Northern Nevada
Water Planning Commission

STAFF REPORT

DATE: April 28, 2016

TO: Chairman and Members, Northern Nevada Water Planning Commission ("NNWPC")

FROM: Jim Smitherman, NNWPC Water Resources Program Manager

SUBJECT: Presentation of comments received and proposed revisions to the "Flood Management and Storm Water Drainage" chapter for the 2016 Regional Water Management Plan ("RWMP") update; discussion and possible direction to staff.

SUMMARY

Since the NNWPC last reviewed proposed revisions to this chapter, staff has discussed additional recommendations regarding floodplain management, floodplain storage and critical flood pools with Truckee River Flood Management Authority staff. Resulting revisions, shown in attached underlined text, include the following Sections:

5.7 Local Government Flood Control and Storm Water Drainage Programs

5.7.1 Flood Plain Storage and Critical Flood Pools - The contents of this section appeared formerly in Section 5.6 Truckee River Flood Management Project. The text has been condensed to remove extraneous or redundant information; however, Policy 3.1.b Flood Plain Storage within the Truckee River Watershed, remains intact. This revision is appropriate because floodplain storage volumes and critical flood zone issues are handled by local government development codes.

5.7.3 Flood Plain Management - Text on flood plain management planning that formerly appeared in Section 5.6 Truckee River Flood Management Project, has been combined with this section.

Revisions reviewed and accepted by the NNWPC at prior meetings appear as normal text.

RECOMMENDATION

Staff recommends that the NNWPC accept the report on review comments and proposed revisions to the "Flood Management and Storm Water Drainage" chapter for the 2016 RWMP update, and provide direction to staff as appropriate concerning future reviews of this chapter as part of the development of the 2016 RWMP update.

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Attachment: Chapter 5 showing redline revisions

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Chapter 5 – Flood Management and Storm Water Drainage

Purpose and Scope

This chapter describes the various entities that provide flood management or storm water drainage services within the Planning Area including the Truckee River Flood Project ("Flood Project"), its governing body and plans, City of Reno ("Reno"), the City of Sparks ("Sparks"), and Washoe County. Subjects covered include flooding history, types of floods, federal programs, federal state and local laws, progress on the Flood Project, structural and nonstructural alternatives for flood control, local drainage programs, flood control and drainage facility design standards, regional facilities and facilities for single drainage basins.

Summary and Findings

The property at risk from a 100-year flood in the Truckee Meadows was valued by Washoe County in 2004 at approximately $5 billion using a geographic information system ("GIS") compilation of the 1997 flood boundary and the assessed value for parcels within the boundary. A 2007 analysis by the Nevada Bureau of Mines and Geology ("NBMG") using a Federal Emergency Management Agency ("FEMA") loss estimation model to estimate 100-year flood risk in Washoe County estimated building exposure, a measure of the economic wealth of the county, at $25 billion and building-related economic losses at $980 million (NBMG, 2007).

Physical damages and economic impacts resulting from the 1997 Truckee River flood (the largest flood of record) totaled about $700 million[1] in Washoe County and $1 billion in the six county area hit by the flood in northern Nevada.

Nevada ranks #1 in flood loss payments from the National Flood Insurance Program ("NFIP") for western, non-coastal states for the last 30 years (January 1, 1978 through November 30, 2009 including Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming).

Over the last 30 years, Sparks, Reno, and Washoe County rank #1, #2, and #3, respectively, for the total amount of flood insurance payments in Nevada from the NFIP. Together, the three areas account for 74 percent of the total flood loss payments in Nevada or almost three times more than all other areas in Nevada combined for the last 30 years ($27,651,343 vs. the statewide total of $37,370,575).

Riverine flooding and alluvial fan flooding are both common in northern Nevada. Riverine flooding occurs when flows in rivers and streams rise over a period of hours or days and overtop stream banks inundating nearby flood plains and low-lying areas. Alluvial fan flooding occurs when floodwaters emerge from canyons flowing out of the upper mountains onto an alluvial fan, typically with little or no warning, and travel downstream at very high velocities carrying significant loads of sediment and debris.

[1] In 1997 dollars. The Army Corps of Engineers ("ACOE") estimated physical National Economic Development ("NED") Plan damage at approximately $500M. The Truckee River Water Management Council did an economic impact study that concluded total damage to be $780M.

Incorporation of hydrologic data since the mid-1980s has resulted in estimated peak flow for specific frequency events higher than originally thought. The 100-year flood event (or one-percent risk flood) at Reno is now estimated to be 20,700 cubic feet per second ("cfs"). Peak flows for certain frequency events are shown in Table 5-1.

These flows can change direction and realign the existing channel through the alluvial fan as the energy of the water erodes small channels, water is diverted over un-channeled ground, and new channels are established.

Table 5-1 Estimated Peak Flows - Truckee River at Reno

Exceedance (i.e., chance of occurrence in any single year)	**Peak Flow (cfs)**
1/20	9,200
1/50	14,800
1/100*	20,700
1/500	63,000

Source: ACOE

* Flooding that has a one-percent chance of being equaled or exceeded in any given year, also referred to as a 1 in 100 year flood event or a 100-year flood. Note: The USGS, using a different analysis technique to account for upstream reservoirs estimates the 1/100 peak flow to be approximately 26,000 cfs.

In the 1985 feasibility report for the Truckee River Flood Project, the estimated discharge for the 100-year event at Reno was computed at approximately 18,500 cfs. This flow has been used by FEMA to identify areas subject to flooding for flood insurance purposes.

The peak water surface elevation for the January 1997 flood, considered to be slightly greater than the 100-year flood event, was approximately 1.6 feet higher than the existing FEMA base flood elevation at the Vista gage. Therefore the actual 100-year flood levels are higher than those shown on FEMA flood maps especially in the area east of U.S. Highway 395, with the greatest difference occurring east of McCarran Boulevard. Structures built to current FEMA standards within the area approximately bounded by Rock Boulevard, Interstate 80, and Mira Loma Boulevard are not necessarily protected during a 100-year flood event despite the depictions on the FEMA flood maps.

Information prepared for the Regional Water Planning Commission ("RWPC") through a study by WRC Nevada in 2003 indicates that loss of flood storage volumes due to development of existing approved land uses within the flood plain on the north and south sides of the Truckee River could result in an increase of 0.4 to 0.6 feet in the base flood elevation. Since this study looked only at development that might occur outside of the floodway and in areas zoned for development at that time, placing fill in the flood plain would result in even higher flood levels than predicted if there were changes in zoning and acceptable land uses.

As land uses change in the Truckee River watershed, both runoff volumes and velocity of flows typically increase. This is reflected in changes in the shape and size of the hydrographs of flows entering the Truckee River at places such as the North Truckee Drain, Boynton Slough, Dry Creek, Evans Creek, and Steamboat Creek. Without mitigation, these changes could affect

the functioning of the Flood Project by causing higher peak flood elevations, thus reducing the effectiveness of the project and reducing the level of protection.

In 1997, approximately 120 to 150 homes were inundated above the first floors. Information prepared by participants in the Flood Project Working Group indicates that an increase in the base flood elevation of as little as two or three inches over the 1997 flood event could result in the inundation of approximately 1,800 additional homes in the Steamboat Creek area under the same flooding conditions. Other properties throughout the region would likely be subject to additional damages (Flood Project staff, personal communication).

FEMA maps were adopted for the region in 1984. Local ordinances were adopted shortly thereafter requiring the first floor of structures to be elevated either one or two feet above the FEMA base flood elevation. Structures constructed after 1984 were generally built in compliance with these ordinances and are at less risk of flooding, while structures constructed prior to 1984 are at higher risk. However, many of the current FEMA flood maps are off by 0.5 to 1 foot as demonstrated in the 1997 flood, during which some homes experienced flooding unexpectedly.

Introduction

Two key points must be recognized when planning for the management of flood events:

1. Flooding is a regional phenomenon; floodwater does not respect municipal or property boundaries.
2. Every area has a flood and storm water drainage conveyance system, whether planned or not.

Definition of Terms

In general, *storm water drainage* refers to the conveyance of flows during storm events that do not result in streams and rivers overflowing their banks or cause the design capacity of storm drain facilities to be exceeded. In contrast, *flooding* occurs when streams or rivers overflow their banks or flows exceed storm drain capacities causing floodwater to inundate nearby lands.

Much of this chapter is focused on the Truckee River Flood Project. Floodplain management services in the Truckee River basin, and in drainages not tributary to the Truckee River are the responsibility of the local jurisdictions' departments that handle public works and community development, in conjunction with storm water drainage activities. Local governments defer to the Truckee River Flood Management Authority for planning and construction of the Truckee River Flood Project. Local government storm water drainage and flood management activities outside the Truckee River watershed are covered in Section 5.7 Local Storm Water Drainage Programs and Section 5.8 Flood Control and Drainage Overview by Hydrographic Basin.

5.1 Flood Damage

Major flooding in an urban environment has many adverse consequences, including monetary damages and loss of real property. Monetary loss is the primary method of depicting flood damages and assessing the effectiveness of flood protection alternatives. Floods also have non-monetary effects, such as impacts on public health and safety, damages from toxic and

hazardous waste contamination, and loss of environmental resources in the flood plain. Monetary loss can come from physical damage and also reduced economic activity due to disruption in the local economy during and after a flood event.

5.1.1 Consequences of Flooding

Following are brief descriptions of potential monetary and non-monetary consequences of flooding in the Truckee Meadows area.

Public Health and Safety

The State Demographer estimates that more than 416,000 people live in the Planning Area. The effect of flood structure failure and resultant flooding on human life depends on the magnitude of a flood, population at risk, flood warning time and evacuation routes. In addition to loss of life, major flooding could result in life-threatening injury and the spread of communicable diseases. Evacuating the flood plain in anticipation of a major flood could have its own consequences, including traffic accidents and other injuries associated with the rapid displacement of thousands of people. There was one fatality during the 1997 flood. In addition, there is the potential for loss of life and property damage associated with flooding on alluvial fans, which is not accounted for in the damage statistics listed for Truckee River flooding.

Contamination from Toxic, Hazardous, and Related Waste

Flooding may result in significant releases of toxic and hazardous substances from above-ground tanks and drums containing heating oil, fuel oil, liquid propane, and kerosene; agricultural chemicals such as herbicides, pesticides, solvents, and fertilizers; many commercial and industrial chemicals; and untreated wastewater. Widespread flooding could also result in groundwater contamination.

Flood Cleanup and Resources Consumption

Major flooding generates large quantities of flood-related debris, most of which is hauled to local landfills. Rebuilding or relocating homes, businesses, and related infrastructure requires additional natural and financial resources.

Property and Businesses

Damageable property in the Truckee Meadows flood plain consisting of commercial, industrial, residential, and public buildings was valued at approximately $5 billion in 2004 using a GIS compilation of the 1997 flood boundary and the assessed value for parcels within the boundary. In a 2007 analysis, the NBMG used the FEMA loss estimation model, HAZUS MR2, to estimate 100-year flood risk in Washoe County. Building exposure, a measure of the economic wealth of the county, was estimated at $25 billion and building-related economic losses were estimated at $980 million (NBMG, 2007). In addition to property and building losses, the effects on the day-to-day business of the Reno-Sparks metropolitan area are significant. During a large flood, many businesses are forced to close, at least temporarily, both during flooding and cleanup afterward, resulting in lost revenues and wages. Additional economic impacts may affect other businesses, even if they do not flood, such as those that rely on materials or products coming

from flooded businesses. People not living in flooded areas can suffer lost wages if their businesses flood or are impacted because other businesses flood.

Physical damages caused by inundation losses or flood response preparation costs are the main types of flood damages within the flood plain. Physical damages include damage to, or loss of, buildings and their contents, raw materials, goods in process, and finished products awaiting distribution. Other physical damages include damage to infrastructure such as roads, utilities, bridges, water and wastewater treatment facilities, and flood structures and floodwalls, as well as cleanup costs. Additional costs are incurred during flood emergencies for evacuation and re-occupation, flood fighting, and disaster relief. Loss of life or impairment of health and living conditions are intangible damages that cannot be evaluated in monetary terms.

Average annual equivalent damages are the expected value of damages for a given economic condition and point in time. They are determined by weighing the estimated damages from varying degrees of flooding by their probability of occurrence. Average annual equivalent flood damages were estimated by the Army Corps of Engineers ("ACOE") at $32 million for existing development conditions in 2004.

Types of Floods

Flood hazards in Nevada are typically underestimated because of the state's arid climate, highly variable precipitation patterns due to the mountain ranges and the valleys between them, the existence of few perennial streams, and the lowest precipitation in the country. Lack of data and a sparse stream-gauging network also contribute to underestimation of flood hazards. Different types of flood hazards in the Planning Area require different kinds of management strategies. Truckee River flooding has been of primary concern to the Reno/Sparks metropolitan area for decades, emphasized by the 1997 flood event, however flooding on Truckee River tributaries, alluvial fans and playas are also concerns.

Riverine flooding and alluvial fan flooding are common in Nevada. Riverine flooding occurs when water levels in rivers and streams rise with increasing discharge volumes over a period of hours or days. Floodwaters overtop stream banks and inundate nearby low-lying areas. In northern Nevada, riverine flooding typically occurs during the winter or spring runoff periods.

Alluvial fans are common landforms in arid areas and are found throughout Nevada. An alluvial fan is a fan-shaped deposit of sediment created where a stream flows out of mountainous or hilly terrain onto the valley floor. The stream may be perennial, intermittent or ephemeral. Alluvial fans are the cumulative result of successive flood events over hundreds or thousands of years. Alluvial fan flooding occurs when floodwaters emerge from a canyon mouth and travel downstream at very high velocities carrying significant loads of sediment and debris. This type of flooding can occur with little warning and as such would be considered a form of flash flooding.

Steep slopes and high stream flow velocities in mountainous terrain allow floodwaters to erode and transport huge amounts of sediment ranging in size from fine silt and clay to house-sized boulders. As these floodwaters exit the mountains onto an alluvial fan, they spread out and slow down causing deposition of the sediment load. This deposition sometimes plugs the active stream channel at the canyon mouth causing the stream to change course and flow down the fan in a new channel. Alluvial fan flooding is potentially more dangerous than riverine flooding

because it is less predictable and the threat is not apparent; therefore it is not often considered during land development. Additionally, the influence of minor grading, roads, and structures can greatly impact and exaggerate damage from this kind of flood. The hazards associated with alluvial fan flooding are compounded by the potential for migration of floodwaters across the width of the fan. Alluvial fan flooding impacts are especially severe on fans where development has occurred without the installation of adequate mitigation measures.

Alluvial fan floods are a type of flash flood; however, flash floods can occur in other kinds of drainages, generally in response to high intensity rainfall concentrated over a relatively small area. Heavy rain collects in a stream or gully, instantly turning the normally calm drainage way into a rushing current. Flash flood waters move rapidly downstream and can have the power to move boulders, tear out trees, and destroy buildings and bridges. Mountainous terrain, thunderstorms and development on alluvial fans are all common in the Planning Area. Flash flooding on streams and washes emerging from steep canyons is another significant flood hazard in Nevada.

Playa flooding occurs when storm waters drain into a closed, dry-lake basin causing water levels to rise. Unlike other types of floods, however, water levels don't recede immediately after the rain event. Water levels can continue to rise after a rain event due to the time it takes for runoff to reach the playa through natural channels, streets, storm sewers and infiltration and transmission as groundwater to the playa. This happens over time as water leaves the playa through infiltration into the ground and/or evaporation. Lake flooding is similar to playa flooding if the lake doesn't have an outlet. Lakes with outlets also flood if the volume of water flowing in is greater than the amount leaving the lake.

5.2 Flood History and Regional Setting

The Truckee Meadows area has a long history of floods. Melting snow, cloudbursts, and heavy rains have all caused floods in the Planning Area. Rain-caused floods, normally occurring from October through March and characterized by high peak flows and short durations, have caused the major flood problems in the area. Flood records indicate that significant damaging flood events have occurred almost every decade since the 1860s. In the 1960s, flood control works consisting of reservoirs and channel modifications, have reduced the magnitude and frequency of flooding in the area. In addition to floods on the Truckee River, a small number of damaging flash floods have occurred in recent history.

Regarding the effect of upstream dams, the ACOE used Truckee River flow records since the early 1900s and, accounting for the effects of the dams, calculated an "unregulated record of flow". Analysis on the unregulated flows produced flow rates for the various flood frequencies, including the 100-year event. The effects of the upstream dams were then added to generate "regulated flow rates" for the various flood frequencies. The 100-year event is 20,700 cfs. To show the impact of the upstream dams on the flow rates through Reno, the ACOE modeled the flood of 1997 as if the dams were not in place. With no upstream dams, except the Tahoe City dam at the Lake Tahoe outlet, the peak flow rate at the Reno gage would have been nearly 50,000 cfs rather than the estimated 23,000 cfs.

The cost of recovery from flood events is rising. Prior to the January 1997 flood event in northern Nevada, damages due to flooding on the Truckee and Carson Rivers totaled more than $31.5 million. The damage caused by flooding on the Truckee River during the January 1997

event exceeded $700 million if indirect damages such as lost revenue, wages, and sales taxes are included.

5.2.1 History of Flooding in the Planning Area

The Truckee Meadows area experiences major flooding caused generally by two types of precipitation events: 1) warm winter storms in which rain is widespread throughout the watershed, and 2) local convective thunderstorms that generally produce isolated sub watershed flooding in the summer months. The 100-year flood event has been based on winter rain-on-snow events. Major Truckee River flood events have been recorded in 1861-1862, 1867-1868, 1907, 1950, 1955, 1963, 1986, 1997 and 2005. Two storms in 2006 (February 12 and March 20) came close to overtopping the banks of the Truckee River, and heavy rains again in 2008 caused Truckee tributaries, including Steamboat Creek to rise significantly, but did not overtop the channel banks and cause significant flood damage.

5.2.2 The Flood of January 1, 1997

Detailed accounts of the January 1997 flood on the Truckee River have been published by the Nevada Division of Water Planning (1997) and the NBMG (1998). The following description draws from these publications and from personal communication with Flood Project staff.

December 1996 was an unusually wet month in northern Nevada. An above-average snow pack had accumulated in the Truckee River drainage basin. A warming trend ensued in late December, followed by the worst possible scenario: heavy rain on a melting snow pack. The frontal storm, which led to flooding in western Nevada, began on December 31, 1996 with rainfall in the foothills west of Reno. During the next three days rain, sleet and some snow was continuous in the Reno/Sparks area, but the overall accumulated rainfall was not extensive in the urban area (1.47 inches at the Reno Airport). In the foothills to the southwest; however, National Weather Service Doppler Radar (“Nexrad”) data indicated that in two areas more than five inches of rain fell on the heavy snow pack. Three to five inches of rainfall were estimated at higher elevations. The resulting discharge in the Truckee River continued to increase and the flood stage ultimately crested in Reno at 10:15 a.m. on January 2, 1997. After the flood, the ACOE estimated that a 100-year flood event would result in flood flows of 20,700 cfs. The ACOE also determined that the 23,000 cfs peak flow at the Reno gage, estimated using high water marks in downtown Reno and HEC-RAS modeling, represents a 117-year event.

Early in the flood event, Reno bridges began accumulating debris reducing their conveyance capacity. Video footage shows construction equipment (logging tractors) on one bridge attempting to clear the debris off the upstream side of the bridge piers. Removal of the debris resulted in a decrease of one foot in the surging flood stage in the downstream Reno streets.

The Truckee River has a varying channel conveyance capacity through Reno and Sparks. Overbank flooding in the Sparks area started at discharges as low as 11,000 cfs. Channel capacity in this area is only 6,000 cfs so significant flooding occurred in the Sparks industrial area. Flooding also inundated and closed the Reno -Tahoe International Airport. Figure 5-1 shows the total area inundated relative to the FEMA 100-year flood zone. Damages recognized by the ACOE that can be used to justify federal expenditures on a flood control project were calculated to be in the range of $450 to $500 million. Local damage estimates, however, exceeded $680 million in a study conducted by the Truckee River Water Management Council –

a group of flood impacted business mostly caused by inundation (Truckee River Water Management Council, 1997).

Historically, the greatest flood damages in the Planning Area have resulted from Truckee River flooding. There are a number of approaches that have been considered to reduce these flood damages over the past 50 years. The flood of 1997 re-energized efforts to implement measures to reduce the impact of flooding on the community.

5.2.3 Alluvial Fan Flooding in the Planning Area

Alluvial fan and flash flooding, while not as present in the community's recent memory, have been even more catastrophic than Truckee River flooding in terms of loss of life. In 1956, Galena Creek flooding resulted in four fatalities versus one fatality due to Truckee River flooding

Figure 5-1 1997 Flood Area Inundated Relative to the FEMA 100-Year Flood Zone INSERT

in 1997. In some cases, development is progressing on alluvial fans without the benefit of adequate upstream protective measures. This development also changes the hydrology of the developed fan area which changes how runoff leaves the developed fan area. This could change impacts downstream depending on what has been done to stabilize channels. Stabilized downstream channels designed before development may not be in the needed location after development, especially if there are directional changes in flows that were not anticipated by the development design. In general, fan development decreases infiltration into the fan and increases runoff volume and velocities downstream.

An alluvial fan flood occurred during June of 2002 in west Spanish Springs Valley when a localized thunderstorm caused a significant amount of sediment to be eroded from Hungry Ridge and deposited in the new Eagle Canyon subdivision immediately to the east. Water and sediment also caused about $500,000 in damage to Spanish Springs High School. Sediment deposition filled detention ponds above the subdivision, decreasing the available storage for floodwater. Water flowed over the emergency spillways of the detention basins and down a channel toward the subdivision. This outflow caused severe erosion in the channels just downstream of the detention dams. When the sediment-laden floodwater met a berm along the edge of the subdivision, sediment deposition occurred again. Some storm water and sediment spilled into the subdivision where it plugged drainage culverts, storm inlets, storm sewers and streets. Water flowed into most yards in the subdivision and caused erosion of landscaping material and the deposition of sediment, which had to be cleaned from storm sewers, drainage structures and channels, streets, and many yards in the weeks after the storm.

5.2.4 Flooding from December 31, 2005 through March 2006

Truckee River flooding that occurred on December 31, 2005 and continued during two additional events through March 2006, was caused by heavy rainfall on the east side of the Carson Range divide, not by rain-on-snow events. This caused larger than normal flows in Truckee River tributaries. Increasing floodwater elevations were somewhat mitigated as rain changed to snow in the upper elevations. Even so, Steamboat Creek flows approached a 100-year event. Flood damages were significant in downtown Reno and in the east Sparks industrial area. Nine hundred businesses flooded, but at lesser depths than in 1997. Flood waters flowed from a small number of low spots along the north banks of the Truckee River and backed up behind the existing levee-like structures (“flood structures”) east of McCarran Boulevard. Floodwater started to overflow the Truckee River banks at the Grand Sierra Resort campground, similar to the 1997 Flood.

In response, Reno installed concrete K-railing and kept flows in the river. This prevented floodwaters from reaching the airport. A month later the same precipitation situation re-occurred and the Emergency Operations Center (“EOC”) was opened. Fortunately flows did not overtop the flood structures along the river; however, some flooding occurred at low areas adjacent to the banks. A month later the same precipitation scenario occurred a third time, although this time the amount was less and forecasts were for about a 10-year event flow. Less physical damage resulted from the third event, but there were three response instances, activity to control flooding during the event and clean up after the event. These costs are usually not reflected in flood insurance claims. Additionally, flood insurance claims don’t include damage to uninsured property, contents of buildings, truck trailers or other storage areas within the flood plain.

5.3 Federal Legislation and Programs to Address Flood Issues

5.3.1 National Flood Insurance Act / Flood Disaster Protection Act

Flood protection for the Reno/Sparks metropolitan area and surrounding Washoe County is provided by two mechanisms: (1) flood plain regulations and (2) flood control projects. Both of these mechanisms are influenced by federal regulations.

The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 offer subsidized flood insurance and flood disaster protection in return for participating communities' implementation of flood plain management regulations as set forth in the NFIP.

5.3.2 National Flood Insurance Program

The NFIP was established in 1968 with the passage of the National Flood Insurance Act. The purpose of the act is to encourage local communities to mitigate future flood damage by adopting and enforcing minimum flood plain management ordinances, thus making the community eligible for the program and allowing property owners to purchase federally subsidized flood insurance.

The NFIP provides Flood Insurance Studies ("FIS") and Flood Insurance Rate Maps ("FIRM") prepared by FEMA for participating communities. A FIRM designates Special Flood Hazard Areas ("SFHA") within a community that is subject to a 100-year flood.

Adoption of the minimum standards for flood plain management identified in the Code of Federal Regulations ("CFR") Title 44, section 60.3, is the primary requirement for participation in the NFIP. The minimum NFIP requirements are flood plain management standards, which are generally applicable nationwide, but that do not take into account unique regional and local conditions.

Participation in the NFIP ensures the availability of federally subsidized flood insurance and flood disaster relief to property owners within the communities. As part of the program, communities are required to adopt ordinances that regulate development within the 100-year flood plain by elevating structures in the floodway fringe and preventing construction in the floodway.

Washoe County, Reno and Sparks are all participants in the NFIP. Studies in the 1970s led to the adoption of local ordinances in the early 1980s. Each jurisdiction has adopted Flood Hazard Reduction Ordinances that established guidelines and requirements for the development of property within areas determined to be subject to flood damage. The NFIP also establishes criteria for construction in Special Flood Hazard Areas.

Counties and communities that do more than the minimum required by the NFIP are eligible for participation in the Community Rating System ("CRS"), which provides credits in the form of reduced insurance costs for property owners holding flood insurance. Washoe County is a CRS participant and, by meeting certain program requirements, has secured a 15 percent reduction in insurance premiums for un-incorporated Washoe County property owners.

Reno, Sparks and Washoe County each has its own flood plain manager and flood plain codes, however the region is mapped as one area. Separate maps and studies are not done simply because a flood plain crosses a local jurisdictional boundary. Separate tributary watersheds studies are done, but the information is reflected on the regional flood maps.

Prior to the adoption of flood hazard reduction ordinances and participation in the NFIP, development within the 100-year flood plain was not regulated to prevent flood damage. The only requirements adopted by the communities at that time were setbacks from stream banks and construction of storm drains to contain and convey away from properties storm water flows from much lower frequency events (5- to 10-year events).

Detailed scientific and engineering studies are performed by FEMA consultants or by the jurisdictions. FEMA reviews the studies to identify the flood hazard areas and limited flooding areas. These studies are used by FEMA to prepare FIRMs that are adopted and incorporated by reference into the flood hazard reduction ordinances administered by each jurisdiction.

The initial FIRMs for Washoe County were completed in 1984. Annually, the community meets with FEMA to discuss the need for new studies or restudies. When complete, the new studies or restudies are used to revise the 1984 maps. Some of the current FEMA maps have been updated as of September 1994 as a result of restudies, however others, including most of the areas along the Truckee River, have not been changed since the original mapping was done, except for a small number of maps updated in 2009.

Following Hurricane Katrina in 2005 and the significant impact of flooding in the New Orleans region, FEMA accelerated its program to update and digitize the existing FIRMS nationwide. The countywide FIRM's for Washoe County were updated on March 16, 2008, but these updates reflect few substantive revisions based on a limited amount of improved data or analysis. The 2008 update was primarily focused on the transition to digital mapping as well as updates to reflect changes in the status of levees and levee-like structures. Although the conversion to digital maps did not substantially change the data, it did highlight areas of incongruity and conflicts. FEMA has been revising the maps for these areas to more accurately portray flood risk. This process has resulted in more homes and businesses in the Truckee Meadows that are located in the 100-year flood plain than were previously identified using non-digital maps, and corresponding flood insurance premium increases.

The Public Works Departments of Reno and Sparks, and the Community Development Department of Washoe County, maintain on file the current FIRMs.

5.3.3 Federal Emergency Management Agency

FEMA – Project Impact

Project Impact is FEMA's program for developing disaster resistant communities. This program was initiated in 1998 and the City of Sparks was named as the first Project Impact Community in Nevada. Project Impact was developed to help communities take responsibility for mitigating the impact of disasters of all types.

Several federal agencies have programs that support flood plain management at the state level by providing funding and technical assistance, and facilitating coordination with local

communities. FEMA provides technical assistance on flood plain management issues and oversees the NFIP. In addition, FEMA offers flood mitigation programs and technical assistance in updating the State Hazard Mitigation Plan, and funds mitigation projects through grants such as the Hazard Mitigation Grant Program and the Flood Mitigation Assistance Program.

5.3.4 US Army Corps of Engineers

The ACOE offers both emergency and long-term services for pre- and post-disaster mitigation and response. The agency performs general investigation studies for flood control, and provides flood plain management planning services, in addition to its role in design and construction of flood retention structures. The ACOE recently introduced a Flood Hazard Mitigation and Riverine Restoration program, entitled Challenge 21, intended to focus on non-structural solutions to restore river channels that were modified for flood control. Two programs in which this region has participated are briefly described below.

General Investigation Program

One of the most common ways the ACOE helps communities solve water resource problems is through individually authorized studies and projects. These studies are undertaken in response to a Congressional Resolution from the House Committee on Public Works and Transportation, the Senate Committee on the Environment and Public Works, or a Public Law. In the General Investigation program, the ACOE jointly conducts a study with a non-federal sponsor and, if shown by the study to be feasible, moves forward with the project. This approach requires that Congress provide the ACOE with authority and funds to first accomplish a feasibility study and secondly, to construct the project. Local sponsors share the study and construction costs with the ACOE, and usually pay for all operation and maintenance costs. The program may be used to address any one of a variety of water resource problems, including navigation, flood damage reduction, and ecosystem restoration. The major stages of a project are:

- Reconnaissance Phase
- Feasibility Phase
- Pre-construction Engineering & Design (“PED”)
- Construction
- Operations/Maintenance, repair replacement and rehabilitation

Section 595 Rural Program

Section 595 of the Water Resources Development Act (“WRDA”) of 1999, as amended, authorizes the ACOE to provide design and construction assistance to non-federal interests in rural Nevada, Idaho and Montana for water-related environmental infrastructure and resources protection and development projects. Design and construction assistance may be provided only for projects that are owned by public entities. Section 595 refers specifically to, among other Nevada Counties, “the portions of Washoe County, Nevada, that are located outside the Cities of Reno and Sparks”, and authorizes $25 million for rural Nevada.

5.3.5 Natural Resources Conservation Service

The US Department of Agriculture, Natural Resources Conservation Service ("NRCS") provides services related to measuring and reducing flood hazards and emergency response following a flood event. The agency conducts flood plain management studies in which ecological resources are cataloged and opportunities for restoring and preserving flood plains are identified. Under the Emergency Watershed Protection program, NRCS provides technical and financial assistance when a natural disaster causes damage in a watershed. Emergency response actions are related to assessing damages and identifying actions.

5.4 State Legislation

Senate Bill ("SB") 218, the Disaster Relief Bill, was passed during the 1997 Legislative session. Nevada Revised Statutes ("NRS") 353.2735, the resulting statute, established a state disaster relief account of $4 million to help communities recover from damages sustained in the event of a disaster. The fund is administered by the Interim Finance Committee, and has been used to provide financial relief following river and flash flooding events in communities throughout the state.

SB 175, approved during the 2009 Legislative session, authorizes Washoe County to acquire and maintain a flood management project in the same manner as any other project authorized under existing law, and provides similar provisions for a municipality within the County. The bill also provides for the creation of a flood management authority by cooperative agreement and authorizes the issuance of bonds similar to the authority of other municipalities.

Assembly Bill 54, also approved during the 2009 session, authorizes the implementation of a flood-proofing and home elevation program in Washoe County including the ability to authorize grants and loans from flood project funds.

5.5 History of Truckee River Flood Control Efforts

Federal flood control projects are generally proposed and constructed under Congressional authority and assigned for implementation to various federal agencies. The NRCS, under the authority of the Watershed Protection and Flood Prevention Act, designed and constructed four flood detention facilities in Northwest Reno. The City of Reno's responsibility was to provide lands, easements, right-of-way, and operation and maintenance of the facilities.

The US Department of the Interior, Bureau of Reclamation (under authorization of the Truckee River Storage Project Act and the Washoe Project Act) completed construction of Boca Reservoir in 1938, Prosser Creek Reservoir in 1963, and Stampede Reservoir in 1969. The ACOE, under authorization of the Flood Control Act of 1954, improved the bankfull capacity of the Truckee River channel to 7,000 cfs from the Glendale Bridge to Vista, including removal of the Vista Reefs and obstructions downstream from the Truckee Meadows to Pyramid Lake. Unfortunately this work, completed in 1963, resulted in flooding, bank erosion, and loss of fisheries and wildlife habitat downstream of Vista.

Under the Flood Control Act of 1962, the ACOE designed and constructed the Martis Creek Reservoir. This reservoir was completed in 1972 along with Truckee River channel improvements through Reno to improve the capacities to 14,000 cfs. Reno, Sparks, Washoe

County, and the Carson-Truckee Water Conservancy District ("CTWCD") are responsible for maintaining these 1972 channel capacities and the river gages that monitor the flood flows. The CTWCD is responsible for the Truckee River from the state line to the Glendale Bridge in Reno. From the Glendale Bridge to the highway bridge in Wadsworth, the river is maintained by the State of Nevada. The Pyramid Lake Paiute Tribe ("PLPT") is responsible for the Truckee River between Wadsworth and Pyramid Lake.

In 1971, the ACOE completed a flood control management plan for the Truckee River reservoirs. Stampede, Boca, Prosser Creek, and Martis Creek Reservoirs have 65,000 acre feet ("af") of flood control space reserved from November to April each year. The operation of the reservoirs for flood control is to be coordinated to limit the flow in the Truckee River at Reno to a maximum of 6,000 cfs. The ACOE estimates that the flood control facilities mentioned above have reduced the 100-year flood flows through Reno from approximately 48,000 cfs to about 23,000 cfs, which still exceeds the Reno channel capacity of 14,000 cfs and the Sparks channel capacity of 7,000 cfs.

In July 1977, the ACOE, at the request of Reno, Sparks, and Washoe County, resumed investigation of alternatives for providing flood protection from the Truckee River through the Truckee Meadows. This investigation resulted in an adopted plan in 1985 consisting of channel improvements, levees, and detention facilities. This plan received Congressional authorization in 1988 and design proceeded.

An economic re-evaluation office report on the project completed in 1991 indicated that the project had an un-fundable benefit to cost ratio. This was due mainly to changes in the WRDA of 1986, which required the market value of public land already acquired to be included in the benefit-cost ratio even though project funds would not be required to purchase the land. As a result of that report the project was re-classified to a deferred status. In 1996, Washoe County asked the ACOE to activate the project and conduct a re-evaluation, which the ACOE initiated in fiscal year 1996-97. The ACOE completed a Reconnaissance Report in March 1998 and started work on a General Reevaluation Report, which is presently ongoing.

5.6 Truckee River Flood Management Project

The Truckee River Flood Management Project ("Flood Project") represents a long-standing collaborative effort by Washoe County, City of Reno, City of Sparks, the U.S. Army Corps of Engineers ("ACOE"), and numerous other stakeholders to reduce the devastating impacts of flooding in the Truckee Meadows.

5.6.1 Flood Project Oversight

Implementation of the Flood Project is currently overseen by the Truckee River Flood Management Authority ("TRFMA"), a joint powers authority created in 2011 by an Interlocal Cooperative Agreement executed among Washoe County, the City of Reno, and the City of Sparks. Nevada Senate Bill 175, approved in June 2009, served as the basis for the new flood authority (refer to Chapter 477 of the Nevada Revised Statutes for more information).

The agency's primary mission is to plan, design, build, operate and maintain infrastructure to reduce flood damages, safeguard public health, and create a more resilient community. TRFMA serves as the official Local (Non-Federal) Sponsor working with the ACOE to evaluate flood risk

management alternatives and secure federal funding (via Congressional authorization and appropriations) to construct the Flood Project. In coordination with various federal agencies and local emergency managers, TRFMA also operates and maintains a network of stream gages that monitor river stage as part of a regional Flood Warning System (see Section 5.6.6 for more information).

The policies, business, and affairs of TRFMA are conducted and governed by a six-member Board of Directors consisting of two elected officials appointed by each of the TRFMA members. Each Director has one vote; actions of the board are decided by unanimous consent of the Directors present at the meeting.

The TRFMA Technical Advisory Committee ("TAC") is a nine-member public body consisting of appointees from Washoe County, the City of Reno, the City of Sparks, Storey County, the Pyramid Lake Paiute Tribe, and the Nevada Division of Environmental Protection. The TAC reviews and advises the Board on matters relating to the design, implementation, construction, ownership, operation, monitoring, and maintenance of capital projects included in the Flood Project; as well as proposed legislation, plans, planning recommendations, regulations, and policy statements to be made by the Board.

The TRFMA Working Group represents a diversity of public stakeholders, including businesses, homeowners, environmental groups, technical experts, activists and interested citizens. Membership in the Working Group is open to the community at large. The Working Group provides a public forum for exchanging ideas and sharing information on the Flood Project. Concerns and issues raised by this community coalition are forwarded to TRFMA staff for consideration by the TRFMA Board of Directors.

An Executive Director and Legal Counsel serve the TRFMA Board of Directors. The Executive Director oversees a small staff to carry out technical, financial, and administrative operations and board directives to move the Flood Project forward.

5.6.2 Flood Project Goals

The Flood Project is designed to provide a variety of public safety, economic, recreational and environmental benefits to the Truckee Meadows region. Its primary goal is to create a more resilient community by reducing flood damages and deaths resulting from a 1997-type flood event (117-year event). Additionally, the Flood Project incorporates certain recreational and ecosystem restoration features within the footprint of the flood protection infrastructure.

TRFMA hopes to achieve these goals by:

- building levees and floodwalls to protect businesses and homes;
- acquiring and protecting flood-prone lands from development;
- relocating businesses and elevating homes out of the floodplain;
- replacing bridges to increase river channel capacity;
- excavating floodplain terraces to improve floodwater storage;
- restoring ecosystem functions and creating habitat for native species; and
- enhancing recreational access and amenities along the river.

5.6.3 Flood Project Elements

The current Flood Project plan (also known as the Local Rate Plan) represents many years of planning and stakeholder coordination. It is based on the "Living River Plan," originally conceived by the Flood Project Community Coalition. Over a period of six years, the agency now known as TRFMA organized hundreds of meetings with community stakeholders in order to develop and build consensus for a regional flood management plan.

The Living River Plan emphasized the community's vision of incorporating environmentally-friendly elements into the flood protection infrastructure in order to reconnect the river to its floodplain, restore habitat for native species, and enhance recreational opportunities along the river. The current Flood Project plan retains some of the elements from the original Living River Plan and incorporates results from TRFMA's updated hydraulic models.

The proposed Flood Project footprint extends approximately 33 miles along the Truckee River, from downtown Reno (near Jones Street) to the town of Wadsworth, Nevada (near Pyramid Lake). Major elements of the Flood Project Plan (Local Rate Plan) are described below in Table 5-2, grouped according to project reach (upstream to downstream). The three project reaches are: Downtown Reno (Jones Street to US Highway 395/I-580); Truckee Meadows (US Highway 395/I-580 to Vista Boulevard); and Lower Truckee River (Vista Boulevard to Wadsworth).

Table 5-2. Description of Flood Project Plan (Local Rate Plan) Elements

Element	*Element Description*
DOWNTOWN RENO REACH (DR) Proposed flood protection infrastructure elements in the Downtown Reno Reach are designed, at a minimum, to pass the 100-year flood flow (20,700 cubic feet per second). No additional freeboard is included except in the case of bridge replacements (designs assume 2-foot freeboard). Where feasible, the Flood Project incorporates certain recreational and ecosystem restoration features within the footprint of the flood protection infrastructure. Elements in this reach are not included as part of the Truckee Meadows Flood Control Project authorized by Congress (Section 7002(2) of the Water Resources Reform and Development Act of 2014); and therefore are not eligible to receive federal funding from the ACOE.	
DR-1	**Jones Street to Arlington Avenue Floodwall Construction:** Construct a floodwall along the north bank of the Truckee River (Riverside Drive) from Booth Street to Arlington Avenue; partially bury it with an earthen berm to minimize visual impact to existing landscape. Floodwall height should be equal to the 100-year water surface elevation (no freeboard).
DR-2	**Jones Street to Arlington Avenue Floodwall Drainage:** Per recommendations from the Final Geotechnical Report (*W91238-10-D-003, released by ACOE Sacramento District on December 6, 2011*); construct a drainage trench along portions of the new floodwalls.

Element	*Element Description*
DR-3	**Jones Street and Keystone Avenue Intersection Improvements:** Replace existing 4-way stop sign controlled intersection with a signalized intersection at same location.
DR-4	**Booth Street Bridge Removal:** Remove existing Booth Street Bridge and construct new pedestrian/bicycle bridge at same location.
DR-5	**Pumping Station:** Install a stormwater pumping station along Riverside Drive.
DR-6	**Pedestrian Safety Closure Structures:** Install pedestrian gates along floodwall to maintain pedestrian access under normal conditions. For public safety, gates would be closed during flood events. Utilize a product such as FloodBreak Automatic Floodgates or Federal Emergency Management Agency (FEMA) approved equivalent.
DR-7	**Pedestrian Bridge Improvements (Arlington Avenue):** Raise existing pedestrian bridges (two total); one located upstream and another downstream of Arlington Avenue.
DR-8	**Floodproofing:** Implement a combination of structural and non-structural measures to reduce/eliminate flood damage to various existing downtown Reno buildings.
DR-9	**Arlington Avenue Bridge Protection:** Install bridge abutment and pier scour protection measures at Arlington Avenue Bridge.
DR-10	**Arlington Avenue to Lake Street Floodwall Replacement:** Replace existing old, inadequate floodwalls located on both (north and south) banks of the Truckee River from Arlington Avenue to Lake Street.
DR-11	**Sierra Street Bridge Replacement:** Remove existing bridge located at Sierra Street and, at the same location, construct a new, hydraulically efficient bridge capable of passing the 100-year flood flow (2’ freeboard).
DR-12	**Virginia Street Bridge Replacement:** Remove existing bridge located at Virginia Street and at the same location, construct a new, hydraulically efficient bridge capable of passing the 100-year flood flow (2’ freeboard). **PROJECT COMPLETE**
DR-13	**Center Street Bridge Replacement:** Remove existing bridge located at Center Street and at the same location, construct a new, hydraulically efficient bridge capable of passing the 100-year flood flow (2’ freeboard).
DR-14	**Lake Street Bridge Replacement:** Remove existing bridge located at Lake Street and at the same location, construct a new, hydraulically efficient bridge capable of passing the 100-year flood flow (2’ freeboard).

Element	*Element Description*
DR-15	**Wells Avenue Pedestrian Bridge Improvements:** Remove existing pedestrian bridge located at Wells Avenue and construct new pedestrian bridge just upstream of Wells Avenue.
DR-16	**Wells Avenue Bank Stabilization and Bridge Protection:** Stabilize stream banks/slopes around the Wells Avenue Bridge. Install bridge pier scour protection measures at Wells Avenue Bridge.
<u>TRUCKEE MEADOWS REACH</u> (TM) Proposed flood protection infrastructure elements in the Truckee Meadows Reach are designed in accordance with FEMA mapping standards. Where feasible, the Flood Project incorporates certain recreational and ecosystem restoration features within the footprint of the flood protection infrastructure. Elements in this reach (including certain recreational features) have been included as part of the Truckee Meadows Flood Control Project authorized by Congress (Section 7002(2) of the Water Resources Reform and Development Act of 2014); and therefore are eligible to receive federal funding from the ACOE.	
TM-1	**Reno-Sparks Indian Colony Levee and Floodwall Construction:** Construct a levee and floodwall system (approximately 2,300 feet) at the Reno-Sparks Indian Colony property located along the south bank of the Truckee River, from US Highway 395/I-580 to Glendale Avenue. **<u>PROJECT COMPLETE</u>**
TM-2	**Grand Sierra Resort Floodwall Construction:** Construct a floodwall on the south bank of the Truckee River from Glendale Avenue to Greg Street (approximately 6' high and 3,000 feet in length). Utilize drainage blankets for seepage mitigation.
TM-3	**Glendale Avenue to Greg Street Levee Replacement:** Replace existing levee located on the north bank of the Truckee River from Glendale Avenue to Greg Street with an on-bank floodwall at same location. Utilize drainage blankets for seepage mitigation.
TM-4	**Greg Street to Rock Boulevard Levee Construction:** Construct set-back levee on the south bank of the Truckee River from Greg Street to Rock Boulevard.
TM-5	**Greg Street to Rock Boulevard Terracing:** Excavate terrace on the south bank of the Truckee River from Greg Street to Rock Boulevard in order to increase flood flow channel capacity and reconnect river to its floodplain. Establish native riparian vegetation on terrace surface. *<u>Note</u>: Overall extent (width) of terracing has been reduced from previous Flood Project designs in order to reduce excavation costs and minimize impacts to Pioneer Ditch.*

Element	*Element Description*
TM-6	**Rock Boulevard Bridge Protection:** If necessary, install bridge abutment and pier scour protection measures at Rock Boulevard Bridge. *Note: No bridge modifications are planned here as part of the Flood Project; levees/floodwalls and terracing elements should confine flood flows to existing bridge opening.*
TM-7	**Rock Boulevard to McCarran Boulevard Levee Construction (South Bank):** Construct set-back levee on the south bank of the Truckee River from Rock Boulevard to McCarran Boulevard. Property located on the "dry" side of the levee (between the levee and Mill Street) may be used as a disposal site for excess fill; this property has been reserved for future recreational use (possibly including flat fields, trails, picnic areas, and other amenities). *Note: As part of this revised design, the levee alignment has been moved closer to the river channel in order to reduce construction costs. In this section of the Flood Project, Pioneer Ditch will be enclosed via piping to facilitate use of a portion of the property as a fill disposal site/recreation area.*
TM-8	**Rock Boulevard to McCarran Boulevard Terracing:** Excavate terraces on the south bank (and a small portion of the north bank) of the Truckee River from Rock Boulevard to McCarran Boulevard in order to increase flood flow channel capacity and reconnect river to its floodplain. Establish native riparian vegetation on terrace surfaces. *Note: Overall extent (width) of terracing has been reduced from previous Flood Project designs in order to reduce excavation costs and minimize impacts to Pioneer Ditch.*
TM-9	**Rock Boulevard to McCarran Boulevard Levee and Floodwall Construction (North Bank):** Replace existing levee on the north bank of the Truckee River from Rock Boulevard to McCarran Boulevard with a system of levees and on-bank floodwalls to minimize impacts to adjacent properties and the railroad. Fill localized low-lying areas on the "dry" side of the levees/floodwalls.
TM-10	**Pumping Station:** Install a stormwater pumping station on the north side of the Truckee River near East McCarran Bridge.
TM-11	**East McCarran Bridge Protection:** If necessary, install bridge abutment and pier scour protection measures at East McCarran Boulevard Bridge. *Note: No bridge modifications are planned here as part of the Flood Project; levees/floodwalls and terracing elements should confine flood flows to existing bridge opening.*
TM-12	**UNR Main Station Farm Facilities Protection:** Implement a combination of structural and non-structural measures to reduce/eliminate flood damage to selected existing buildings located at the University of Nevada, Reno Agricultural Experiment Station (UNR Main Station Farm). Elevate existing pads under hay storage barns to keep hay dry (above flood waters). *Note: Existing main building (meat processing facility) is located above 100-year flood level; no additional protection measures for this building are proposed as part of the Flood Project.*

Element	*Element Description*
TM-13	**McCarran Boulevard to Vista Boulevard Levee and Floodwall Construction:** Replace existing levee on the north bank of the Truckee River from McCarran Boulevard to Vista Boulevard with a system of levees and on-bank floodwalls to minimize impacts to adjacent properties. Construct an on-bank floodwall in the Larkin Circle vicinity to avoid impacts to the roadway.
TM-14	**Steamboat Creek Terracing:** Excavate small terrace on along Steamboat Creek in order to increase flood flow channel capacity and maintain existing water surface elevations. Establish native riparian vegetation on terrace surface.
TM-15	**North Truckee Drain Relocation:** Relocate the existing North Truckee Drain (mostly via buried concrete box culverts) to move its confluence with the Truckee River to a location downstream of the Steamboat Creek confluence. When completed, storm water will be delivered east of Vista Boulevard, thereby reducing flooding in the Sparks Industrial area. **PROJECT PHASE 1 and 2 COMPLETE; FINAL PHASE 3 FINANCING IN PROGRESS**
TM-16	**Vista Narrows Terracing:** Excavate terraces on the south bank (and a small portion of the north bank) of the Truckee River from Steamboat Creek to the second railroad bridge over the Truckee River (downstream of the Vista Narrows) in order to increase flood flow channel capacity and reconnect river to its floodplain. Establish native riparian vegetation on terrace surfaces. *Note: Terraces would be excavated to an elevation above the existing low flow river channel to avoid environmental impacts to the river channel (e.g., channel incision).*
TM-17	**Hidden Valley Voluntary Home Elevation Program:** Establish and manage a program to provide financial assistance to eligible homeowners in Hidden Valley wishing to raise their homes to the 100-year flood elevation (minimum). *Note: This Flood Project element is not eligible to receive federal funding from the US Army Corps of Engineers.* **PROGRAM INITIATED**
TM-18	**Eastside Subdivision and Rosewood Lakes Voluntary Home Elevation Program:** Establish and manage a program to provide financial assistance to eligible homeowners in the Eastside Subdivision and Rosewood Lakes area wishing to raise their homes to the 100-year flood elevation (minimum). *Note: This Flood Project element is not eligible to receive federal funding from the US Army Corps of Engineers.* **PROGRAM INITIATED**
TM-19	**Mandatory Home Elevation Program:** *Only if necessary; requires additional analysis.*

Element	*Element Description*
LOWER TRUCKEE RIVER REACH (LT) It is likely that construction of the Flood Project will significantly impact the environment and therefore require mitigation. Ecosystem restoration serves multiple purposes and may be used to satisfy at least a portion of required mitigation measures (e.g., related to hydraulic and habitat impacts). **Ecosystem Restoration Goals:** • Attenuate flood waters — help mitigate the effects of increased peak flows due to upstream flood control measures • Restore the structure and function of the river ecosystem • Establish habitat for native wildlife species (including federally-listed threatened and endangered fish species) • Reduce existing infestations and control the spread of invasive weeds • Improve water quality • Enhance recreational access and amenities along the river	
LT-1	**Lockwood Ecosystem Restoration and Recreational Trailhead:** Restore approximately 0.6 miles of river channel; create approximately 37 acres of native habitat. Construct a recreational trailhead and improve recreational access along the Truckee River. **PROJECT COMPLETE**
LT-2	**Rainbow Bend Mitigation:** Explore various structural/non-structural measures that may be required to mitigate potential downstream hydraulic impacts caused by construction of the Flood Project. Measures may include establishment of a non-voluntary home elevation program. *Note: Additional analysis required.*
LT-3	**Lower Mustang Ranch Ecosystem Restoration:** Restore approximately 2.5 miles of river channel; create approximately 187 acres of native habitat. **PROJECT COMPLETE**
LT-4	**Tracy Power Plant Ecosystem Restoration:** Restore approximately 2.5 miles of river channel; create approximately 115 acres of native habitat. **PROJECT COMPLETE**
LT-5	**102 Ranch Ecosystem Restoration:** Restore approximately 2.0 miles of river channel; create approximately 114 acres of native habitat. **PROJECT COMPLETE**
LT-6	**Wadsworth Mitigation:** Explore various structural/non-structural measures that may be required to mitigate potential downstream hydraulic impacts caused by construction of the Flood Project. Measures may include establishment of a mandatory home elevation program. *Note: Additional analysis required.*

5.6.4 Flood Project Cost and Funding

TRFMA is committed to building a cost-effective flood project to benefit the community. In response to local concerns regarding the overall cost and scope of the Living River Plan (which was estimated to cost $1.6 billion), TRFMA worked with its consultants and numerous stakeholders to revise the plan, significantly reducing the cost while still providing a 100-year level of flood protection for the Truckee Meadows (thereby maintaining compliance with the National Flood Insurance Program).

Through a series of meetings in 2012 and 2013—including an in-depth "value engineering" exercise, the overall cost was reduced to just $446 million. This represents roughly 72% in cost savings to the communities of Reno, Sparks and Washoe County.

The Flood Project and TRFMA are currently funded by a 1/8-cent infrastructure sales tax authorized by NRS Chapter 377B (Tax for Infrastructure) and imposed by Washoe County in December 1998 under Ordinance 1048 (Washoe County Code 20.914). The initial Infrastructure Tax Plan was adopted by the Washoe County Commission in 1998 for the financing of a regional emergency dispatch facility, a public safety training facility, and the Flood Project.

The TRFMA members (Washoe County, City of Reno, and City of Sparks) have determined that the Flood Project provides significant benefits to the community by:

- preventing the loss of life and property;
- avoiding adverse economic impacts due to the disruption of commerce, transportation, communication and other essential services;
- safeguarding the public health;
- improving water quality; and
- providing opportunities to create habitat for native species and enhance recreational access and amenities along the Truckee River.

Additional funds are required to construct the Flood Project (total cost of approximately $466 million). Presently, TRMFA is exploring a variety of funding options to raise additional revenues, including (but not limited to):

- fees collected from property owners (commercial and residential) who directly benefit from decreased flood risk as a result of Flood Project implementation;
- taxes (e.g., sales taxes, property taxes, excise taxes) collected in Washoe County to support the Flood Project, which has regional significance; and
- flood impact fees for new development in order to mitigate related impacts on Flood Project facilities.

Ecosystem Restoration

TRFMA has partnered with The Nature Conservancy and numerous other local, state, and federal agencies and non-profit organizations to restore the lower Truckee River ecosystem (from Vista to Pyramid Lake). To date, the partners have invested more than $28 million to create more than 450 acres of habitat and restore more than 8 miles of the lower Truckee River. An estimated 216 jobs were created as a result of this work (full-time equivalents).

The agency has contributed about $2.1 million in sales tax funds for land acquisition, planning, and construction—less than 8% of the overall cost of restoration project implementation. In

addition, TRFMA contributed $4.775 million in grant funds to implement ecosystem restoration projects via Assembly Bill No. 5 (AB-5), passed by the Nevada State Legislature in 2007.

This relatively small investment may result in significant returns for TRFMA. The ecosystem restoration work could potentially satisfy a portion of the environmental mitigation required to obtain permits and construct the Flood Project.

5.6.5 Federal Support for the Flood Project

Over the years, TRFMA has worked diligently with the ACOE to implement the Flood Project. During the latest planning effort iteration, the Living River Plan was presented to the ACOE as the Locally Preferred Plan ("LPP") alternative for flood risk management. Unfortunately, due to recent federal budgetary constraints, the Living River Plan was not recommended by the ACOE for Congressional authorization.

However, as part of the Water Resources Reform and Development Act of 2014 ("WRRDA 2014"), Congress authorized and pledged almost $200 million in federal funds to construct the ACOE National Economic Development ("NED") Plan, which is designed to provide 50-year flood protection for the Truckee Meadows.

With the help of its lobbyists and delegates, TRFMA was able to draft a special piece of legislation to benefit the Truckee Meadows. Section 1036 of WRRDA 2014 directs the ACOE to build a LPP that provides a higher level of flood protection than the authorized NED Plan as long as the LPP meets certain ACOE requirements.

Per Section 1036, the Flood Project Plan—which provides cost-effective 100-year flood protection for the Truckee Meadows—can be constructed with federal support, including funds authorized for the NED Plan (federal cost-share of $181,652,000).

TRFMA continues to work with its lobbyists and delegates to secure federal funding appropriations for project construction.

5.6.6 Flood Warning System and Emergency Management

TRFMA is responsible for operating and maintaining a portion of the regional Flood Warning System's network of stream gages and meteorological stations. This regional hydrologic data network includes a total of 157 gages, 30 of which are directly maintained by TRFMA employees. TRFMA cooperates with the US Geological Survey and other agencies to fund, operate and maintain the network; and to transform the collected data into useable information for regional emergency flood response efforts.

TRFMA is the lead agency for implementing the Truckee River Flood Warning Plan, which is designed to notify emergency managers of potentially significant flooding approximately 5-7 days in advance of an event. These notifications assist regional responders with emergency preparations, including activation of the Washoe County Regional Emergency Operations Center ("REOC"). Technical staff from TRFMA also provide support to the Washoe County REOC during heavy rain events.

TRFMA is a participating agency in a cooperative local effort among Washoe County, City of Reno and City of Sparks to develop a Regional Hazard Mitigation Plan; which identifies natural hazards and potential mitigation measures to increase regional disaster resiliency and meet FEMA requirements for future disaster assistance.
Technical personnel from TRFMA also participate in regional exercises designed to train agencies how best to respond to a variety of emergencies and natural disasters, including earthquakes and catastrophic floods events.

5.7 Local Government Flood Control and Storm Water Drainage Programs

Reno, Sparks and Washoe County must each provide for adequate drainage systems to convey storm water in order to preserve and promote public health, safety, welfare, and economic well being. The need for adequate drainage affects all governmental jurisdictions and all parcels of property and therefore requires coordination among the jurisdictions and the Flood Project, and cooperation from both the public and private sectors.

Flood plain management and drainage facilities are two main components of each jurisdiction's storm water drainage program. In addition, drainage program staff members actively participate in planning and engineering for the Flood Project.

5.7.1 Flood Plain Storage and Critical Flood Pools

Flood Project staff and local government flood management staff met for approximately 2 years as part of a RWPC committee on flood plain storage mitigation to develop guidelines relative to Policy 3.1.b, adopted by the RWPC in early 2004 to address the need to mitigate losses of flood plain storage due to development of properties in critical flood pools. Guidelines were intended for incorporation into local ordinances and development codes, which provide a mechanism to implement mitigation measures. In March 2004, Reno amended its Land Development Code (Section 18.12.605 - Critical Flood Pools) to be consistent with Policy 3.1.b. Similarly, Washoe County amended its Development Code (Section 110.416.18 Critical Flood Storage Areas) in February 2005.

Later in 2005, the Flood Project Coordinating Committee ("FPCC"), the Flood Project local government oversite committee prior to the formation of TRFMA, requested that the RWPC provide clarification of Policy 3.1.b regarding the mitigation ratio of flood plain storage volume displaced by placing fill in Critical Flood Zone 1. The RWPC responded in November 2005 with a small number of recommendations, including a mitigation ratio of 1 to 1.

In October 2008, the FPCC adopted "Resolution number 2008-1, A Resolution Proposing Principles and Guidelines to be used as a Basis for Adoption of Local Ordinances for Floodplain Storage Mitigation within Critical Flood Zone 1." The resolution, developed in coordination with Reno, Sparks and Washoe County flood management staff, strongly recommended mitigation requirements for all projects proposing to displace any volume of flood water in Zone 1. Specifically, storm water discharges should be limited to pre-development peak flows and flood storage volume mitigation should achieve no adverse impact. This would be achieved by providing mitigation in a volume equal to the volume of flood storage displaced, in the same flood storage area, at the same elevation and at the same time or prior to displacement. The

resolution also included definitions for key terms, such as "no adverse impact" and "flood storage area" and a reference map (Figure 5-2).

In September 2010, Reno amended Section 18.12.605 of its Land Development Code to be consistent with the resolution. Washoe County also amended its Development Code (Section 110.416.18 Critical Flood Storage Areas), which adopts and incorporates the provisions of Policy 3.1.b.

Policy 3.1.b: Flood Plain Storage within the Truckee River Watershed

Until such time as Reno, Sparks, and Washoe County adopt and begin to implement a Flood Plain Management Plan for the Truckee River, the local flood management staff[2], using the best technical information available and applicable local ordinances, will work with a proposed project applicant or a proposed land use change applicant to determine the appropriate level of analysis required in order to evaluate and mitigate the impacts experienced during the 1997 flood. On an annual basis, all three local flood management agencies and the Flood Project shall jointly agree on and adopt the "best technical information" available for use in implementation of this policy.

Criteria to implement policy: The local flood management staff shall evaluate impacts using qualitative or quantitative analysis and the evaluation may be uncomplicated and brief. If a more in-depth analysis is appropriate, the following "tiered" approach and criteria shall be used unless otherwise required by local ordinance:

- Current development codes require that a project not increase the 100-year peak flow at the boundary of the property. If the project can also demonstrate no increase in volume of 100-year runoff at the boundary of the property, the analysis is complete.
- If there is an increase in 100-year volume of runoff at the boundary of the property, the project may demonstrate either:
    - The increase in volume of runoff will have no adverse impact to downstream properties and no adverse impact to hydrologically connected properties, or
    - The increase in volume of runoff will be mitigated in a regional project without adverse impact to hydrologically connected and downstream properties. (Until a storage mitigation plan is in place with respect to this paragraph, no flood plain storage mitigation will be required.)
- Impacts of a proposed project will be evaluated by comparing conditions without the proposed project (current conditions) and conditions with the proposed project.
- Impacts of a proposed land use change will be evaluated by comparing conditions without the proposed land use change (current conditions) and conditions with the buildout of the reasonable development potential of the proposed land use change.

The watershed is divided into four zones with different project size thresholds for the purposes of review (See Figure 5-2):

[2] Each local government has assigned one or more staff members the responsibility of designing and reviewing flood management projects. These staff members are also responsible for reviewing certain proposed projects to address concerns of drainage and flooding.

Zone 1: Critical flood pool – all proposed land use changes and proposed projects will be reviewed for their impact on hydrologically connected and downstream properties

Zone 2: Existing flood pool that will be removed from the flood pool by the proposed Truckee River Flood Project – proposed land use changes and proposed projects five acres and larger will be reviewed

Zone 3: Adjacent sheet flow areas not part of the flood pool – proposed land use changes and proposed projects five acres and larger will be reviewed

Zone 4: Remainder of the Truckee River Watershed – proposed land use changes and proposed projects five acres and larger will be reviewed

Figure 5-2 Critical Flood Zone Areas

INSERT

5.7.2 Drainage Facilities

Local storm water drainage facilities typically include curb and gutter, inlets and storm sewers, culverts, bridges, swales, ditches, channels, detention facilities, or other drainage infrastructure required to convey storm runoff to its ultimate drainage way. Reno, Sparks and Washoe County are involved primarily in drainage improvements funded, designed or constructed by the local governments, or where these functions are performed in cooperation with other groups or partners. Many other public drainage facilities are constructed and paid for by developers, with oversight provided by the local government having jurisdiction for the project. Once constructed and dedicated to the local government, maintenance of drainage facilities becomes the responsibility of the local government or an entity such as a homeowner's association. The local governments administer drainage programs within their respective jurisdictions as set forth in the drainage code sections shown in Table 5-3.

Table 5-3 Drainage Code References for Reno, Sparks and Washoe County

Jurisdiction	Reference	Entitled	Description
City of Reno	12.04.010 Article IV Reno Administrative Code, Title 12, Public Works and Utilities (repealed by ord. 6343, 9-10-2014)	Standard Specifications for Public Works Construction	Adopts "Standard Specifications for Public Works Construction" published by RTC (“Orange Book")
	12.16 Article IV Reno Administrative Code, Title 12, Public Works and Utilities	Storm Water Management and Discharge Control	Regulates storm water discharge procedures
	18.12.701 Article VII Reno Administrative Code, Title 18, Annexation and Land Development (“Land Development Code”)	Streets	Adopts "City of Reno Public Works Design Manual" which contains current storm drainage policies and technical design criteria in Chapter 2
	18.12.1701 Article XVII of Land Development Code	Flood Hazard Areas	FEMA Flood Requirements
	18.12.1801 Article XVIII of Land Development Code	Wetlands and Stream Environment Protection Standards	Establishes regulations pertaining to wetlands and stream environments
	18.12.1901 Article XIX of Land Development Code	Drainage Way Protection Standards	Establishes setbacks from select waterways and regulates the uses in those setbacks
City of Sparks	Sparks Municipal Code, Title 15, Chapter 15.11	Flood Plain Management	FEMA Flood Requirements
	Sparks Municipal Code, Title 17, Chapter 17.16, Section 17.16.140	Drainage	Subdivision drainage requirements

Table 5-2 Drainage Code References for Reno, Sparks and Washoe County - Continued

Jurisdiction	Reference	Entitled	Description
Unincorporated Washoe County	Chapter 110 Development Code, Article 416	Flood Hazards	FEMA flood requirements
	Chapter 110 Development Code, Article 418	Significant Hydrologic Resources	Establishes setbacks from select waterways and regulates uses in setbacks
	Chapter 110 Development Code, Article 420	Storm Drainage Standards	Current policies and technical design criteria
	Ordinance 1223 (expect codification in Article 421)	Storm Water Discharge Ordinance	Regulates storm water discharge procedures

The Reno flood and drainage staff operates within the Environmental Engineering Section of the Public Works Department. Staffing and a limited number of projects are paid through a portion of the sewer fees dedicated to drainage projects, as described on the City's sewer bills. Other Reno storm water improvements have historically been paid for by the general fund. The City of Sparks maintains a storm drain utility supported by user and connection fees, bond proceeds, grants and participation from other agencies.

Washoe County's storm water management program is administered by its Department of Community Services ("CSD"), including maintenance of the storm drainage system which is provided by the Roads Division and funded through the general fund. Capital improvements are also funded through the general fund.

For private development within Reno, Sparks or the unincorporated County, citizens, developers, engineers and planners typically interact with the Community Development Departments, which are responsible for plan review, permitting, development code enforcement and requests for FEMA flood map revisions.

5.7.3 Flood Plain Management

A community's agreement to adopt and enforce flood plain management ordinances, particularly with respect to new construction, is an important element in making flood insurance available through the NFIP to home and business owners. See Section 5.3.2 above.

Local government storm water drainage programs manage local and regional components of drainage planning and drainage issues; interact with FEMA for flood map updates; design and construct publicly-funded projects; and serve as repositories for FEMA flood map information. Each jurisdiction has designated a person as flood plain management administrator for FEMA purposes.

In 2003, the RWPC approved as a working document, the draft *Regional Flood Plain Management Strategy* ("RFMS"), which may serve as the basis for a flood plain management plan required by the ACOE before entering into a project cost agreement for the Truckee River Flood Management Project. Some elements of the RFMS have been included in the County's *All Hazard Mitigation Plan*, required of all communities under the Disaster Mitigation act of 2000, while others have been used by the County to qualify for participation in the FEMA CRS.

Flood plain management generally consists of planning and implementing programs designed to alleviate the impact of flooding on people and communities. It includes activities such as instituting land use policies and regulations for development in flood prone areas, and restoring and preserving natural resources and functions of flood plains and contributing watersheds.

Flood plain management can include both structural and non-structural measures for mitigating flood impacts. Structural approaches include measures that reduce the amount of floodwater in a stream or contain floodwater in a channel so that it does not inundate nearby areas. Such measures may include detention facilities, flood structures or dikes and floodwalls. Structural measures built with public money have been used historically to manage existing flood impacts with varying degrees of success. Structural flood controls may require the use of valuable land and natural resources. A structural approach to flood control in existing urban areas can provide a cost-effective benefit to the public. In southern Nevada, the Clark County Regional Flood Control District uses structural controls very effectively to manage flash flooding impacts in developing areas.

Non-structural approaches to flood plain management are being used increasingly as the limitations of flood control become apparent. The most cost-effective approach to flood hazard protection can be achieved using land use planning and sound flood plain management regulations in flood prone areas. Non-structural approaches to flood plain management include:

- Development of tools to monitor changes in the watershed and better understand changes to the hydrologic response of the watershed due to land use changes and transmittal of recommendations to local government
- Development of regional master plans for flood management
- Mapping and study of historic flood prone areas
- Implementation of flood plain regulations, including zoning ordinances, subdivision regulations, and building codes that guide development in flood plains and flood prone areas
- Implementation of a development review process at the local or regional level
- Acquisition and removal, or relocation of structures which experience repetitive losses
- Flood proofing existing structures by elevating a building's structure or infrastructure, or sealing and reinforcing walls, doors and windows
- Flood forecasting and warning systems
- Disaster preparedness plans
- Rehabilitation of disturbed watersheds, wetlands, and riparian zones
- Designation of green belts
- Providing education and information to the local communities

Although flood plain management most effectively occurs at the local or regional level, the state plays an important role. The state's primary functions include coordination between federal and local agencies, education and information dissemination, and management of grant funds passed through from the federal government or the state to the local communities.

5.7.4 Truckee Meadows Regional Drainage Manual

In an effort to provide consistent guidance for developers, planners and engineers, key staff members of Reno, Sparks and County Public Works Departments and the Flood Project collaborated on the development of the *Truckee Meadows Regional Drainage Manual* (2009) ("TMRDM"). The purpose of the manual is to provide minimum standards for (and to ensure consistency with) analysis, planning and design of projects with flood control and drainage components within Reno, Sparks and the unincorporated County.

The manual is a common reference for policies and criteria relating to drainage design and hydrology for the three jurisdictions. The manual supports the jurisdictions' regulation of future development and regional flood plain management, providing an integrated system which acts to protect public health, safety, comfort, convenience, welfare, property and commerce. The manual was reviewed by development community stakeholders and revised accordingly before being submitted for approval. Reno, Sparks and Washoe County Public Works Departments have provided endorsements and the manual is in use by all three jurisdictions. Reno references the manual in Chapter II of its Public Works Design Manual and Washoe County has adopted the manual by reference in Washoe County Code Chapter 110, Article 420.

The TMRDM updates and supersedes the 1996 draft *Washoe County Hydrologic Criteria and Drainage Design Manual* by using current state-of-the-art technology and procedures, and including updated technical references, charts and graphics. The new manual includes criteria that are more representative of Reno, Sparks and Washoe County programs, either by use of the same standards, or by specific identification of subjects in which criteria differ, such as rainfall criteria for Reno, unincorporated Washoe County and Sparks. The manual also updates chapters on open channels, including a new section on natural channel design and storm sewer systems, particularly with respect to capacity and design criteria.

5.7.5 Draft Washoe County Regional Flood Control Master Plan

The draft *Washoe County Regional Flood Control Master Plan* (WRC, 2005) was prepared to update the *Washoe County Flood Control Master Plan, Concept Level Report* (KJC, 1991). The purpose of the 2005 update was to evaluate existing and projected drainage and flooding conditions and to recommend regional drainage facilities that can effectively reduce future flood damages within the region. This plan is separate from, and does not include, the Flood Project. The draft Plan serves as general guidance for the local governments as watershed- and project-specific master plans are developed. It also provides planning-level cost estimates for recommended flood and drainage facilities.

5.7.6 Flood Plain Storage Outside the Truckee River Watershed

Flood plain storage mitigation outside the Truckee River watershed is addressed by the following policy:

Policy 3.1.c: Flood Plain Storage outside of the Truckee River Watershed

> *As appropriate, the local flood management staff will work with proposed project applicants or proposed land use applicants to identify the best approach to mitigate the impacts of changes to 100-year flood peaks and flood plain storage volume that are a result of proposed land use changes or proposed projects.*

Criteria to implement policy: The local flood management staff shall evaluate impacts using qualitative or quantitative analysis according to applicable local codes and ordinances. A more in-depth analysis will be required when significant impacts must be mitigated. Local flood management staff will develop guidelines for evaluation and mitigation of impacts in specific closed basins. In multi-jurisdictional basins such guidelines will be developed with the concurrence of all responsible agencies.

5.8 Flood Control and Drainage Overview by Hydrographic Basin

This section provides overviews of potential flood control and drainage issues relative to the Truckee Meadows Service Areas ("TMSA") in hydrographic basins outside of the Truckee Meadows. Two comprehensive reports, one prepared for Sparks (Stantec, 2008) and the other for Reno and Washoe County (ECO:LOGIC, 2007), provide more detail on certain areas. Some of the following sections summarize information presented in the two reports referenced above, while others rely on other information sources or describe recently completed or ongoing work.

5.8.1 Spanish Springs Valley Hydrographic Basin

A basin-wide master plan and hydrologic / hydraulic model has been developed for Spanish Springs. When new projects are proposed within the Sparks Sphere of Influence area, project proponents must demonstrate that proposed new facilities are adequate both for existing and build-out conditions. The Regional Hydrologic Model will greatly improve the ability to monitor watershed impacts due to land use change and develop appropriate design criteria for development.

Key components of the master-planned facilities are planned for construction within the unincorporated area. Construction of these facilities is critical to ensure that the capacity of the Spanish Springs Detention Facility in Sparks is not exceeded during flood events.

A funding mechanism for flood control facilities in the unincorporated area is essential. Proposals for new development in the unincorporated area need to be evaluated from a regional perspective to ensure that the effects of increased runoff are manageable within existing facility constraints downstream. The tools used for evaluation should be agreeable to both Washoe County and Sparks.

The North Spanish Springs Flood Control Project was completed by Washoe County in 2007 to capture storm water from the Griffith Canyon area and safely convey flows to an 80-acre basin where the water is metered out at a manageable rate so as not to overwhelm the North Truckee Drain or other downstream storm water conveyance systems. The project was designed and constructed to accommodate storm water flows generated from events up to a 100-year, 24-hour event. Project infrastructure consists of channels, settling basins and a concrete dam.

In 2002, 2005 and 2013, severe thunderstorm events caused significant flooding along the east and/or west foothill areas of Spanish Springs Valley. In the unincorporated area of west Spanish Springs, residential structures and property, Spanish Springs High School, private drainage systems owned and maintained by homeowner associations, and public roadways and drainage systems were significantly affected by large quantities of sediment-laden runoff. Culverts and ditches at many locations were either overtopped due to excessive flow or the capacity was compromised due to sediment clogging. Roadways located at the lowest point of the watershed were flooded to depths of up to three feet.

A 2008 hydrologic study of the area prepared for Washoe County by Gray and Associates identified a suite of proposed drainage improvements ranging from sediment and detention basin upgrades located along the west boundary of the residential subdivisions both north and south of Eagle Canyon Boulevard and culvert upgrades at several road crossings. The analysis assumes a 100-year design storm; however, the final analysis will determine the appropriate design storm to optimize the cost versus benefit of the project.

5.8.2 Truckee Canyon Hydrographic Basin (Verdi)

A comprehensive flood control master plan for this hydrographic basin has not been developed. Significant changes to land use would require the development of such a plan and an evaluation of the possible impacts to the Truckee River flood plain in the Truckee Meadows. The *Somersett Development Storm Drainage Master Plan*, prepared in 2004 for Reno by Manhard Consulting, is being implemented as development progresses. The Regional Hydrologic Model will greatly improve the ability to monitor watershed impacts due to land use change, support the development of flood control master plans, and develop appropriate design criteria for development.

5.8.3 Lemmon Valley Hydrographic Basins

Lemmon Valley consists of two topographically closed hydrographic basins. Runoff in the West Lemmon Valley basin drains to the Silver Lake playa and the Swan Lake playa receives drainage from the East Lemmon Valley basin. Playas have no outlet; therefore, runoff that drains to these lakes must either infiltrate or evaporate. Hydrologic studies have been prepared for the Silver Lake and Swan Lake drainage basins. A drainage master plan for Stead, Nevada (Stantec Consulting, 2002) has been prepared for Reno to provide a comprehensive drainage document specifically for the Lemmon Valley hydrographic basin to identify present condition flooding and problem areas so that capital flood improvements could be scheduled.

In 2007, Quad Knopf Consulting Engineers prepared a report for Reno entitled *North Valleys Flood Control Hydrologic Analysis and Mitigation Options*. The purpose of the report was to evaluate the impact of development in the Silver Lake and Swan Lake watersheds since 1987, and the effect of updated precipitation data on the projected water surface elevations in these

playa lakes. The existing computed water surface elevation in the Swan Lake basin is below the existing FEMA 100-year base flood elevation ("BFE"); however, existing conditions in the Silver Lake basin are reported to be approximately three feet above the existing BFE. The study recommends as the preferred mitigation option, the submittal of an application for a Letter of Map Revision ("LOMR") to raise the FEMA BFE in Silver Lake to reflect current conditions. lThe application for a LOMR was approved by FEMA in July 2009.

The Marlin Channel (located in Golden Valley, an east Lemmon Valley sub-basin) and Lemmon Drive Channel ("Lemmon Channel") have a history of flooding during significant flood events, most recently in December 2005. Drainage from the Marlin Channel combines with runoff from other tributary areas and flows to the Lemmon Channel. The total contributory watershed to the Lemmon Channel is estimated at 10.9 square miles, which is about 25 percent of the approximately 40 square mile total watershed draining to Swan Lake. The *Marlin and Lemmon Channels, Flood Plain Analysis and Improvement Alternatives* report, prepared for Washoe County in 2010 by Manhard Consulting, Ltd., concluded that a flood detention project on the Marlin Channel would provide significant flood hazard risk reduction for a small number of properties, however, the cost of a complete solution for the Lemmon Channel would likely outweigh the avoided damages. Further flood control planning is not anticipated unless there are significant changes to approved land uses.

5.8.4 Pleasant Valley Basin

Alternatives to address flood problems at the Toll Road – Bailey Creek crossing were developed for Washoe County by Wood Rogers (2007). Sediment basins, channel improvements and a conveyance channel are among the recommended alternatives. The Regional Transportation Commission has plans to realign the South Virginia Street – Highway 341 intersection that will include flood control improvements.

5.8.5 Warm Springs Valley Hydrographic Basin

The Spring Mountain planned unit development was added to the TMSA in 2006 and the Spring Mountain east development area is located in the Warm Springs basin. The development handbook on file with the City of Reno states that Spring Mountain will be responsible for flood management facilities, which will be designed and maintained in accordance with applicable ordinances and regulations in effect at the time of permit application. The Sage and Warm Springs portions of the TMSA are also in the Warm Springs basin. Washoe County's Warm Springs Specific Plan includes a development standards framework covering drainage and large lot flood protection. Flood control requirements for the Specific Plan Area will be incorporated into project development plans. When single-family homes are constructed on large lots, consideration should be given to the potential of flood hazards that may not have been mapped by FEMA. Otherwise, the limited development potential within this hydrographic basin, but outside the TMSA, minimizes flood control issues.

5.8.6 Sun Valley Hydrographic Basin

A storm water master plan was completed for Sun Valley in the late 1990s that includes the identification of drainage improvements required to route flows from a 10-year recurrence interval storm event, and an evaluation of the possible impacts to the Wildcreek Golf Course dam that could result from a 100-year, 6-hour storm event. Further flood control planning is not

anticipated to be required in this hydrographic basin unless there are significant changes to approved land uses.

5.8.7 Washoe Valley Hydrographic Basin

There are a number of flood hazards within this hydrographic basin, including alluvial fan flooding, lake flooding during wet years, and riverine flooding of creeks and landslides. A comprehensive flood control master plan for this hydrographic basin has not been developed; however, an east Washoe Valley flood control master plan has been developed by Washoe County. To date, funding has not been available to implement the plan recommendations.

5.8.8 Antelope Valley Hydrographic Basin

The limited development potential of this hydrographic basin has not justified significant planning for flood control. An analysis of the potential for flood hazards that might not have been mapped by FEMA should be performed when projects for development are proposed.

5.8.9 Bedell Flat Hydrographic Basin

The limited development potential of this hydrographic basin has not justified significant planning for flood control. An analysis of the potential for flood hazards that might not have been mapped by FEMA should be performed when projects for development are proposed.

5.8.10 Dry Valley Hydrographic Basin

The Spring Mountain planned unit development was added to the TMSA in 2006 and the Spring Mountain west and central development areas are located in the Dry Valley basin. The development handbook on file with the City of Reno states that Spring Mountain will be responsible for flood management facilities, which will be designed and maintained in accordance with applicable ordinances and regulations in effect at the time of permit application. Otherwise, the limited development potential of this hydrographic basin has not justified significant planning for flood control. An analysis of the potential for flood hazards that might not have been mapped by FEMA should be performed when projects for development are proposed.

5.8.11 Red Rock Valley Hydrographic Basin

The limited development potential of this hydrographic basin has not justified significant planning for flood control. An analysis of the potential for flood hazards that might not have been mapped by FEMA should be performed when additional projects for development are proposed.

5.8.12 Cold Springs Valley Hydrographic Basin

Cold Springs Valley is a topographically closed basin. Imported water and precipitation that falls within the basin generally stays within the basin. Hydrologic studies have been prepared for the White Lake drainage basin. Future changes to flood peaks and flood plain storage volume will need to be evaluated to ensure that the effects of increased volumes of runoff are manageable. A Letter of Map Revision for White Lake effective August 11, 2010 establishes a 100-year water

surface elevation. In addition, Reno has identified a future condition flood advisory area for the White Lake Playa, available on www.reno.gov.

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