevada and California | Emergency Management Coordinator | (775) 265-8695 |
| | William Bergquist | |

## *7.1 FLOOD FORECAST AND WARNING SYSTEMS*

According to the National Weather Service (NWS) there are three official river forecast points in the Carson River Watershed. There are five locations which NWS also monitors and will issue warnings for these locations if needed, but there are no official forecasts. Locations for all systems and stations are shown in Table 15.

Table 15. NWS Flood forecast and warning systems and weather stations in the Carson River Watershed

| JURISDICTION | | |
|---|---|---|
| National Weather Service River Forecast Points | 1 | West Fork Carson River at Woodfords, California |
| | 2 | East Fork Carson River near Gardnerville, Nevada |
| | 3 | Carson River near Carson City, Nevada |
| NWS Monitoring Station | 1 | East Fork Carson River below Markleeville Creek near Markleeville, California |
| | 2 | Carson River at Dayton, Nevada |
| | 3 | Carson River at Fort Churchill, Nevada |
| | 4 | Carson River below Lahontan Dam near Fallon |
| | 5 | Carson River at Tarzyn Road near Fallon (Bafford Lane area) |
| Flood Warning Systems | 1 | Minden – East Fork Carson River |
| | 2 | Genoa Canyon – two miles west of Genoa |
| | 3 | Lebo Springs – 12 miles northeast of Minden in Buckeye Creek drainage directly east of Johnson Lane/Buckbrush Wash drainage |
| | 4 | Pine Nut Creek – 10 miles east southeast of Gardnerville |
| | 5 | Fish Springs – 5 miles from Gardnerville |
| | 6 | Gardnerville |
| | 7 | Spooner Summit |
| Weather Stations | 1 | Upper Clear Creek |
| | 2 | Carson City Airport |
| | 3 | Upper Ash Canyon |
| | 4 | Carson City Fire Station #3 |
| | 5 | Vicee Canyon |
| | 6 | Snow Valley Peak |
| | 7 | Lower Ash Canyon |
| | 8 | Lower Kings Canyon |
| | 9 | North Upper Kings Canyon |

# 8.0 REFERENCES


Alpine County, California 2008. "Floodplain Development Standards Code". Section 16.08. http://www.codepublishing.com/CA/alpinecounty/

Carson City, Nevada 2006. "Carson City Master Plan". http://www.carson-city.nv.us/Index.aspx?page=809

Carson City, Nevada 1996. "Carson River Master Plan". Chapter 3. Carson River Advisory Committee.

Carson Water Subconservancy District. 2007 and 2017. "Carson River Watershed Adaptive Stewardship Plan and 2017 Supplemental Update. CRC & CWSD.

Churchill County, Nevada 2005. "Master Plan 2005 Update". pgs. 3.1- 3.4 http://www.churchillcounty.org/planning/newforms/2005Master_Plan.pdf

Douglas County, Nevada 2007. "Douglas County Master Plan 2006 Update". p. 5-76. http://www.douglascountynv.gov/sites/CDAdmin/planning/master_plan.pdf

Federal Emergency Management Agency (FEMA). 1996. Protecting Floodplain Resources-A Guide for Communities.

FEMA. 1996. "Addressing Your Community's Flood Problems – A Guide for Elected Officials". Association of Floodplain Managers, Inc., and the Federal Interagency Floodplain Management Task Force.

FEMA. 2002. National Flood Insurance Program Community Rating System, CRS Coordinator's Manual. FEMA. 2005. NFIP Floodplain Management Requirement. FEMA 480.

HDR. 2006. "Review of County Floodplain Ordinances" White paper, CWSD Flood Planning Assistance, March 22, 2006.

Inter-Fluve, Inc. 1996. Fluvial Geomorphic Assessment of the Carson River with Implications for River Management. Prepared for Western Nevada Resource Conservation and Development. Leopold, L.B. 1994. "A View of the River", Harvard University Press, Cambridge, Mass, p. 135

Lichtenberg, Erik 1994. "Sharing the Challenge? An Economist's View". University of Maryland. Lyon County, Nevada 1990. "1990 Master Plan". pgs. 27-32

Lyon County, Nevada 2008. "Comprehensive Master Plan". http://www.lyon-county.org/documents/Planning/Master%20Plan/Natural%20Resources%20&%20Environment%20and%20Parks%2C%20Recreation%20&%20Opne%20Space%200307.pdf

MACTEC, et al. 2004. Upper Carson River Watershed Stream Corridor Condition Assessment. Prepared for the Sierra Nevada Alliance and the Alpine Watershed Group.

Morgan, Ginger. 2003. "What exactly is a 100-year flood?"

Nevada Bureau of Mines and Geology. 1998. "The 1997 New Year's Floods in Western Nevada"

Nevada Natural Resources Status Report. 2008. http://dcnr.nv.gov/nrp01/content.html

NOAA National Weather Service, Advanced Hydrologic Prediction Service: Reno: Carson River near Carson City http://ahps2.wrh.noaa.gov.

Ramelli, A.R., Bell, J.W., dePolo, C.M., and Yount, J.C., 1999, Large-magnitude, late Holocene earthquakes on the

Genoa fault, west-central Nevada and eastern California: Seismological Society of America Bulletin, v. 89, no. 6.

State of Nevada Standard Multi-Hazard Mitigation Plan, October 2004.

State of Nevada 2004. “Standard Multi-Hazard Mitigation Plan”. Pgs. 53-56

State of Nevada 2004. “Nevada Model Floodplain Management Plan”. State of California Water Plan Update 2005. p. 10.3

University of Nevada Cooperative Extension (UNCE) 2003. Carson River Main Message Fact Sheet

University of Nevada Cooperative Extension (UNCE) 2015. Floodplain Protection Inventory for the Carson River Special Publication 15-05, John Cobourn and Steve R. Lewis.

University of Nevada Cooperative Extension (UNCE) 2014. Nevada Floods Brochure FS 14-12, John Cobourn, Steve R. Lewis, and Courtney Walker.

USGS. 2006. “Flood Chronology of the Carson River Basin, California and Nevada Web Site”. Fact Sheet

2006-3102, June 30. https://nevada.usgs.gov/crfld/Carson/floodevents.htm

Wright, J. 1996. “Addressing Your Community’s Flood Problems, A Guide for Elected Officials, Association of State Floodplain Managers, Inc. and Federal Interagency Floodplain Management Task Force.