Chapter 4

Background on Flood Control / Storm Drainage

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Purpose and Scope

In developing the flood element of the Regional Water Plan, background concerning flood control and drainage policies and facilities as they exist today provides a resource from which to make future decisions for this element of the plan. Additionally, this chapter suggests options for developing performance standards concerning flood control and drainage for future consideration in the planning process. Other options beyond these may be developed for acceptance by local jurisdictions.

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 storm water and flood drainage conveyance system, whether planned or not.

In general, storm water drainage means conveyance of flows during storm events that do not cause streams and rivers to overflow their banks or the design capacity of storm drain facilities to be exceeded. Flooding occurs when streams or rivers overflow their banks or flows exceed storm drain capacities causing floodwater to inundate nearby land.

The region encourages coordination among local government agencies in implementing a strong flood plain management program that will minimize future flood risks to people and property.

The purpose and goals of flood control in the Region focus on the following:

- Reduction of flood damages and losses to businesses, residents and the general economy of the region
- An updated flood warning system and especially a completed emergency response plan for flooding events that is adopted by the region and administered through the regional Emergency Operations Center (EOC)
- River restoration for multiple benefits
- A mechanism to fund the capital cost of flood protection and the operation and maintenance of flood protection facilities
- Development of consistent flood plain regulations across the region
- Consistent building regulations for flood plain properties
- Identification and adoption of a flood plain management plan that identifies policies to be adopted and actions needed to be taken to reduce flood damages in the region before a disastrous flood hits again. This would include land use design policies and control of runoff rates and runoff volumes.
- Consistent drainage design standards for controlling runoff rates and volumes
- Consistent drainage design and best management practices to deal with water quality monitoring and treatment of storm water runoff. This is especially important for the more frequent events that only flush the contaminants off the impervious surfaces but do not provide larger flows to dilute these contaminants, such as a 50-year or 100-year flood project design scenario (see Chapter 5).
- Consistent retention standards that help recharge groundwater, and reduce runoff (example: Low Impact Development standards currently being developed)

The Regional Water Planning Commission (RWPC) and other groups have made substantial progress in completing a number of documents related to flood control and storm water management, but more remain. For additional background on flood control and storm drainage, the reader is referred to this list of the completed studies:

- Draft Hydrologic Criteria and Drainage Design Manual (Washoe County, 1996)
- Flood Plain Management Strategy (RWPC, 2003)
- Flood Storage Volume Mitigation for Zones 1 & 2 (Nimbus and MIG, 2004)
- Truckee Meadows Construction Site Best Management Practices for Storm Water Management (Kennedy/Jenks, 2003)
- Truckee Meadows Storm Water Quality Management Program (Kennedy/Jenks, 2001)
- Truckee Meadows Structural Controls Design Manual – Guidance on Source and Treatment Controls for Storm Water Quality Management (Kennedy/Jenks, 2004)

Remaining studies: (list may be incomplete as new information becomes available)

- Hydrologic Criteria and Drainage Design Manual Update (WRC Nevada, in progress)
- Flood Storage Volume Mitigation for Zones 3 & 4 (Nimbus and MIG, in progress)
- Storm Water Mitigation Criteria
- Regional Flood Control Master Plan (WRC Nevada, in progress)
- Flood Storage Mitigation Plans for closed basins
- Flood Storage Volume Mitigation Financial Impact and Financing Plan
- Low Impact Development Manual

Summary of Findings

- Damageable property in the Truckee Meadows flood plain consists of commercial, industrial, residential, and public buildings valued at about $5 billion.
- There were more than $600 million in physical damages and economic impacts as a result of the 1997 Truckee River flood.
- Incorporation of hydrologic data since the mid-1980s has resulted in estimated peak flow for specific frequency events higher then originally thought. The 1 in 100 year event at Reno is now estimated to be 20,700 cubic feet per second (cfs). Peak flows for certain frequency events are shown in Table 4-1.

Table 4-1
Estimated Peak Flows – Truckee River at Reno

Exceedance (Chance of Occurrence in any 1 Year)	Peak Flow (cfs)
1/20	9,200
1/50	14,800
1/100	20,700
1/500	63,000

Source: US Army Corps of Engineers

- Riverine flooding and alluvial fan flooding are common in Nevada. Riverine flooding occurs when flows in rivers and streams rise over a period of hours or days and overtop stream banks inundating nearby low-lying areas. Alluvial fan flooding occurs when floodwaters emerge from canyon mouths, typically with little or no warning, and travel downstream at very high velocities carrying significant loads of sediment and debris.
- In the 1985 feasibility report for the Truckee River Flood Control Project, the estimated discharge for the 1 in 100 year event at Reno was computed at approximately 18,500 cfs. This flow has been used by the Federal Emergency Management Agency (FEMA) to identify areas subject to flooding for flood insurance purposes.
- The base flood 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. 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.
- Information prepared for the RWPC (WRC Nevada, 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 river could result in an increase of 0.4 to 0.6 feet in the base flood elevation.
- Information prepared by participants in the Truckee River Flood Management 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. Other properties throughout the region may also be subject to additional damages.
- Recently built homes and businesses were constructed in compliance with current ordinances requiring the first floor to be elevated either one or two feet above the existing FEMA base flood elevation. Structures constructed prior to current ordinances may have been elevated to a lesser extent or not at all.
- The Community Coalition, comprised of a diverse community membership, came together in April 2000 to develop flood management alternatives for Reno, Sparks and neighboring residents on the Truckee River, embracing the concept of a "Living River": a valuable resource to the community and a natural system with beneficial functions through restoration and preservation.
- Broad community support is essential to implement flood control and storm drainage plans and projects that seek to minimize flood damages.

4.1 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 way of depicting flood damages and assessing the effectiveness of flood protection alternatives. However, floods have many other disturbing, non-monetary effects. Among these are effects on public health and safety, damages from toxic and hazardous waste contamination, and loss of environmental resources in the flood plain. Following are brief descriptions of potential monetary and non-monetary consequences of flooding in the Truckee Meadows area.

Public Health and Safety

Approximately 30,700 people in the Region reside within the FEMA 100-year flood zone. The population within the FEMA 100-year flood zone delineated for the Truckee River, Steamboat

Creek, North Truckee Drain, Whites Creek and Thomas Creek is approximately 22,000. The effect of levee failure and resultant flooding on human life would depend on the flood magnitude, population at risk, flood warning time and evacuation routes. In addition to loss of life, major flooding could result in life-threatening injury and spread of some communicable diseases. Evacuating the flood plain in anticipation of a major flood could result in traffic accidents and other injuries associated with the rapid displacement of up to 22,000 people. In addition, there is the potential for loss of life and property damage associated with flooding on alluvial fans.

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. Also, rebuilding or relocating homes, businesses, and related infrastructure would require additional natural and financial resources.

Property and Businesses

Damageable property in the Truckee Meadows flood plain consists of commercial, industrial, residential, and public buildings valued at about $5 billion. Additional effects on the day-to-day business of the Reno-Sparks metropolitan area would be significant. Many businesses would be forced to close, at least temporarily, during flooding and clean up afterward, resulting in lost revenues and wages.

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 improvements such as roads, utilities and bridges, and cleanup costs. Additional costs are incurred during flood emergencies for evacuation and reoccupation, 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 are estimated at $32 million for existing development conditions in 2004.

4.1.1 Issues for Consideration

The following items are suggested areas of investigation that could be undertaken to further delineate flood control and storm drainage issues:

- Continue work to update and develop a Flood Control Master Plan for the Region. Coordination for consistency of flood plain management, drainage design, and other storm water and flood control management. Consideration of various governance structures to implement this would need to be developed through cooperative negotiations between Reno, Sparks and Washoe County.

- A study to determine the costs and impacts of flood storage volume mitigation and other flood related impacts and costs, analysis of the same, and an assessment for meeting those costs including some form of administration
- Regionally coordinated flood warning system with a regionally coordinated flood emergency response plan with regular exercising, evaluating, and improving of the response plan
- Development of funding mechanisms that allows local entity control over flood projects and storm water management in their jurisdiction. This element would be developed through negotiations between Reno, Sparks and Washoe County. Consideration of various governance structures to implement this would likewise be investigated.
- Consistent local flood plain management regulations for compliance with the National Flood Insurance Program (NFIP)
- Participation in the Community Rating System to lower flood insurance premiums through implementation of flood damage reduction strategies such as:
    - Regional flood plain management plan
    - Aid in "smart growth" planning and proactive measures for flood protection
    - Maintain existing flood protection
    - No Adverse Impact to existing development from new development
    - Identify areas to keep open for natural flood storage
    - Identify multiple flood incident areas that need a solution – Structural / Non-Structural relocation
- Recognize the ongoing flood plain management/flood control project planning activities of the communities and encourage continuation of the current level of effort.
- Ensure coordination of local projects with regional objectives, the entities in charge should be required to present major flood plain management / flood control project planning activities for review and adoption by the RWPC.
- The water conservation proposal to capture storm water onsite through change in drainage design and standards should be supported, and changes should be implemented if feasible.

4.2 Flood Types

Flood hazards in Nevada are typically underestimated due to the arid climate, few perennial streams, and low precipitation. Lack of data and a sparse stream-gaging network also contribute to underestimation of flood hazards as noted in the Summary of Findings. There are different types of flood hazards in Washoe County that require unique management strategies. Truckee River flooding has been of primary concern to the Reno/Sparks metropolitan area for decades. The most recent and costly event occurred in 1997. Also of concern are flooding on Truckee River tributaries, alluvial fan flooding, sheet flooding, flash flooding and lake/playa flooding.

Riverine flooding and alluvial fan flooding are common in Nevada. Riverine flooding occurs when water levels in rivers and streams rise and discharge volumes increase over a period of hours or days. Floodwaters overtop the stream banks and inundate nearby low-lying areas. In 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 alluvial fan flooding. 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.

A flash flood is the fastest-moving type of flood. It happens when heavy rain collects in a stream or gully, turning the normally calm area into an instant rushing current. The quick change from calm to raging river is what catches people off-guard, making flash floods very dangerous. Flash flood waters move at very fast speeds. They have the power to move boulders, tear out trees, destroy buildings, and obliterate bridges. Flash flooding on streams emerging from steep canyons in the mountains is another significant flood hazard in Nevada. This term can be used to describe most alluvial fan floods in the Region. Alluvial fan floods are a type of flash flood, but flash floods can occur in areas other than alluvial fans.

Any flood involves water rising and overflowing its normal path. But a flash flood is a specific type of flood that appears and moves quickly across the land, with little warning that it's coming. Flash floods are very unpredictable, and can cause flooding at a significant distance from the precipitation source. Many things can cause a flash flood. Generally they are the result of high intensity rainfall concentrated over one area.

Playa flooding occurs when flows drain into a closed basin. Since there is no outlet, the flows into the playa cause water levels to rise. The water levels don't recede after the rain event like in other flood types. Water only recedes as water leaves the playa through infiltration into the ground and/or evaporation. Therefore playa flooding can happen without a rainfall event happening at the same time. Drainage from any runoff producing storm, or other source of water draining into the playa, fills the basin and continues raising water levels until there is enough infiltration and/or evaporation to reduce the amount of water in the playa, or the drainage stops, and therefore lowers the water level.

Lake flooding is the same as the playa flooding description just mentioned if the lake doesn't have an outlet. Lakes with outlets also flood when the volume of water entering it is greater than the amount of water leaving the lake. This causes the water level to rise. This rise continues until the water is high enough to cause the outlet to release more water than what is coming into the lake.

Rapid population growth is contributing to flood impacts. As more land is developed in river basins, flood plains, lakeshores, playas and alluvial fans, a greater percentage of the population

is exposed to increased flood risk. The severity of flooding and cost of flood recovery will increase, pointing to a need for flood plain management in the region.

4.3 Flood History and Regional Setting

The Truckee Meadows area has a long history of floods. Melting snow, cloudbursts, and heavy general rains have all been causes of floods in the Region. Rain-caused floods, normally occurring from October through March and characterized by high peak flows and short duration, 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. Since about 1960, 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, numerous flash floods take place throughout the state annually.

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 $600 million if indirect damages such as lost revenue, wages, and sales taxes are included.

4.3.1 History of Flooding in the Region

Records of historic flood events in western Nevada begin with 1861 in which the entire Truckee Meadows became a vast lake. Early accounts indicate that flooding or periods of high water occurred during December 1861, January and February 1862, December 1867, January 1886, and May 1890. According to the flood chronology of the Truckee River basin compiled by Victor Goodwin of the US Forest Service in 1977, there had been five major flood events prior to this document. These include the 1861 - 1862, 1867-1868, 1907, 1950 and 1955 events. Recent large flood events have occurred in 1963, 1986 and 1997. A number of lesser magnitude floods have occurred in 1871, 1886, 1890, 1904, 1909, 1914, 1928, 1937, 1942, 1943 and 1964. Goodwin reported that the majority of the flood events covering the time span from 1890 to 1943, except for the few major floods, all were about equal “intensity and resultant damages”.

The Truckee River bank-full discharge was historically less than the existing channel conveyance capacity. Channel forming discharges on the order of 4,000 cfs to 6,000 cfs created over bank flows in the Truckee Meadows area. According to Goodwin, flows higher than 5,000 cfs took out one bridge in 1890 and covered 4,000 acres of cropland in the Meadows. The 1907 peak discharge was on the order of 14,600 cfs. The Meadows flooded in 1928 with a peak discharge of 10,000 cfs. The 1937 flood peak discharge was about 15,000 cfs according to the River Water Master as related by Goodwin. In 1943, 11,000 cfs flooded the Truckee Meadows. The Truckee River channel through the upper reach of the Meadows now has a minimum conveyance capacity of about 14,000 cfs following the dredging of the channel by the US Army Corps of Engineers (Corps) in 1964.

The Truckee Meadows area experiences two types of major flooding, warm winter storms in which rain on snow is widespread throughout the watershed, and local convective thunderstorms that will generally produce isolated sub watershed flooding in the summer months. The winter floods are of long duration and large volumes. The inundation of the Truckee Meadows to the east of Reno would last days or even weeks. High snow packs can also produce protracted spring runoff flooding as in the April 20 - May 13, 1890 flood. The 100-

year return period flood event has been based on winter rain on snow events.

4.3.2 The Flood of January 1, 1997

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, 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 5 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 through the night and the flood stage ultimately crested in Reno at 1:30 a.m. on January 1, 1997. After the flood, the Corps estimated that a 100-year flood event would result in flood flows of 21,000 cfs. The locally accepted peak discharge estimate for January 1, 1997 was approximately 22,000 cfs.

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 the cities of Reno and Sparks. Over bank flooding in the Sparks area started at discharges as low as 11,000 cfs, resulting in significant flooding in the Sparks industrial area. Flooding also inundated and closed the Reno -Tahoe International Airport. Figure 4-1 shows the total area inundated relative to the FEMA 100 year flood zone. Estimates, by the Corps, of damage caused by the 1997 flood were reputed to be in the amount of $450 million. This figure only includes damages recognized by the Corps that can be used to justify federal expenditures on a flood control project. Local damage estimates exceed $600 million. Most of the damage was incurred by inundation.

Historically, the greatest flood damages in Washoe County 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 the effort to implement measures to reduce the impact of flooding on the community. A strong interest in evaluating options that would also enhance the Truckee River as a community asset, with restoration of the natural flooding functions of both the river and portions of its historical flood plain evolved.

4.3.3 Alluvial Fan Flooding in the Region

Alluvial fan and flash flooding, while not as present in the community's recent memory, has 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 in 1997. In some cases, development is progressing on alluvial fans without the benefit of upstream protective measures.

Most recently, alluvial fan flooding occurred during June of 2002 in the Desert Springs area of Spanish Springs Valley where a localized thunderstorm caused a significant amount of sediment to be eroded from Hungry Ridge, immediately west of the developed area, and

deposited in a new subdivision. Water and sediment also caused about $500,000 in damage to the new and not yet opened Spanish Springs High School. Sediment deposition filled detention ponds above the Eagle Canyon subdivision on the west side of Spanish Springs Valley, 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 over the berm 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. Sediment had to be cleaned from storm sewers, drainage structures and channels, streets, and many lawns in the weeks after the storm.

4.4 Storm Water Management Planning

The RWPC released a request for proposals in mid-2002 for Storm Water Management Planning. Storm water management planning was a high priority for the RWPC in fiscal year 2002. They identified several issues related to storm water management in the Region, including impacts of current and future development on volume and timing of storm water runoff, increased sediment loads, reduced recharge, inconsistencies in storm drainage design criteria among the communities, and financing storm water management projects to correct drainage deficiencies in existing developments.

Projects to date have included a concept level Flood Control Master Plan (Kennedy/Jenks/Chilton, 1991) and a Draft Hydrologic Criteria and Drainage Design Manual (Washoe County, 1996). WRC Nevada, Inc. was awarded a contract as a result of the above-mentioned request for proposals to develop a final Hydrologic Criteria and Drainage Design Manual and an updated Flood Control Master Plan. Additional projects include the Southern Washoe County Groundwater Recharge Analysis (Kennedy/Jenks, 2001), the Truckee Meadows Regional Storm Water Quality Management Program (Kennedy/Jenks, 2001) and the Truckee Meadows Structural Controls Design Manual – Guidance on Source and Treatment Controls for Storm Water Quality Management (Kennedy/Jenks, 2004).

In addition, the South Truckee Meadows Facility Plan (ECO:LOGIC, 2001) Technical Memorandum No. 6, Flood Detention Ponds and Effect on Flows in Thomas Creek, identifies the impacts of peak flow analysis versus volume management.

Currently, storm water drainage design in most of the region is done on a subdivision-by-subdivision basis, with little consideration for regional drainage needs. As mentioned above, the RWPC is in the process of updating the Hydrologic Criteria and Drainage Design Manual for the Region that addresses the issues outlined above. The expected outcome of this effort would be a set of consistent guidelines for the planning, design and construction of storm water drainage facilities that the RWPC will, upon review and adoption, recommend that Washoe County and the Cities adopt.

4.5 Flood Plain Management and Regional Flood Control Master Plan

4.5.1 Flood Plain Management

Flood plain management 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. The National Flood Insurance Program (NFIP) establishes minimum requirements for flood plain management that communities must implement in order to be eligible for flood insurance. The NFIP, discussed further in Section 4.6.5, establishes criteria for construction in Special Flood Hazard Areas. This is only one aspect of flood plain management. Flood plain management also includes the pro-active management of watersheds to reduce existing and future potential flood hazards.

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, levees 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. Washoe County is currently implementing a Regional Flood Control Master Plan, which will also incorporate structural flood control measures, along with other measures.

Non-structural approaches to flood plain management have been gaining adherents as our recognition of the limitations of flood control has increased. 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 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 the infrastructure
- 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.

The RWPC has developed a regional Flood Plain Management Strategy (RWPC, 2003) that serves as the first step towards a comprehensive regional flood plain management program.

4.5.2 Regional Flood Control Master Plan

A Draft Flood Control Master Plan was completed for the Region (Kennedy/Jenks/Chilton, 1991). The RWPC has retained WRC Nevada to update this plan. The purpose of the Regional Flood Control Master Plan is to re-evaluate current and future flood risks, and develop potential flood damage reduction measures. It will include cost estimates and a proposed implementation plan that can serve as a guide for future development.

This policy reflects the desires of the RWPC:

> ***Policy 3.1.a: Regional Flood Plain Management Plan and Regional Flood Control Master Plan***
>
> *The RWPC will, after its review and approval of the Regional Flood Plain Management Plan and Regional Flood Control Master Plan, recommend that local governments adopt and implement those plans.*

4.5.3 Flood Plain Storage Mitigation

Flood plain storage is a critical component of flood protection. Many properties that were built in compliance with FEMA standards for the NFIP may be at risk because of loss of flood plain storage. The 1997 flood caused over $600 million in flood damages. The community is proposing to implement a $260 million flood damage reduction project (Truckee River Flood Management Project). The flood plain storage volume mitigation program seeks to ensure that the Truckee River Flood Management Project remains feasible and to minimize flood impacts in the future.

The fiscal analysis for flood storage volume mitigation remains a very high priority for the Region. The RWPC recommends a cooperative effort with local governments to fund this study to help local governments determine if fees are necessary, how many dollars are needed to implement a program, and how fees might be equitably applied.

> ***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 the Regional Flood Plain Management Plan and the Regional Flood Control Master Plan, the local flood management staff[1], using the best technical information available, will work with a proposed project applicant or a proposed land use change applicant to determine the appropriate level of analysis required*

[1]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.

*in order to evaluate and mitigate the impacts to 100-year flood peaks and flood plain storage volumes. On an annual basis, all three local flood management agencies shall jointly agree on and adopt the "best technical information" available for use in implementation of the Regional Water Plan policies relating to flooding. The local flood management staff would be responsible for coordinating with the other appropriate local government agencies. (*Related criteria are located in Chapter 1.)

The local governments have the responsibility to work together to quantify the impacts of development and land use changes on the Truckee River Flood Management Project. The regional flood plain storage mitigation program intends to discourage small on-site mitigation facilities in favor of connected regional projects or facilities which have been planned and designed to work with natural systems / watershed protection. Local governments also have the responsibility to work together to plan and implement these connected regional flood plain storage mitigation projects.

The RWPC is working with local governments to take the following action steps:

- Develop flood plain storage mitigation options or plans to ensure that an undue burden is not placed on property owners.
- Work in a cooperative manner to implement the Truckee River Flood Management Project, the Regional Flood Plain Management Strategy (RWPC, 2003), and the Regional Flood Control Master Plan (WRC Nevada, in progress). Special attention shall be given to land acquisition and early implementation of the Truckee River Flood Management project elements which are critical to the preservation of flood storage and/or the feasibility of any of the project alternatives.
- Jointly develop and formally adopt the best available technical data on the hydrology and hydraulics of flooding as used by the Truckee River Flood Management Project (being developed in coordination with the Corps). Another of the region's highest priorities is to immediately complete the hydraulic and hydrologic modeling tools needed to quantify cumulative flooding impacts in the watershed.
- Use best efforts and good faith to jointly develop and present to the RWPC within six months a Regional Flood Plain Storage Mitigation Plan that will be incorporated into the Regional Flood Control Master Plan for its implementation. This will facilitate the ability of property owners to develop their properties and/or participate in regional solutions for mitigation of increased volume of runoff or loss of flood plain storage volume if appropriate. The Regional Flood Plain Storage Mitigation Plan will also provide a mechanism for monitoring and enforcing this element of the Regional Flood Control Master Plan.
- Provide background information and public outreach to ensure support from the community and from elected officials for the region's interconnected flood policies and projects.

The Regional Flood Plain Storage Mitigation Plan, which will become an element of the Regional Flood Control Master Plan, will address the following:

- Ensure that current flood impacts and flood conditions are "locked into place". The plan is designed to minimize current flood impacts to existing residents and businesses and also to prevent flood impacts from getting worse over time.
- Properties in Zone 1, as described in Chapter 1, Policy 3.1.b, will be under the most

stringent development constraints because they are in the most critical flood plain storage volume areas. (See Figure 1-2.)

- Properties in Zone 2, as described in Policy 3.1.b, are in a unique situation: displacement of flood plain storage may cause increased flood impacts to nearby properties under current conditions. Once the Truckee River Flood Management Project is implemented, the flood plain storage volume associated with these properties will no longer need to be maintained.
- Properties in Zone 3, as described in Policy 3.1.b, are important areas in terms of flood conveyance under current conditions. Once the Truckee River Flood Management Project is implemented the flood plain storage volume associated with those properties in Zone 3 will no longer need to be maintained. However, current conditions of water volume and peak discharge must be maintained after the project is implemented or the local interior drainage must be designed for future conditions.
- Properties in Zone 4, as described in Policy 3.1.b, may impact the hydrology of the Truckee River Flood Management Project if there is a significant change to the timing, duration or volume of runoff from the property.
- Larger projects will be expected to provide a higher level of analysis and may be required to contribute to the regional solution that provides mitigation for the loss of flood plain storage volume.
- Smaller projects will not be expected to provide undue levels of analysis, but may also be expected to contribute to the regional solution that provides mitigation for the loss of flood plain storage volume.
- Where appropriate, maximize the opportunity to receive credits under FEMA's Community Rating System for protection of properties, which may result in flood insurance premium price reductions under the NFIP.
- Mitigation options will be identified which may include any or all of the following:
    - Local government purchase of existing excess storage volume to be reserved for offsetting the impacts caused by developments
    - Local government implementation of storage mitigation projects to be reserved for offsetting the impacts caused by developments
    - Private developer creation of storage mitigation projects to mitigate the impacts caused by larger developments and/or to sell additional storage for offsetting the impacts caused by developments
    - Creation of a framework to allow local governments to buy and sell storage to offset impacts caused by developments
    - Generally, mitigation should be provided in an area hydrologically or hydraulically connected to the project requiring mitigation in a way that will not increase flood levels by any amount.
    - Early implementation of flood project elements is an option for providing mitigation

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 the proposed project applicant or proposed land use applicant 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.

(Related criteria are located in Chapter 1.)

4.6 Legislation and Programs to Address Flood Issues

4.6.1 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 management 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 National Flood Insurance Program.

4.6.2 Disaster Relief Bill

During the 1997 legislative session, the Disaster Relief Bill (Senate Bill 218, now NRS 353.2735) was passed, which 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.

4.6.3 Clark County Regional Flood Control District

Provisions for formation of flood control districts are described in NRS 543. The Clark County Regional Flood Control District was formed under this statute in 1985. It is the only such district in the state. The District is comprised of the county and the five incorporated cities within the county and was created to manage flooding hazards through land use controls, and to fund and coordinate construction and maintenance of flood control structures. Flood control projects are funded by a one-quarter of one percent sales tax. The District has also implemented a comprehensive flood plain management program that includes flood hazard mitigation and mapping. NRS 543 also gives criteria for the formation of flood control districts in counties with population greater than 100,000 and less than 400,000.

4.6.4 Flood Hazard Reduction Ordinances

Washoe County and the Cities of Reno and Sparks have been participants in the National Flood Insurance Program since the mid 1970s. Each jurisdiction has adopted Flood Hazard Reduction Ordinances that establish guidelines and requirements for the development of property within areas determined to be subject to flood damage. 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 the 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.

4.6.5 National Flood Insurance Program (NFIP)

Each jurisdiction has adopted Flood Hazard Reduction Ordinances that establish guidelines and requirements for the development of property within areas determined to be subject to flood

damage. Local communities and counties are responsible for developing and implementing ordinances for management of areas in their communities, which are prone to flooding.

A key component of flood plain management is implementation of the National Flood Insurance Program (NFIP) at the local level. The US Congress established the NFIP 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 federally-subsidized flood insurance.

In Nevada, 15 counties and 13 communities currently participate in this program. Participation allows property owners to purchase federally subsidized flood insurance. The program provides Flood Insurance Studies (FIS) and Flood Insurance Rate Maps (FIRMs) prepared by the FEMA for participating communities. A FIRM designates Special Flood Hazard Areas (SFHAs) within a community that is subject to a "100-year" flood, which means flooding that has a one-percent chance of being equaled or exceeded in any given year.

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. Washoe and Clark Counties have adopted ordinances, which go above the minimum NFIP standard. 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.

Following completion of the first detailed flood hazard studies (circa 1981-83) in southern Washoe County, the communities were required to adopt flood hazard regulation ordinances that complied with the federal requirements necessary for participation in the NFIP. Prior to the communities' participating in the NFIP, development within the 100-year flood plain was not regulated to prevent flood damage. The only requirements adopted by the communities were setbacks from the stream bank (riverbank) and construction of storm drains to contain and convey away from properties storm waters from much lower frequency events (5- to 10-year events).

Detailed scientific and engineering studies are performed by the FEMA 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. These new studies or restudies are used to revise the 1984 maps. Some of the current FEMA maps were updated through September 1994. Others, like most of the areas along the Truckee River, have not been changed since the original mapping was done. Finally, a small number were updated in 2001. The Public Works Departments of the City of Reno and the City of Sparks, and the Community Development Department of Washoe County, maintain on file the current FIRMs for the communities.

4.6.6 Federal Emergency Management Agency (FEMA)

Initially, the Federal Emergency Management Agency (FEMA) places the communities in an emergency program. The communities stay in the emergency program until FEMA completes detailed studies of the areas identified by the communities as being subject to known flooding. During the emergency phase of the program, the communities advise property owners of the potential for flooding and the need to protect their properties but do not have ordinances that require specific building requirements.

4.6.7 FEMA – Project Impact

Project Impact is FEMA's program for developing disaster resistant communities. This program was initiated in 1998, with the City of Sparks 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, which 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.

4.6.8 US Army Corps of Engineers

The US Army Corps of Engineers (Corps) offers both emergency and long-term services for pre- and post-disaster mitigation and response. They perform general investigation studies for flood control, and provide flood plain management planning services, in addition to their role in design and construction of flood retention structures. The Corps has recently proposed a new 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.

4.6.9 Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) provides services related to measuring and reducing flood hazards and emergency response following a flood event. They conduct 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.

4.6.10 Western Governors' Association

The Western Governors' Association (WGA) adopted a policy resolution on Flood Mitigation and Recovery Issues in December 1997. The task force organized by WGA concluded that flood planning and flood plain management are essential elements in reducing flood risk. The task force developed An Action Plan for Reducing Flood Risk in the West (WGA, 1997). The action plan developed by the task force contains 21 recommendations for improving flood plain management and coordination and communication of flood issues.

4.6.11 State Water Plan

Some of the issues identified in the State Water Plan related to flood plain management include:

- Communities participating in the NFIP outside major urban centers have not had access to consistent state-level assistance in implementing and managing their flood plain management ordinances. In some cases, this lack of state assistance, combined with turnover in personnel at the community and county level, and resultant lack of training have made it difficult for local communities to comply with NFIP regulations.
- Alluvial fan or flash flooding is a critical issue for two reasons: a) flash flooding is less predictable than riverine flooding and results in high velocity flows with great erosive capability, and there is a high potential for channel migration to previously unidentified areas; and b) the risk of alluvial fan flooding is either over- or under-predicted due to disagreement on effective models for predicting flows and mapping alluvial fan flood zones among engineering and planning professionals.
- The FIRMs used by the local administrators outside of major urban centers for planning and permitting development are well over five years old. Areas that are currently being developed were never mapped in detail in the original studies. Use of regression equations that are based on generalized hydraulic geometry and do not incorporate site specific geologic and soil type data have resulted in underestimating the extent and depth of flooding. Rapid growth in areas with outdated flood zone maps can result in the construction of homes and businesses in harm's way.
- Flood plain management must be considered an essential ongoing element in local and regional planning; not something that takes place after a flooding event. In a presidentially declared disaster, FEMA sets aside a portion of the total reimbursed damages to fund mitigation work. The State has a Disaster Relief Fund, but funds for preventive mitigation are not currently available.
- To avoid recurrence of losses experienced in the 1997 flood event in northern Nevada, the 1997 State Legislature requested development of a Flood Management Plan for the state.
- The State's Model Flood Plain Ordinance contains the *minimum* NFIP requirements. The minimum NFIP requirements are flood plain management standards, which do not take Nevada's unique regional conditions into consideration. Conditions that make Nevada NFIP requirements (that communities and counties must implement to obtain flood insurance) unique are rapid growth in areas with outdated flood maps, alluvial fan flooding and flash flooding. The State Model Ordinance was developed in 1994, prior to the 1997 flood event in northern Nevada, and needs to be updated to include lessons learned from that event. Further, to adequately prevent flood impacts and keep damages and costs of recovery to a minimum, the state also needs to develop a set of recommended standards over and above the minimum standards established in the model ordinance to reflect Nevada's unique flood management concerns.
- In Northern Nevada, communities located along rivers are incurring increasing costs due to flooding. Growth and development in flood plains has exacerbated flood losses. Further, structural controls can create additional risk of damages due to catastrophic failure during floods greater than the design flow. It is estimated that the 1997 flood would have had a peak flow of about 40,000 cfs if the upstream reservoirs were not in place. Instead the peak flow was about 22,000 cfs. Flood officials nationwide are concluding that existing structural controls, without constant maintenance, are not effective in preventing damages. Studies throughout the west show the benefits of

incorporating non-structural measures such as preservation and restoration of flood plain areas, through zoning and conservation easements, and relocating structures out of flood plain areas.

4.6.12 Regional Plan Settlement Agreement of October 17, 2002

The Regional Plan Settlement Agreement, effective October 17, 2002, caused the RWPC to develop criteria policies for water and water-related issues for cooperative planning. These policies included some directly related to flood planning. Those policies are adopted into this plan and are found in Chapter 1.

4.7 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 US Department of Agriculture, Natural Resources Conservation Service (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 Corps, under authorization of the Flood Control Act of 1954, improved the bank-full capacity of the Truckee River channel to 7,000 cfs from the Glendale Bridge to Vista including removal of the Vista Reefs and removed obstructions downstream from the Truckee Meadows to Pyramid Lake. This work was completed in 1963. Removal of the Vista Reefs resulted in major flooding, bank erosion, and loss of fisheries and wildlife habitat downstream from Vista.

Under the Flood Control Act of 1962, the Corps designed and constructed the Martis Creek Reservoir. This reservoir, along with channel improvements through Reno to improve the Truckee River channel capacities to 14,000 cfs, was completed in 1972. Reno, Sparks, Washoe County, and the Carson-Truckee Water Conservancy District are responsible for maintaining these 1972 channel capacities and the river gages that monitor the flood flows.

In 1971, the Corps completed a flood control management plan for the Truckee River reservoirs. Stampede, Boca, Prosser Creek, and Martis Creek Reservoirs have 65,000 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 Corps estimates that the flood control facilities mentioned above have reduced the 100-year flood flows through Reno from 41,000 cfs to 18,500 cfs, which still exceeds the Reno channel capacity (14,000 cfs) and the Sparks channel capacity (7,000 cfs).

In July 1977, the Corps, 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. As a result of that report the project was re-classified to a deferred status. In 1993, Washoe County asked

the Corps to activate and re-evaluate the project. The Corps included funds in fiscal year 1996-97 to initiate the reevaluation.

The Corps, under the authority of the 1948 Flood Control Act, can evaluate, design, and construct small watershed protection projects. At Reno and Washoe County's request, the Corps evaluated the feasibility of a flood detention facility in the Thomas Creek watershed to protect City of Reno and Washoe County citizens. This study determined that the damages to existing residences were insufficient to warrant federal participation in a flood detention facility.

4.7.1 Truckee River Flood Management Project

The Truckee River Challenge

Truckee River flood control remains one of the Region's most significant water management challenges. To protect the Region's most valuable natural resources - land and water - residents of Sparks, Reno, and Washoe County undertook a complex challenge: implement a flood management program that restores the health and vitality of the Truckee River while protecting communities along the river.

Floods cannot be prevented. The Region can, however, reduce flood damage by working with the river. Flooding is a natural part of healthy rivers and ecosystems. High flows and floodwaters cleanse channels of debris, carry gravel downstream for spawning fish, and create healthy riparian habitats. Flood plains, the low, flat lands adjacent to the river, store and slowly release flood flows, reducing flood damage and recharge groundwater. Today, much of the natural flood plain for the Truckee River has been developed or protected for agriculture and the natural process of flooding is gone. But, combining sensitively designed and located flood barriers with benching and terracing techniques can help return the river to a more natural state. This will allow water to spread out naturally across designated open lands during a flood, rather than inundating the developed areas that must be protected. This concept also incorporates designs to reduce the possibility of breaks in flood barriers that lead to catastrophic flooding.

Environmentally sensitive flood management projects can provide flood protection, healthy river ecosystems and habitat preservation, and yet remain natural and unintrusive.

Formation of a Community Coalition and a "Living River" Concept

In order to develop a consensus for a flood plan with public input, Reno, Sparks and Washoe County created a community-based group known as the Community Coalition for Truckee River Flood Management, which works in cooperation with the Corps. Diverse members of the community came together in April 2000 to develop flood management alternatives for Reno, Sparks and neighboring residents on the Truckee River.

The Community Coalition has spent three years developing a community concept for the river that minimizes flood damages while embracing the concept of a "Living River". There is recognition of the Truckee River as a valuable resource to the community and a natural system with beneficial functions in need of restoration and preservation. The concept of restoring and working with natural systems is one that will be expanded as planning is completed for the remainder of Washoe County.

Several alternatives, including the Community Coalition plan alternative, are currently being evaluated by the Corps in their General Re-evaluation of the 1985 project design. This re-

evaluation will become part of the Environmental Impact Statement (EIS) process for this project. The four alternatives being considered are:

1. "No Action"
2. Setback Levees and Floodwalls
3. Setback Floodwalls and Levees with Detention Basin
4. Community Coalition Plan

The Community Coalition is creating a flood protection plan that will benefit residents, businesses, the river, and the communities that surround the river. The Coalition has the support of the community, including residents, businesses, 35 stakeholder organizations, 24 resource and regulatory agencies, and a range of technical consultants, including hydraulic, environmental and geomorphology specialists.

At Community Coalition meetings, members of the public, professional experts, local stakeholder organizations, and agency representatives exchanged ideas about a flood management plan that would work for the entire Truckee River community. The Coalition put in more than 9,000 hours over eight months to develop a consensus for a flood management plan.

Evaluating Issues and Options

The Coalition studied and evaluated previously proposed solutions for the Truckee River. The overwhelming conclusion was that many proposals had problems, including:

- Extremely high floodwalls, up to 18' in some places on top of banks
- Damage to downstream habitat, environment and water quality
- Harm to existing endangered fish populations and river ecosystems
- Need for lengthy and complex re-negotiations of existing agreements
- Increased risk of catastrophic damage from levee failure
- Did not take advantage of principles of watershed management
- Did not create or integrate parks and recreation

To better respond to these complex issues, the Coalition identified six major flood protection goals, and recommendations to achieve those goals, which are the basis of this preliminary flood management plan.

1. Community Safety and Well-Being: Protect public and private property from flood damage
2. River Restoration: Create a living river that supports fish and wildlife habitat, improves water quality, and restores and preserves natural characteristics of the river
3. Downstream Mitigation: Ensure that any increases in downstream flood flows are mitigated
4. River Parkway: Create scenic, accessible, multi-use, fish-friendly river parkways where possible
5. Flood Plain Management: Ensure the plan works over the long-term through responsible management of the adjacent flood plain. Protect the community's investment in flood protection
6. Financial Feasibility: Ensure that the plan is financially suitable for the community and stays within allowed project costs

Major Coalition Plan Concept Elements

The Coalition Plan recognizes that flood management solutions are evolving to respect a river's natural tendencies and take into account the natural processes and habitats surrounding the river. This Coalition Plan combines unique elements that allow the Truckee River to function as a river, not just a flood channel.

The Community Coalition has spent more than two years developing Truckee River Flood Management Project alternatives. The alternatives being evaluated in the Corps' Integrated General Re-evaluation Report and EIS are based on 2002 conditions and the assumption that future conditions in the region will not cause a net loss of flood plain storage volumes nor changes to the base flood elevation in the project's hydrology.

Local governments need to be especially careful in managing development in the period preceding implementation of the Truckee River Flood Management Project to ensure that flood damages to existing properties are not exacerbated. Any increase in current flood levels during this period will increase flood damages. The following points are made to illustrate the problem:

- The base flood elevation for the January 1997 flood event was approximately 1.6 feet higher than the existing FEMA base flood elevation at the Vista gage. This event was considered to be slightly greater than the 100-year flood event.
- Recently built homes and businesses were constructed based on current ordinance requirements, that is, with the first floor elevated either one or two feet above the FEMA base flood elevation. Structures constructed prior to current ordinances may have been elevated to a lesser extent or not at all. There were more than $600 million in damages as a result of the 1997 Truckee River flood.
- Information prepared by participants in the Truckee River Flood Management Project Working Group indicates 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. Other properties throughout the region may also be subject to additional damages.
- Information prepared by WRC Nevada for the RWPC (WRC Nevada, 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 river could result in an increase of 0.4 to 0.6 feet in the base flood elevation.

Several constraints were identified during the development of the Truckee River Flood Management Project alternatives that resulted in a proposed project configuration that does not accommodate increased peak flow or volume of runoff during the critical flooding period. This means that other measures must be implemented within the watershed to manage the runoff from future development. Following is a list of some of the key constraints that resulted in the currently proposed project configuration:

- Broad community support is essential to implementing a project of such magnitude. Many objectives must be balanced, including flood damage reduction for properties within the flood plain, continued economic viability of commercial / industrial areas, quality of life for existing residents, enhancement of the river as a community and environmental amenity, mitigation of possible flood damages to downstream communities, and many more.
- Existing businesses and residences within the 100-year flood plain need to be protected.

This could be largely accomplished if the base flood elevation for the 100-year design event could be reduced to the existing FEMA recognized level.

- The alternatives to reducing the base flood elevation are:
    - Build levees and floodwalls, an extremely costly project element that was limited to areas where absolutely necessary for a number of reasons; cost, vulnerability to failure, unacceptable impacts to residences, creation of interior drainage problems, loss of access to the Truckee River, and environmental degradation of the river, to name a few.
    - Increase peak discharge from the Truckee Meadows

Increasing the discharge from the Truckee Meadows has been discussed with downstream communities, and is only acceptable to the point that any potential damages have been mitigated through restoration of the river between Vista and Pyramid Lake. The use of this strategy is limited by existing informal agreements between some of the downstream communities and the project sponsors. The Corps will evaluate an increased downstream discharge in the EIS process. Corps policy for flood control projects will not allow a project to increase the risk of flooding downstream. If a project sends more water downstream, areas that will have increased flooding need to be protected to the level of flood protection they had before construction of the upstream flood project. It is important to note that there are no formal agreements to accept the proposed increase in downstream discharge. Such agreements would be formalized when it can be demonstrated that there would not be an adverse impact to downstream communities.

Corps funding for this project is limited to mitigating existing flood damages. Federal funding is not available to mitigate flood damages that result from future development conditions. Local sponsors do have the option of designing for and fully funding a higher level of protection than required for existing conditions.

With the above constraints identified, it is apparent that in order to develop economically feasible flood damage reduction alternatives, existing conditions must not be aggravated as a result of changes in the watershed. The opportunities to mitigate damages within the flood plain itself are extremely limited. Therefore, increased peak flows that add to the Truckee River flood peak and volume must be mitigated elsewhere within the watershed. Two planning efforts are underway to develop these mitigation strategies: the RWPC Regional Flood Plain Management Strategy (RWPC, 2003) and the RWPC Regional Flood Control Master Plan (WRC Nevada, in progress) (see Policy 3.1.a in Section 4.5 and in Chapter 1).

There are many regional flood control facilities within the Truckee River watershed for which operations need to be coordinated with both the Truckee River Flood Management Project and proposed new facilities developed as a result of the Regional Flood Control Master Plan.

4.8 State and Local Storm Water Drainage Programs / Development Codes

Each local government entity has a number of storm water and flood plain management regulations within their ordinances and codes. A partial listing of these follows:

- City of Reno Storm Water Drainage Program
- City of Sparks Storm Water Utility
- SE Truckee Meadows Storm Water Utility
- North Spanish Springs Storm Water Utility
- Washoe County Development Code – Flood Hazards – Article 416
- Washoe County Development Code – Significant Hydrologic Resources – Article 418
- Washoe County Development Code – Storm Drainage Standards – Article 420
- City of Reno Municipal Code – Wetlands and Stream Environments
- City of Reno Municipal Code – Drainage ways
- City of Sparks Municipal Code – Flood Plain Management

4.9 Flood Control Overview by Hydrographic Basin

This section provides overviews of potential flood control issues relative to other hydrographic basins outside of the Central Truckee Meadows.

Tracy Segment Hydrographic Basin (lower Truckee River)

This reach of the Truckee River has been identified in work done for the Truckee River Flood Management Project and Lower Truckee River Restoration Project as having excellent potential for mitigation of increased flood flows from the Reno/Sparks metropolitan areas if significant restoration efforts are undertaken, including reconnecting the river with its historical flood plain and reintroducing river meanders. There are also water quality, habitat and recreational benefits associated with implementation of a restoration program.

Restoration of this reach of the river is essential to the viability of the Truckee River Flood Management project. Local governments need to recognize this and take the steps necessary to acquire or protect critical flood plain and restoration areas.

Warm Springs Valley Hydrographic Basin

The limited development potential within this hydrographic basin minimizes flood control issues. 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.

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. Management strategies in the unincorporated area are moving towards the same methodology.

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 the City of 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 the City of Sparks.

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.

Washoe Valley Hydrographic Basin

There are a number of flood hazards within this hydrographic basin, including alluvial fan flooding, lake flooding during wet years, riverine flooding of creeks and landslides. A comprehensive flood control master plan for this hydrographic basin has not been developed.

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 Central Truckee Meadows.

Stead / Lemmon Valley Hydrographic Basins (combined)

The Stead / Lemmon Valley is a topographically closed basin. Precipitation that falls within the basin generally stays within the basin. Hydrologic studies have been prepared for the Silver Lake and Swan Lake drainage basins. Future changes to flood peaks and flood plain storage volume, particularly in the Swan Lake basin, will need to be evaluated to ensure that the effects of increased volumes of runoff are manageable. A Drainage Master Plan for Stead, Nevada (Stantec Consulting, 2002) has been prepared for the City of 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.

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.

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.

Dry 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.

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.

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.

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