Post Flood Report: Record Rainfall and Flooding Events During September 2013 in New Mexico, Southeastern Colorado and Far West Texas

US Army Corps of Engineers ®
Albuquerque District

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Cover Photo: September 17, 2013. Looking Southwest at the Rio Grande at Bernardo (Courtesy of Civil Air Patrol).

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1 - Introduction

From 9-18 September 2013, the Albuquerque District of the Corps of Engineers (Figure 1), adjacent mountain regions of Colorado, and portions of far west Texas experienced a major precipitation event (Figure 2) that resulted in extensive flooding in some drainages, and record and near-record flows in many streams. Precipitation resulted from the interaction between monsoonal circulation from the south that tracked in moisture sourced from tropical storms over Mexico, and a trough over Arizona and Nevada that helped steer this moisture into New Mexico and Colorado and, eventually, Texas. Interaction with mountainous terrain intensified the precipitation in some areas. Two Presidential Disaster Declarations were issued. In New Mexico, flood damages were estimated at $16,598,503 (FEMA-4152-DR), with an additional $1,984,960 in damages on Santa Clara Pueblo (FEMA-4151-DR).

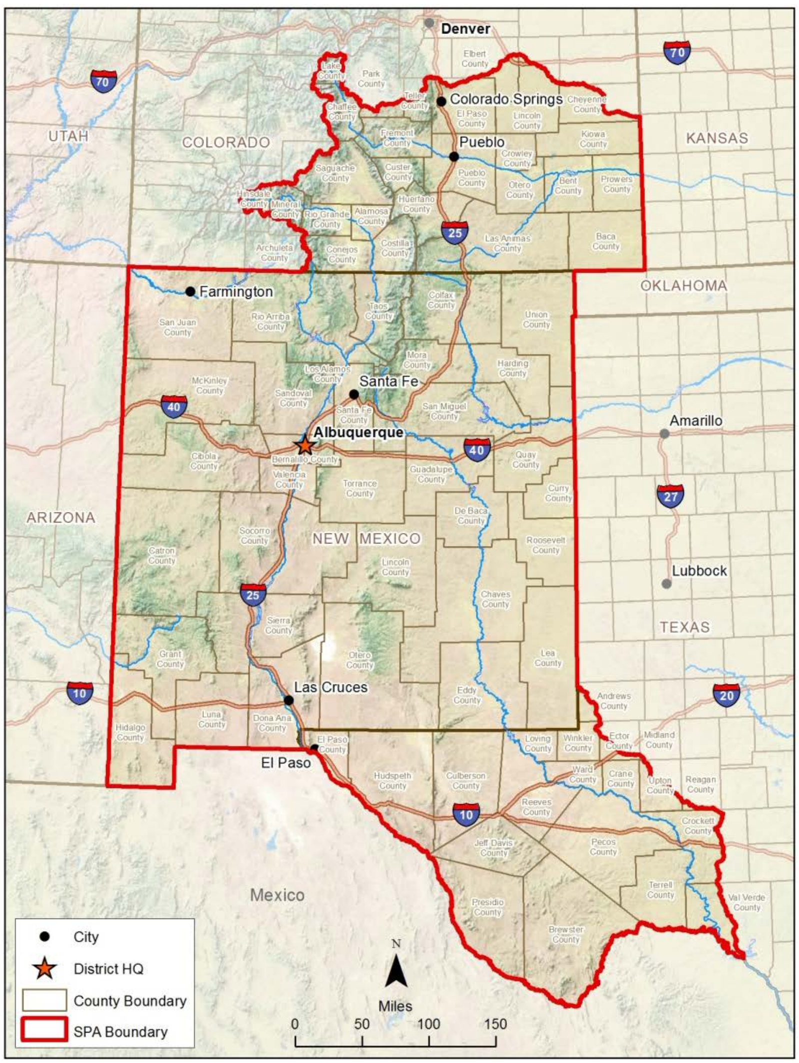


Figure 1 - Map showing the location of the Albuquerque District.

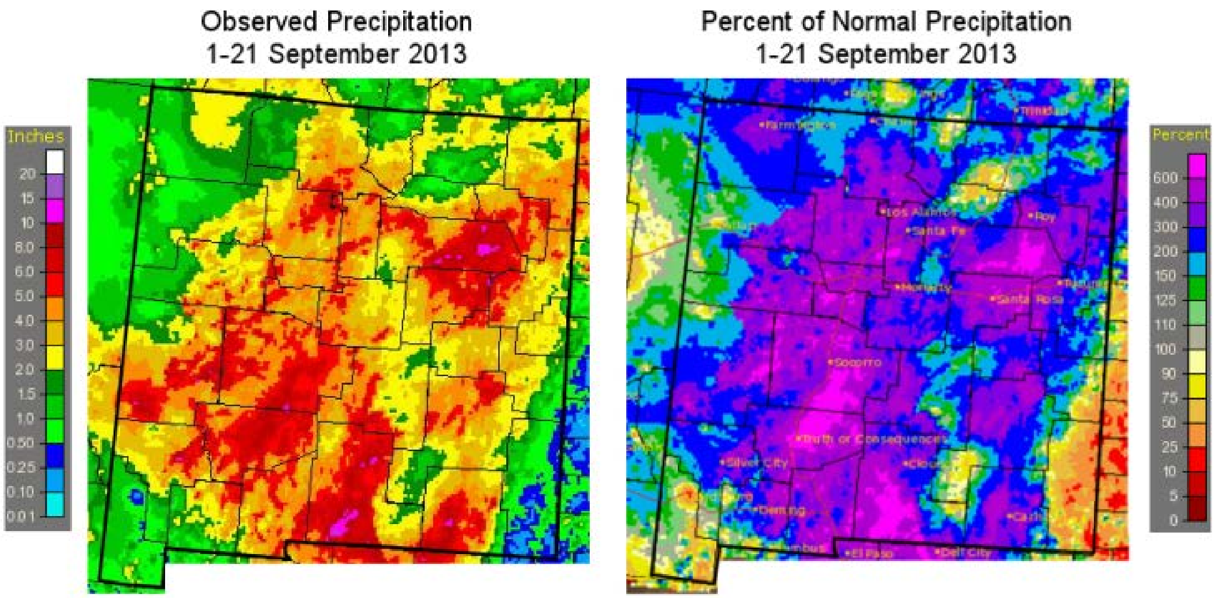


Figure 2 - Observed precipitation and percent of normal precipitation for New Mexico for the first three weeks of September 2013 (NOAA/NWS 2013a).

1.1 Scope of this Report

This report summarizes the meteorological and hydrological characteristics of the 9-18 September 2013 flood event, and its impacts to infrastructure and communities. The operation of USACE flood control structures (project operations) in each major basin within the USACE, Albuquerque District is reviewed. In addition, an overview of damages caused by these events as well as damages prevented by the presence and operation of USACE flood control structures are documented. Damages estimates were provided by FEMA and augmented by reports from tribal, state and local governments and other sources.

Climatologically events similar to the September 2013 event not uncommon in the Southwest region; however, the areal extent of this event does make it exceptional. Within the Albuquerque District boundaries, major river basins impacted include the Rio Grande, Pecos, Arkansas, and San Francisco rivers. Although this same event also impacted much of central and northern Colorado, this report does not address impacts outside the Albuquerque District.

1.2 Authorization for this Report

This post flood assessment report was prepared and authorized under the Flood Plain Management Services (FPMS) Program under Section 206, 1960 Flood Control Act, P.L. 86-645.

1.3 Agencies and Scope of Services Provided

The U.S. Geological Survey (USGS) collected field data at arroyo and stream channels, and where gages had been destroyed or overtopped by flood waters, used high water mark evidence to estimate flows. The National Weather Service Albuquerque Office provided precipitation data for the affected areas. Preliminary damages estimates were obtained from FEMA, and these were augmented by reports from tribal, state and local governments and other sources.

1.4 Organization of this Report

The first few chapters of this report provide an overview of the 9-18 September flood event and its climatological setting. The remainder of the report examines how the flood event played out in each of the six major river basins in the Albuquerque District area of responsibility (Figure 3). These are followed by a basin-by-basin treatment of the event that highlights when and where rain fell, the hydrologic responses of major rivers and tributaries, and the flooding that resulted. The remainder of each chapter details reservoir operations in response to high flows, USACE responses under emergency and other authorizations, and information about relevant FEMA damages assessments. The last chapter provides recommendations for future actions. This is followed by a series of appendices providing additional data on this event.

1.5 A Note on Precipitation Gages as Compared to NEXRAD Precipitation Data

Precipitation gages are the traditional method for measuring rain and snow produced from a storm system. The most common type of automated precipitation gage currently in use in the National Weather Service's Automated Surface Observing System (NWS ASOS) is the automated tipping bucket which, as the name suggests, contains a small tipping seesaw that fills with rain, tips to empty and appends 0.01 inch to the record. Tipping bucket gages are reliable and accurate for rain collection during monsoon season in the desert southwest. Precipitation gages are excellent for tracking rain in populated regions. In the southwestern US, the population density does not support a robust gage network, Doppler radar provides a viable alternative to generate rainfall estimates.

Weather Surveillance Radar – 1988 Doppler (WSR-88D) or more commonly known by its colloquial name, NEXRAD (Next-Generation Radar) consists of a network of high resolution Doppler radar stations originally developed for storm tracking in the Great Plains. The National Weather Service (NWS) converts the radar signals into images containing precipitation estimates used for visualization and quantitative analysis. Ground truthing is conducted by integrating ground based precipitation gages from the ASOS network in to the final imagery. The southwestern United States, being sparsely populated, has a thin network of gages for calibration resulting in slight under estimates rain amounts. These under estimates vary depending upon distance from the radar station and ground topology as well as intensity and temperature of precipitation.

Precipitation gages are more precise than NEXRAD but the spatial distribution of the radar proves better coverage to capture small scale, high intensity events common in the southwestern United States.

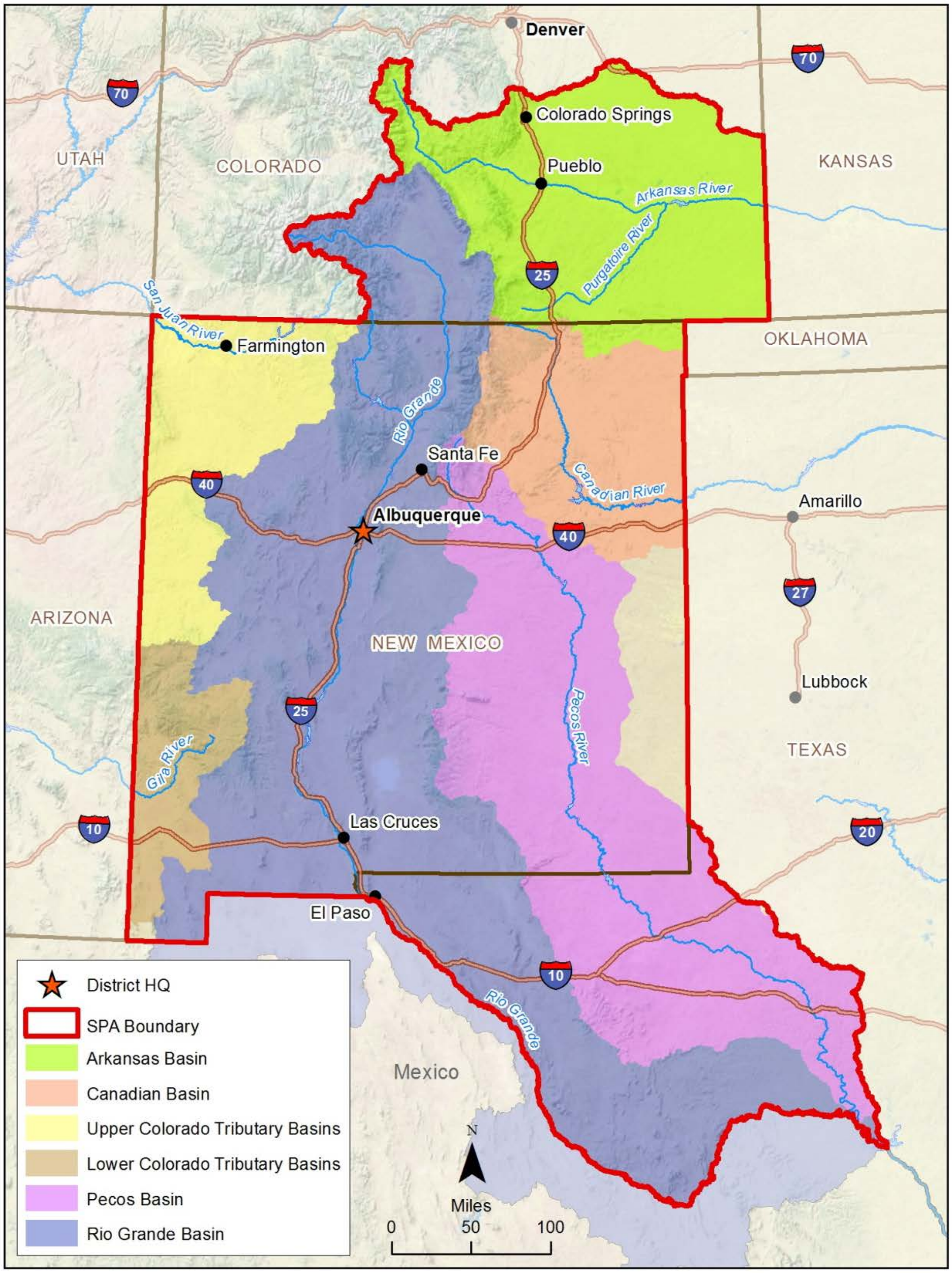


Figure 3 - Map showing the location of river basins within the Albuquerque District area of responsibility.

2 - Overview of the 9-18 September 2013 Flood Event

At the time of the September 2013 flood event, many factors were in place that contributed to the large precipitation event: southwesterly monsoon flow was strong over New Mexico and Colorado, two tropical storms were present in monsoon moisture source regions in Mexico, and a trough was present over northern Arizona and Utah steering airflow over New Mexico and Colorado, with a high pressure to the east (Western Water Assessment 2013). Thus, conditions were optimal for funneling large quantities of low-level and mid-level moisture into the Albuquerque District Area of Responsibility and northern into central Colorado.

Beginning in mid- to late-August, high pressure over the region blocked monsoonal flow, producing hot, dry conditions in New Mexico and Southern Colorado. In early September, the high shifted to the east and beginning 9 September, a large trough of low pressure approaching from the west enabled re-establishment of deep southerly winds across New Mexico and Texas (NOAA/NWS 2013v, a, 2014e). This re-initiation of southerly flow coincided with the presence of very humid air associated with a tropical easterly wave moving across north-central Mexico spawning both hurricanes Ingrid and Manuel (Pasch and Zelinsky 2014). Thus abundant low level and mid level moisture was transported into New Mexico and Southern Colorado beginning late on Monday, 9 September (Figure 5) and peaking Tuesday, 10 September through Thursday, 12 September 2013 (Figures 6-8). Rainfall on 9 September consisted of isolated to scattered thunderstorms giving way over the ensuing three days to more widespread rainfall responsible for the majority of the major flooding across the region. Near-record rainfall occurred in the central Rio Grande and Pecos River basins on Tuesday, but fell primarily over the Pecos Basin and the Salt Basin (a closed basin on the Texas-New Mexico border east of El Paso) on Wednesday, 11 September. This rain produced record flooding throughout the Pecos Basin, refilling the conservation pool at Sumner, Brantley and Santa Rosa Lakes, taking Avalon reservoir from a record low volume to the top of the flood pool, and putting Two Rivers into flood operations. Although rain continued to fall across the Albuquerque District on Thursday, 12 September, heavy rain was concentrated in the southern Rio Grande Basin and the Salt Basin.

On Friday, 13 September, rain continued to fall, with the heaviest in the Rio Grande Basin and portions of the Gila River Basin, a pattern that continued into Saturday, September 14 (NOAA/NWS 2014e). During this period (Figures 10 and 11), the approaching low moved over the region, resulting in active but less wide-spread showers and storms. Although rainfall began easing over the weekend across the region, the ground was saturated, contributing to the flooding that occurred when additional strong to severe thunderstorms between Monday, 16 September and Wednesday, 18 September (Figures 12-14). Record to near record river flooding and areal flooding was observed in many areas of northern and central New Mexico during the course of this event, and numerous locations also experienced significant flash flooding as well. Flooding continued for several days after rain's end as flood flows worked their way downstream (NOAA/NWS 2013v, a, 2014e). Total rainfall amounts over the 10-day period averaged 3 to 6 inches and in some areas just over 10 inches (NOAA/NWS 2013a).

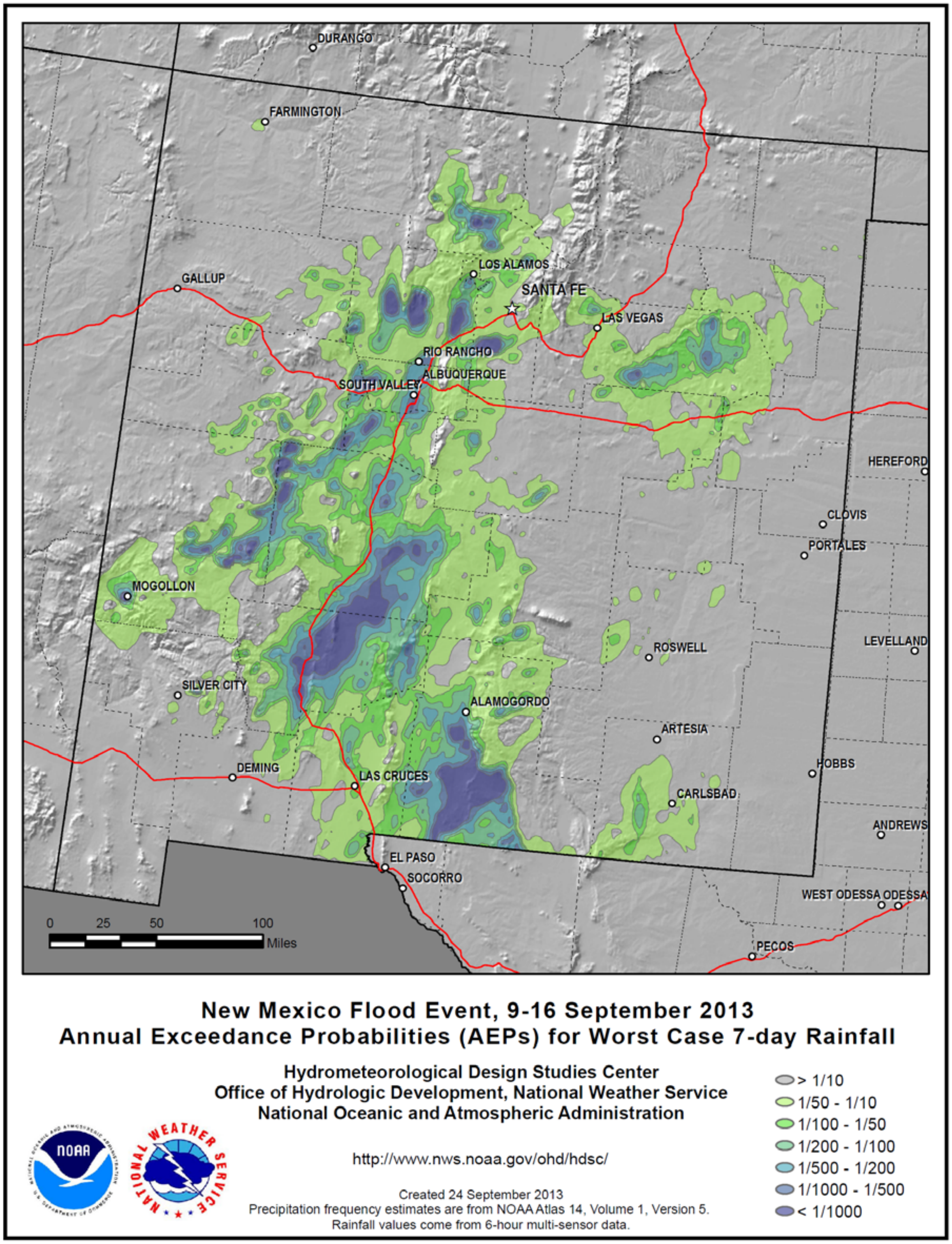


Figure 4 - NOAA map showing annual exceedance probabilities for precipitation during the period 9-16 September 2014.

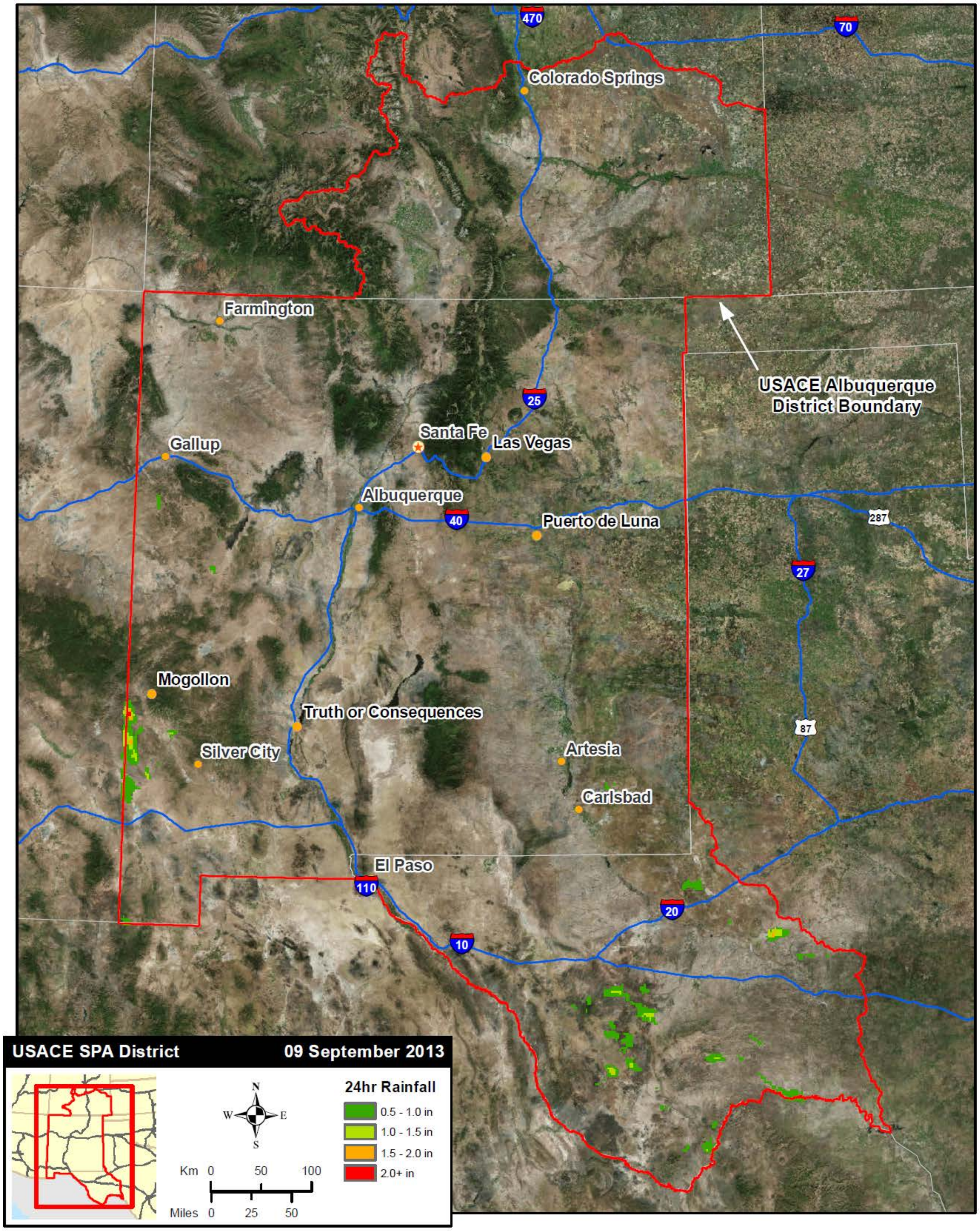


Figure 5 - Map showing areas with precipitation >0.5 inch on 9 September 2014 based on Doppler radar data.

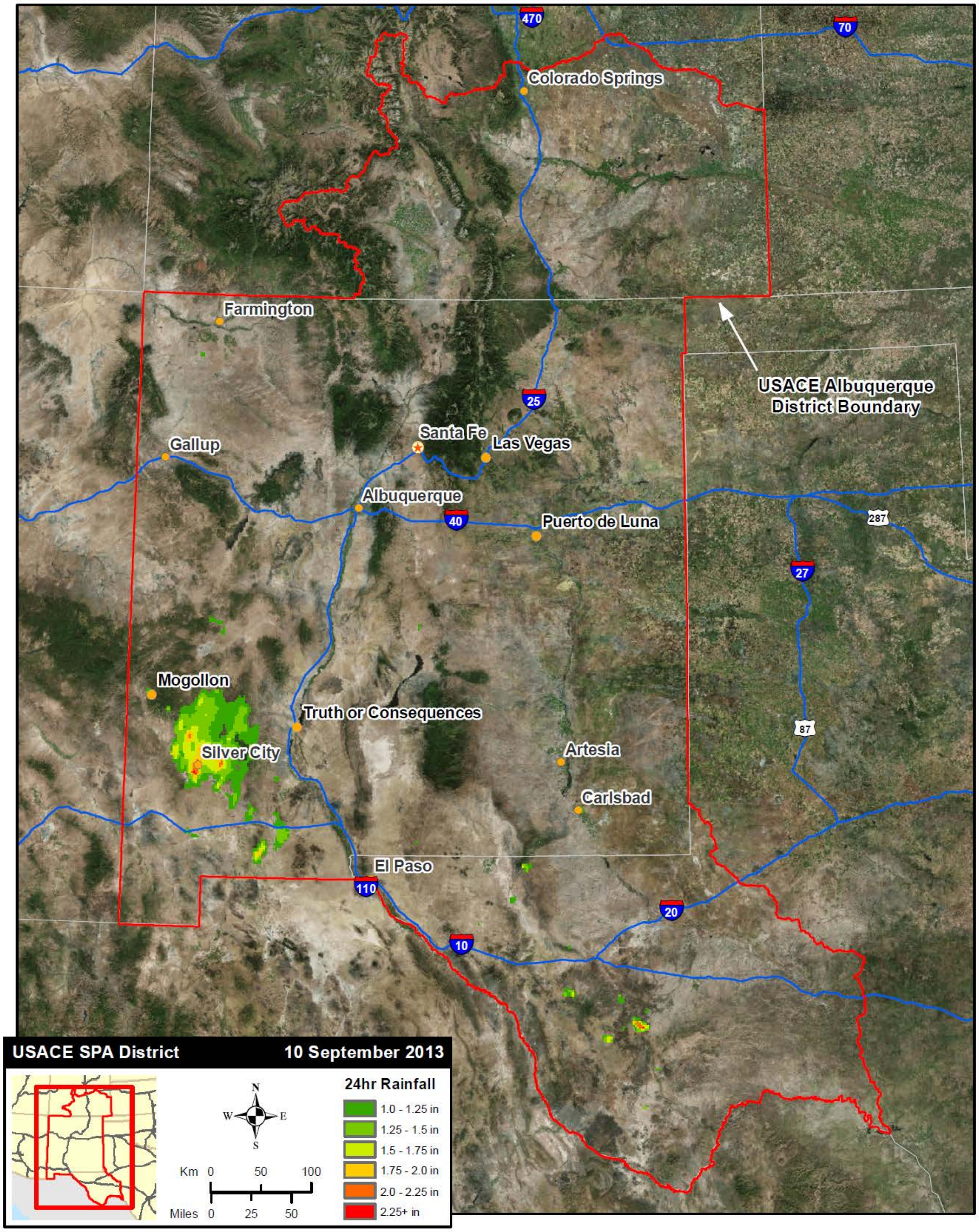
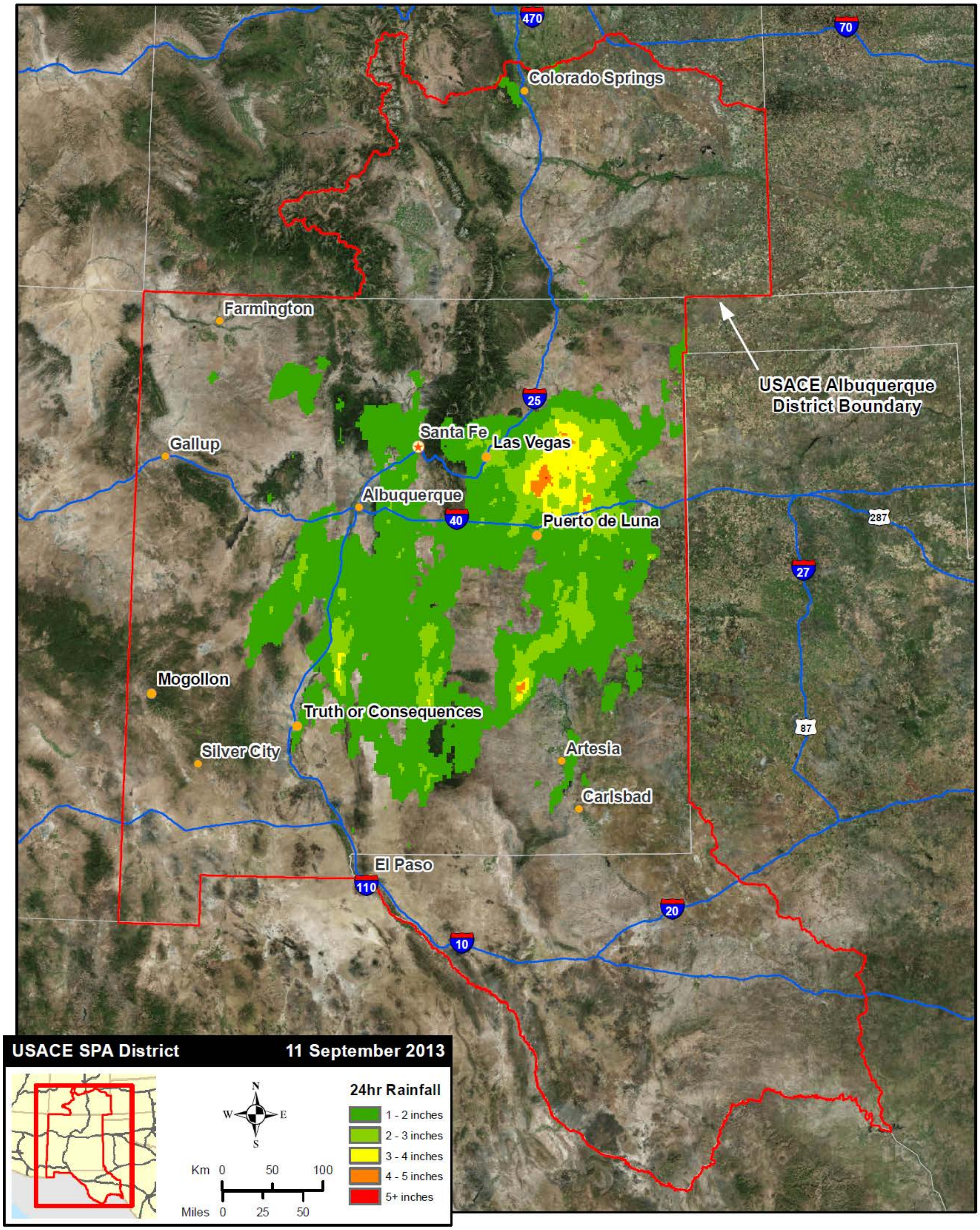


Figure 6 - Map showing areas with precipitation >1 inch on 10 September 2014 based on Doppler radar data.



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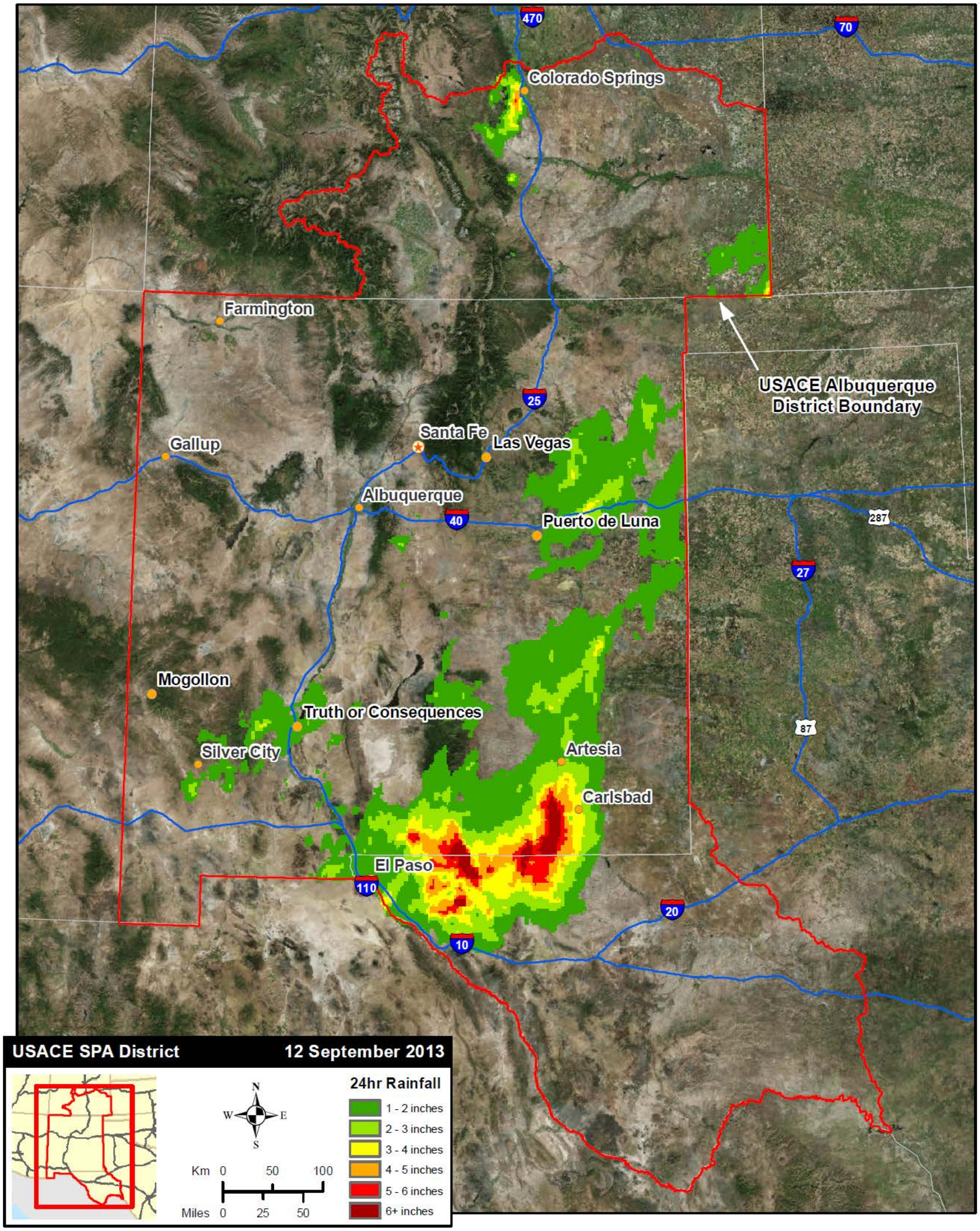


Figure 8 - Map showing areas with precipitation >1 inch on 12 September 2014 based on Doppler radar data.

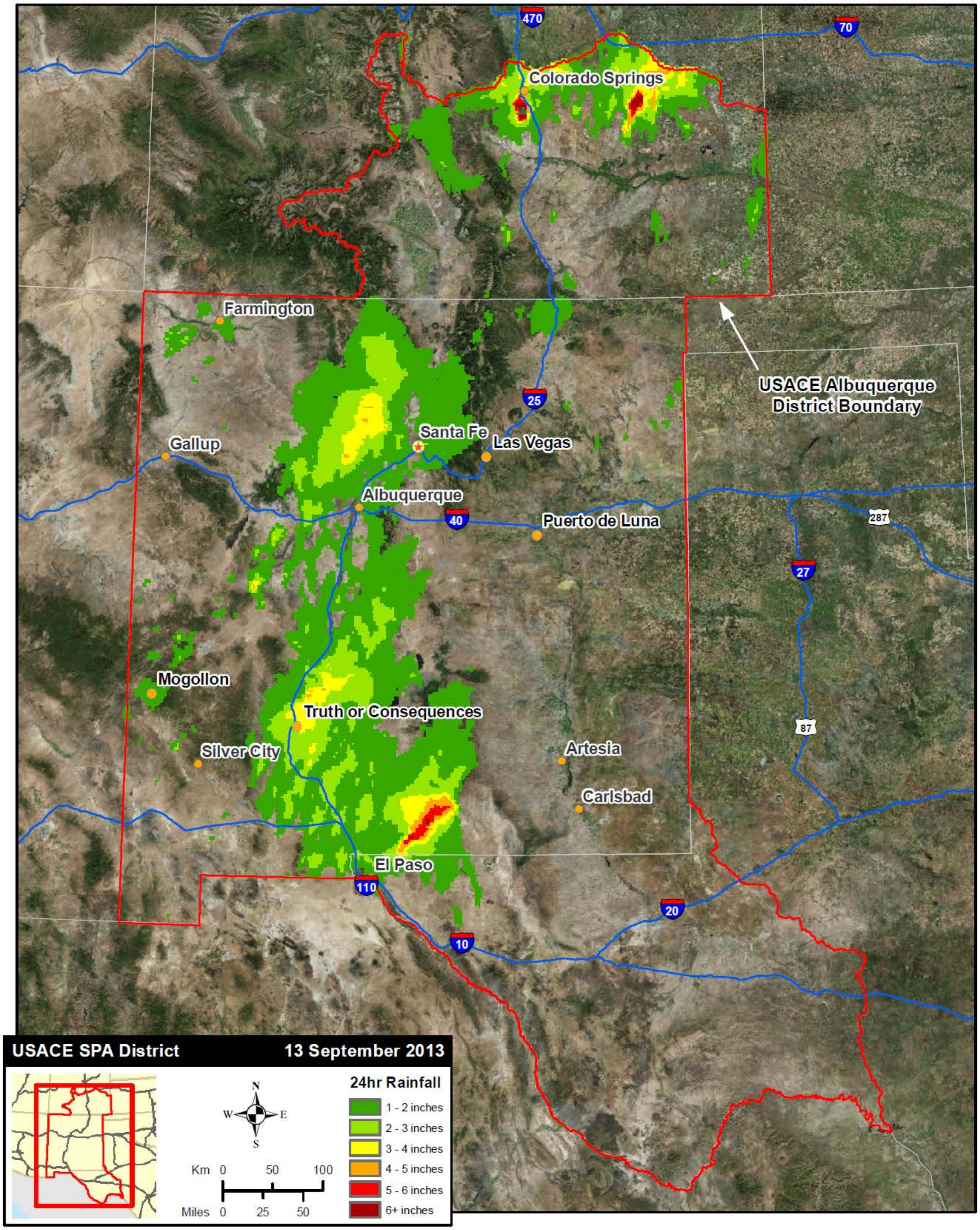
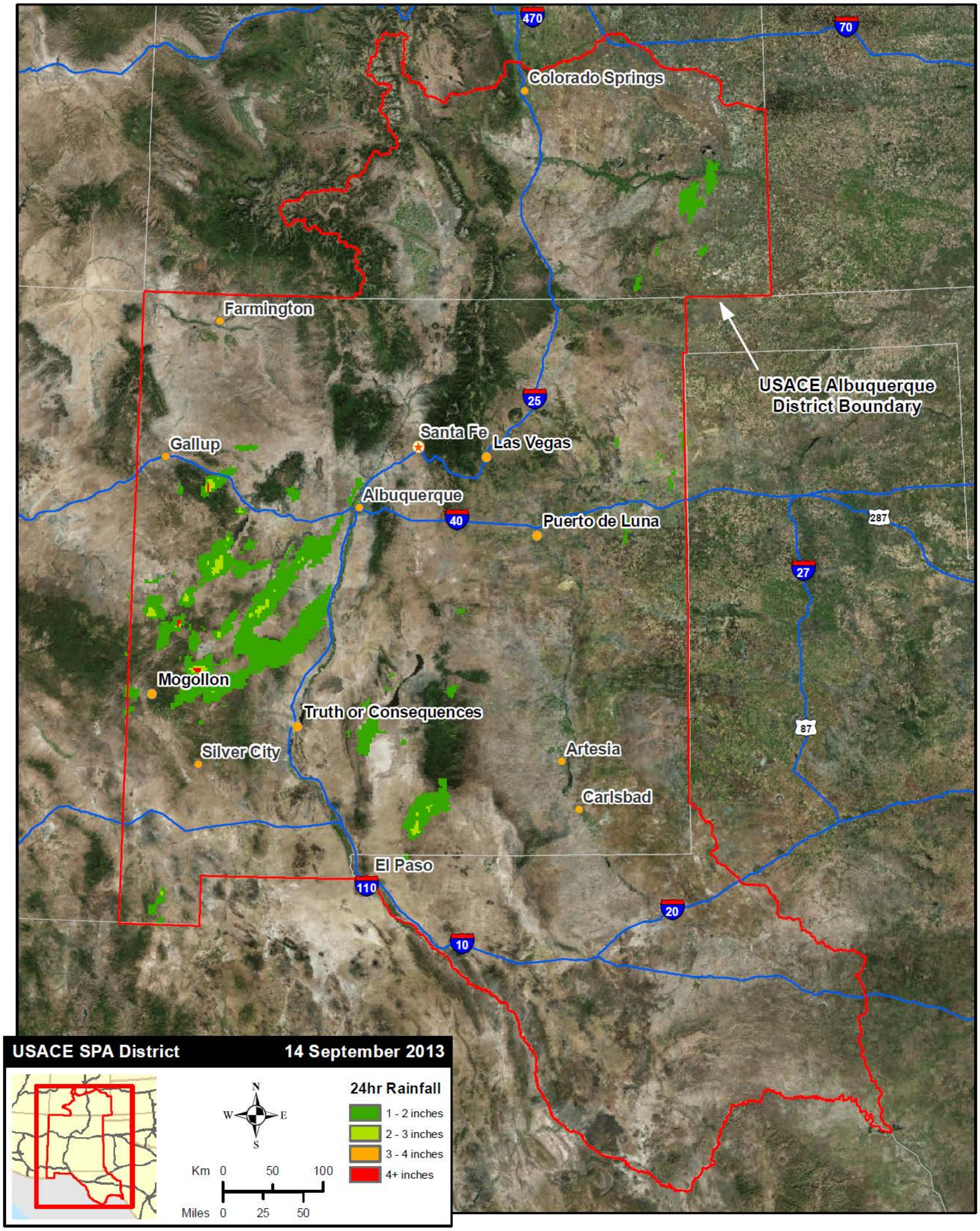


Figure 9 - Map showing areas with precipitation >1 inch on 13 September 2014 based on Doppler radar data.



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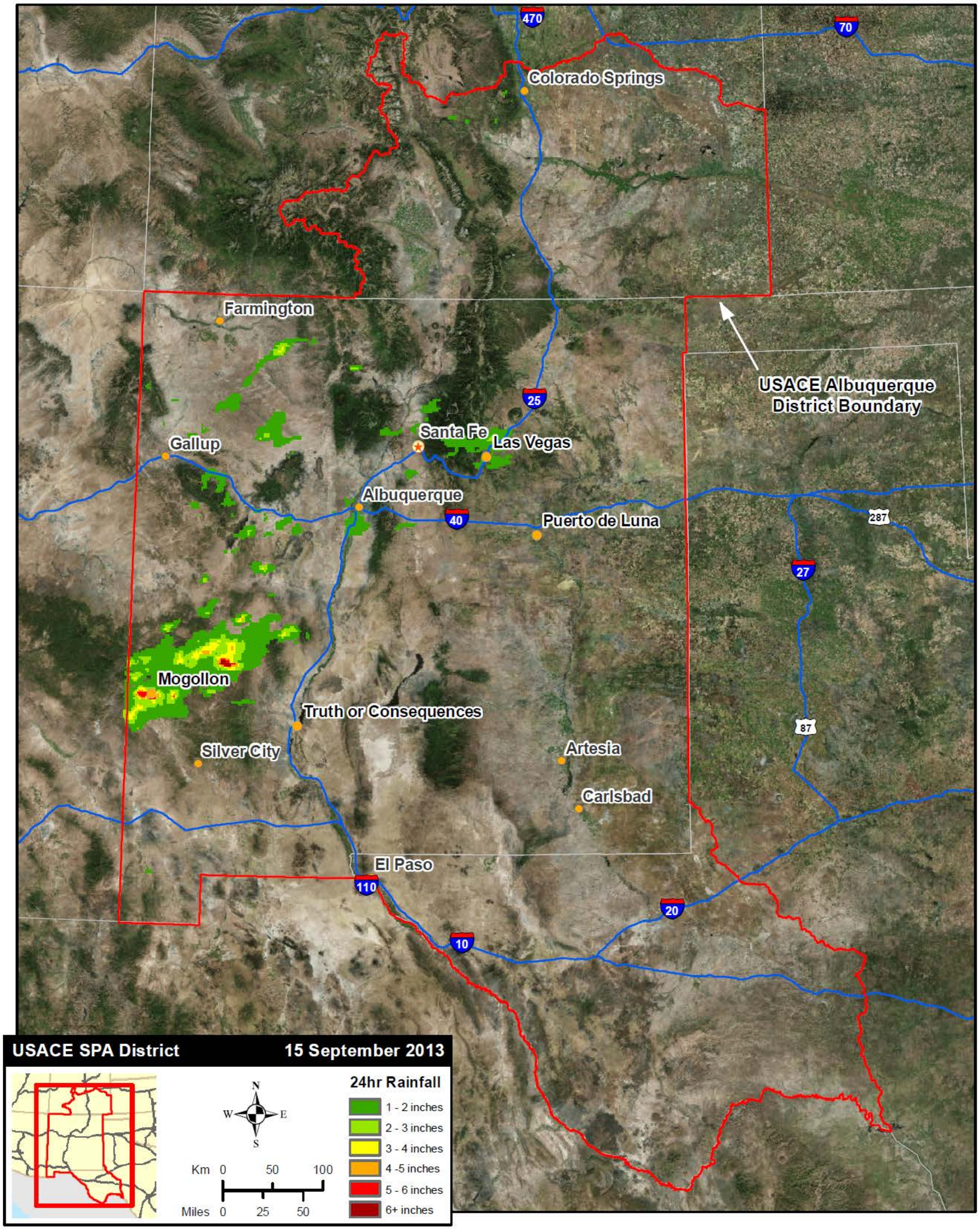


Figure 11 - Map showing areas with precipitation >1 inch on 15 September 2014 based on Doppler radar data.

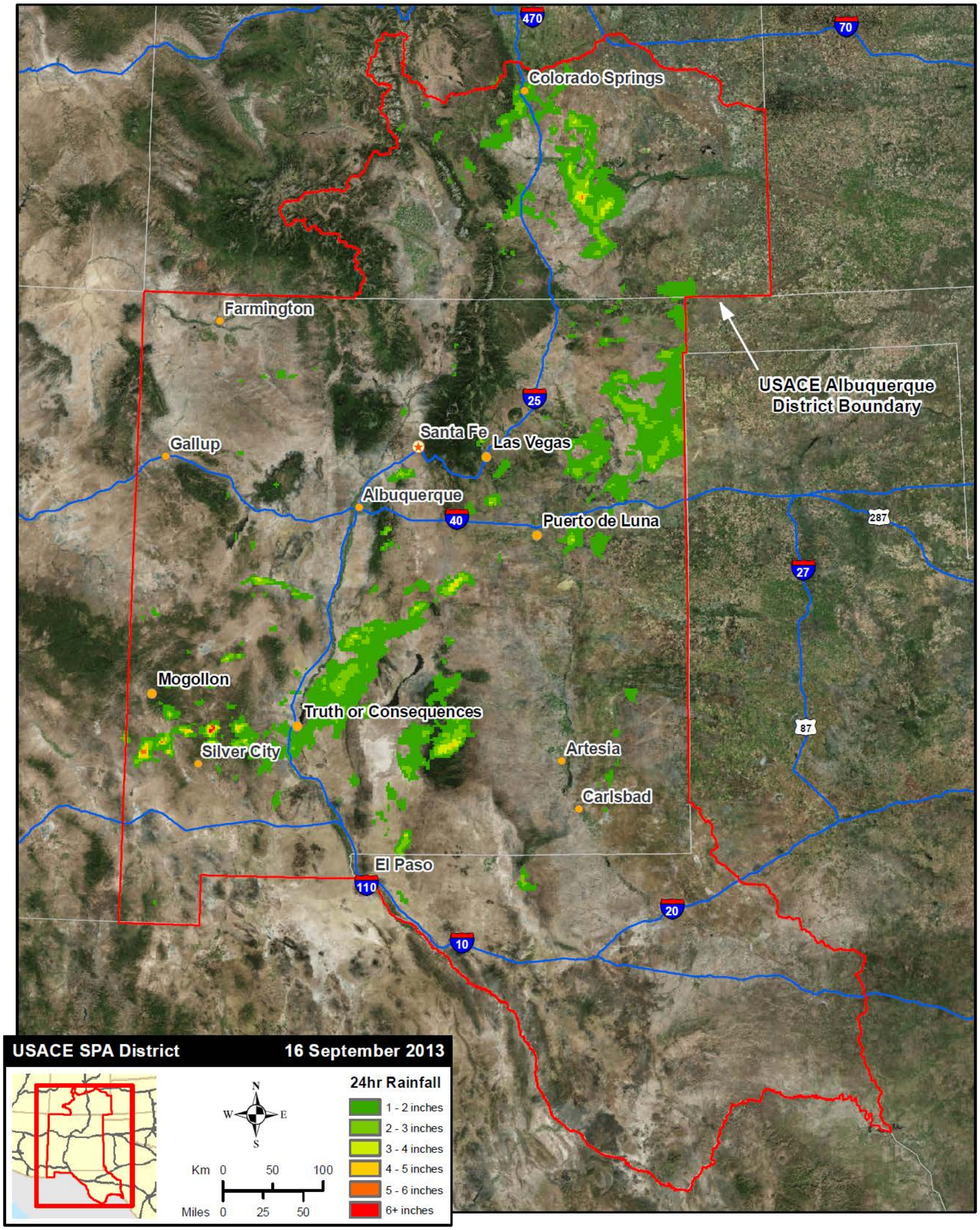


Figure 12 - Map showing areas with precipitation >1 inch on 16 September 2014 based on Doppler radar data.

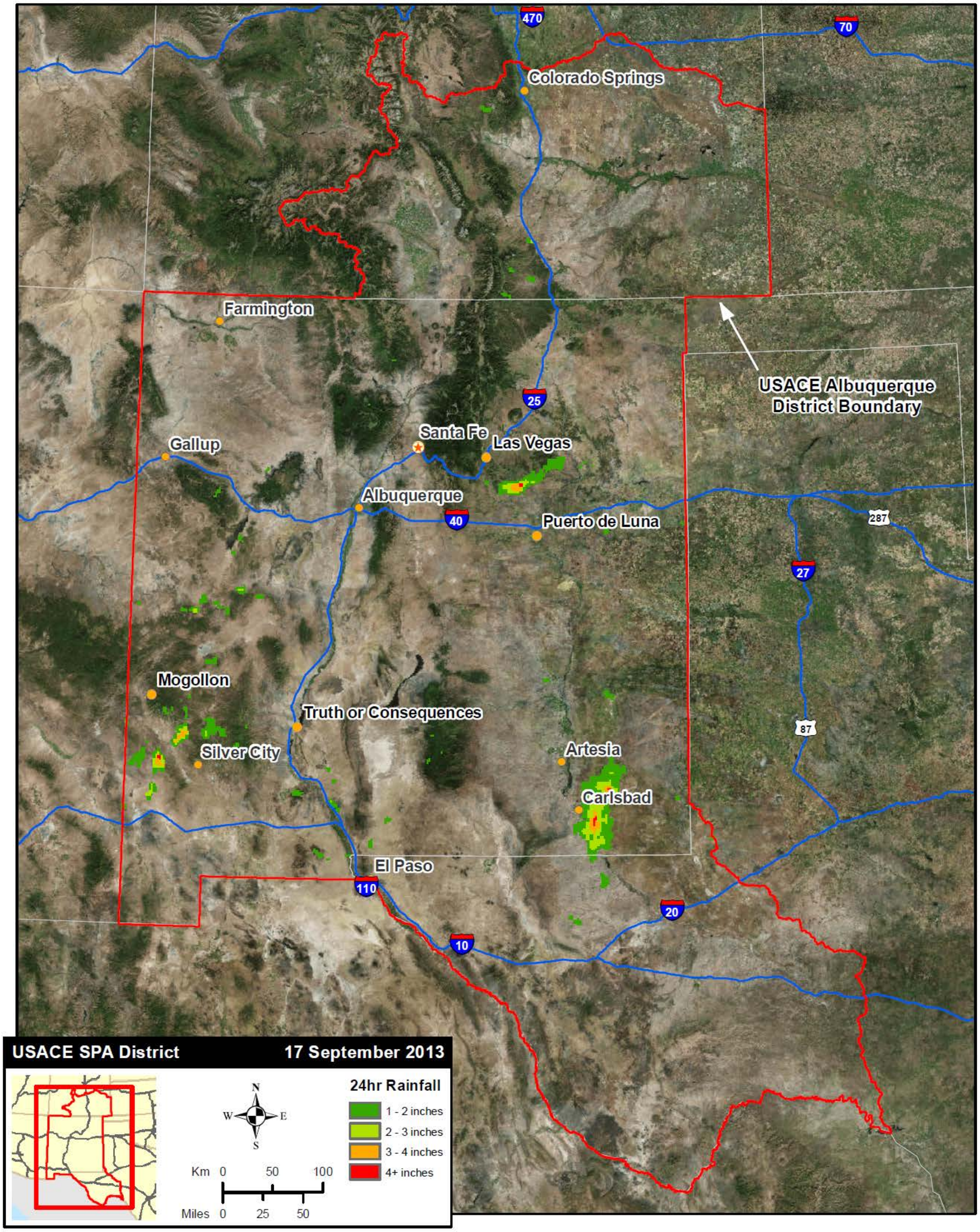


Figure 13 - Map showing areas with precipitation >1 inch on 17 September 2014 based on Doppler radar data.

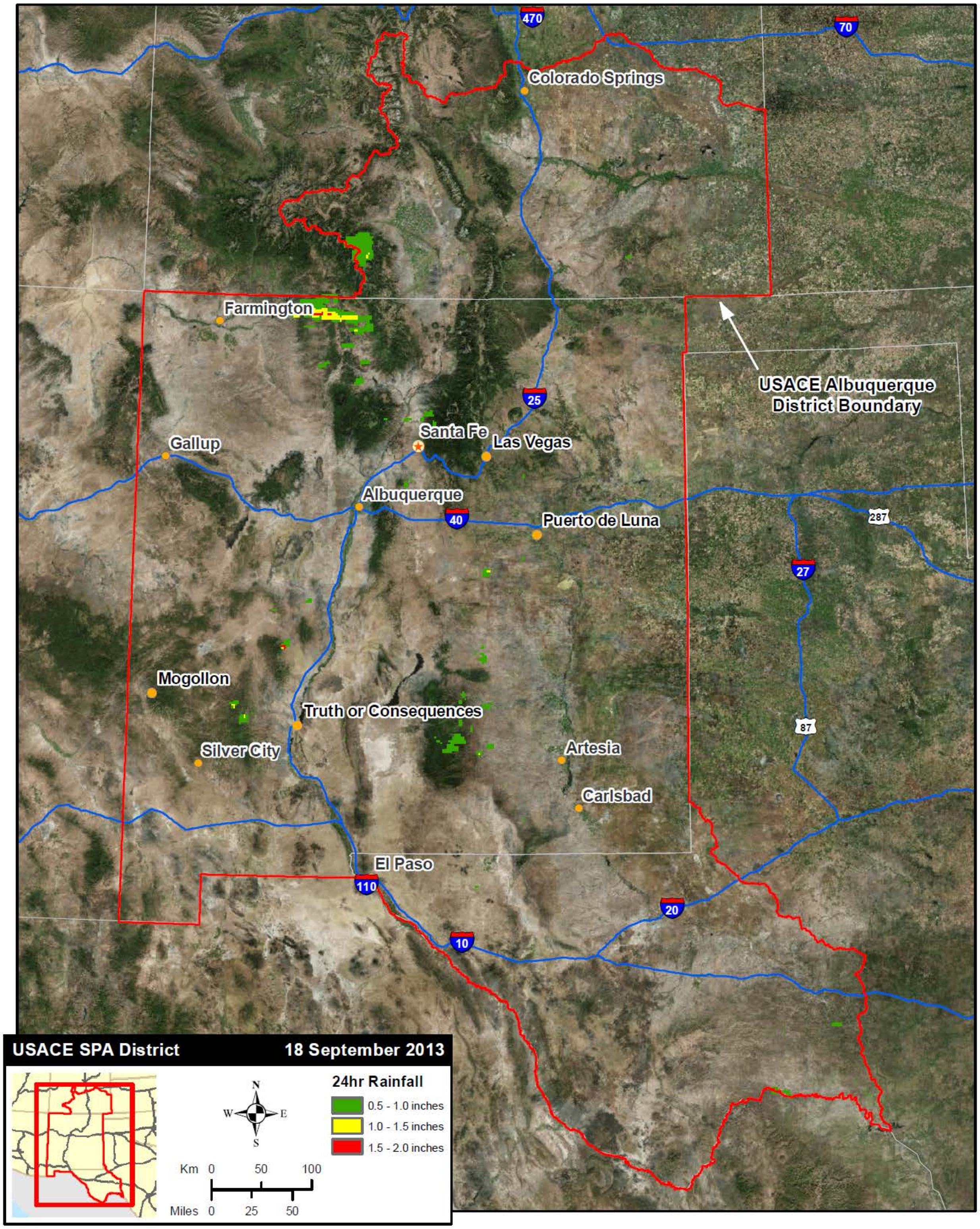


Figure 14 - Map showing areas with precipitation >0. 5 inch on 18 September 2014 based on Doppler radar data.

2.1 Drought Context of the Flood Event

The majority of the Albuquerque District was in persistent drought beginning in 2011 and continuing up to and after the 9-18 September 2013 flood event. According to the University of Nebraska - Lincoln Drought Monitor (National Drought Mitigation Center 2014), 99.63% of New Mexico and 98.09% of Colorado was in drought in 3 September 2013, with 77.62% and 59.65% of each state, respectively in severe to exceptional drought. By 24 September, following the extreme precipitation event, only 37.71 % of New Mexico and 15.75% of Colorado remained in severe to exceptional drought. Late fall/early winter precipitation have maintained these levels of drought: almost all of both states are dry or in moderate drought, with only about one-third of New Mexico (mainly in the east-central portion of the state) and 1/6th of Colorado (mainly in the southeast) in severe to extreme drought by late spring 2014.

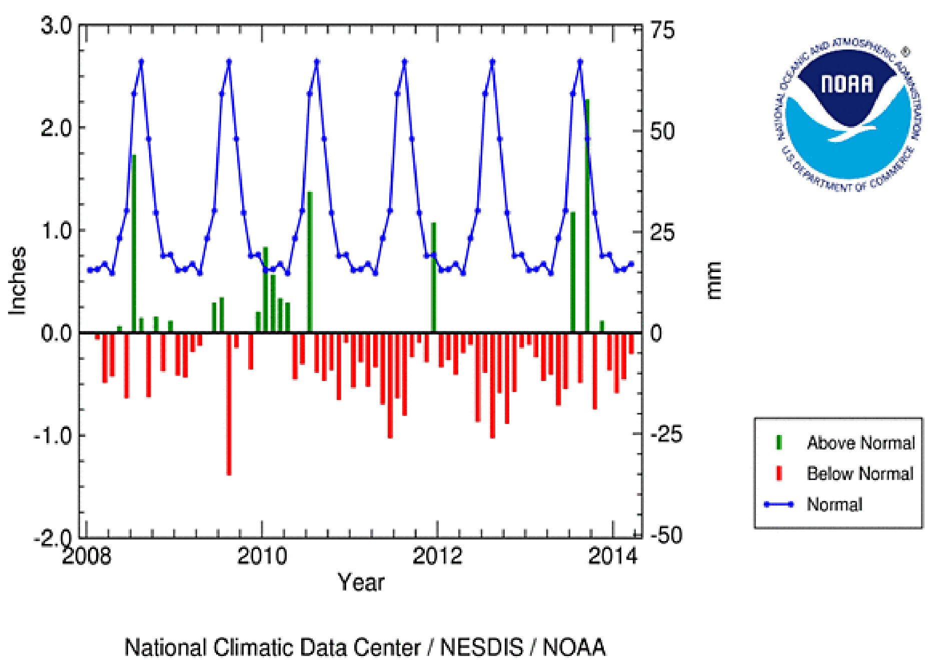


Figure 15 - New Mexico statewide precipitation, normals and departures, January 2008 through March 2014 (NOAA/NWS 2013u).

Although the September 2013 flood event ameliorated the effects of drought over much of New Mexico and Colorado, drought persists in these regions (National Drought Mitigation Center 2014). In the months following the September event, northern New Mexico and most of Colorado received near normal precipitation. For New Mexico, statewide average precipitation for the first three months of the 2014 Water Year was 72% of normal. The driest area was the Southern Desert Division with 42% of normal. The wettest area was the Northern Mountains Division with 96% (NOAA/NWS 2014b). However, with the exception of the Pecos, Canadian and Arkansas River headwaters, where less than an inch of precipitation fell, virtually no rain fell in New Mexico or southeastern Colorado in January 2014 (NOAA/NWS 2014b).

The antecedent long-term drought conditions likely had a significant impact on the resulting flooding. Prolonged winter and summer drought contributed to die-off of many annual grasses and forbs, and some perennial shrubs and trees throughout the region. The consequences are increased rainsplash erosion, reduced infiltration and heightened overland flow, resulting in increased runoff. Later in the event, saturated soils, particularly in upland areas, played a role in perpetuating flooding despite decreases in precipitation in the latter days of the event.

In areas where wildfire in previous years had resulted in denuded slopes, large floods were produced. This was particularly evident in the drainages along the eastern side of the Jemez Mountains impacted by the Las Conchas fire, including Santa Clara, Frijoles, and Peralta Canyons; in southwestern New Mexico in the tributaries of the San Francisco and Gila Rivers that head in the vicinity of the Whitewater Baldy Wildfire burn scar; and along Fountain Creek in Colorado, a tributary of the Arkansas River, whose headwaters and tributaries are located in the Waldo Canyon Wildfire burn scar area. All three of these burn scars received significant quantities of rain during this event, and severe flooding and extensive flood damage resulted in downstream reaches of the streams.

2.2 Monsoon Context of the Flood Event

The North American Monsoon (NAM) is defined by a change in wind direction at the lower and mid-tropospheric levels that entrains tropical moisture originating over the East Pacific and Caribbean Basins to penetrate into northern Mexico, Arizona, New Mexico, southeastern Utah and southern Colorado via “low-level jets” or “rivers of air in the lower troposphere”. In New Mexico, the monsoon season typically lasts from mid-July through the end of September.

According to Sheppard et al. (2002), the onset of the monsoon is tied to the northward shift in the westerlies and the simultaneous northward advance of subtropical high pressure ridge over the region. At the same time, a thermal low forms over the Lower Colorado River Basin and a high forms over the Gulf of Mexico/Southeastern U.S. The onset of the monsoon is time transgressive, occurring in June in Mexico and by the end of July over the northern Southwest. Sources of monsoon moisture include mid- and high-level air masses over the Gulf of Mexico and surface moisture over the Gulf of California, as well as moist, subtropical upper level lows (easterly waves) moving across the region (Ritchie et al. 2011). Generally, the intensity of the monsoon rainfall decreases towards the north.

Monsoonal precipitation typically consists of intense and highly localized thunderstorms, and sometimes may include isolated supercells. It is not unusual in portions of the NAM region for more than 90% of summer precipitation to fall over fewer than 5 days (Ritchie et al. 2011). When moist air is present, mountainous terrain favors more frequent thunderstorm development as daytime heating typically causes upslope and up-valley movement of air that contributes to thunderstorm development. Precipitation in most low elevation areas may be quite sparse.

There is large interannual variation in the strength and intensity of the summer monsoon. The position of the Gulf of Mexico high pressure system is critically important for determining the location of precipitation in the region (Crimmins 2006). As a result, in a typical year, monsoon precipitation will be unevenly distributed across the region, constituting a greater share of annual precipitation in some portions of the NAM region than others. The monsoon season typically ends around the end of September.

Summer 2013 started out with warm, exceptionally dry conditions in May and June following a dry winter and spring. The early monsoon was characterized by a series of violent thunderstorms in July and early August consisting of intense but highly-localized storm events (NOAA/NWS 2014e). Monsoon intensity decreased substantially by mid-August and, with the exception of the period September 9-18, was fairly quiet thereafter.

2.3 The Contribution of Tropical Cyclones over Mexico

While moist air masses over the Gulf of Mexico and the eastern Pacific provide the majority of the moisture in a typical monsoon year, the moisture source region lies within the latitude where tropical cyclones (hurricanes in the Atlantic Basin) are generated in both the western Gulf of Mexico and the eastern Pacific. Moisture from these tropical cyclones or moisture from them as they decay can penetrate the Southwest contributing to more widespread precipitation events than is "typical" of the monsoon. Historically, many of the largest floods in New Mexico – including the September 1942 and June 1965 floods – were associated with tropical storms in the moisture source region (U.S. Geological Survey (USGS) 1989).

As the monsoon season progresses, mid-latitude westerlies begin to interact with monsoonal flow as the boundary between the subtropics and the midlatitudes shifts southward. Whereas early summer tropical storms originating in the eastern Pacific tend to move northwest and dissipate over the ocean, as August and September progress, midlatitude troughs begin to interact with these storm tracks, causing dissipating tropical storms and associated moisture to recurve northeastward over New Mexico and Texas. The peak season for tropical cyclones in both the eastern Pacific and western Gulf of Mexico is mid-September. Since the tropical storm season in the eastern Pacific lasts until late November, this mechanism may cause occasional significant precipitation in the fall after the traditional "September 30" end of the NAM (Wood and Ritchie 2013).

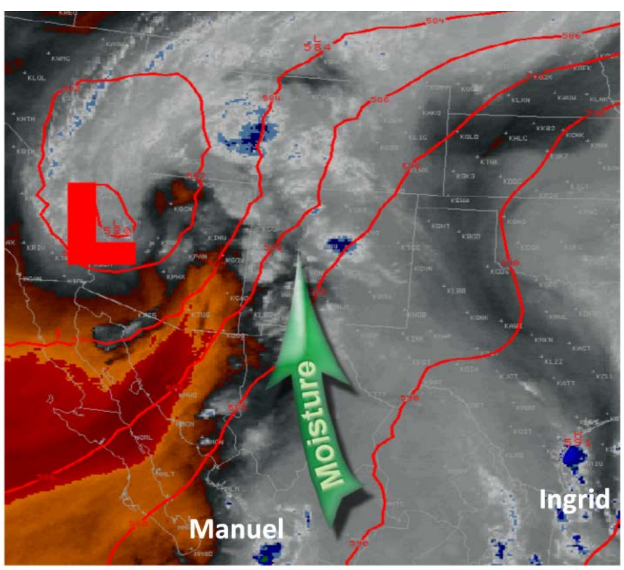


Figure 16 - Map showing how moisture from Hurricanes Manuel and Ingrid was funneled into the study area (from NOAA/NWS 2014e).

As described by Pasch and Zelinsky (2014), in late August 2013 a tropical wave moved off the west coast of Africa, crossing Central America on 10-11 September 2013. The wave was characterized by widespread deep convection and a broad surface trough. The northern portion of this wave spawned Hurricane Ingrid in the Bay of Campeche and Tropical Storm Manuel on 12 September. Manuel moved northwestward long the Mexican coast, making landfall near Pichilinguillo around 0600 on 15 September (all times are local New Mexico times and 6 hours behind UTC time) before weakening. Manuel reformed over the southern Gulf of California mid-day on 16 September, progressing northward. The storm made a second landfall just west of Culiacán, Mexico on 19 September before quickly degenerating. Throughout, there was “no clear separation between the rainfall produced by Hurricane Manuel and the rainfall due to the large-scale southwesterly flow over southern Mexico” (Pasch and Zelinsky 2014:4), indicating that moisture from this storm was entrained in monsoonal flow over much of its lifetime(s). The result was not only heavy rain across most of Mexico, but transport of large quantities of tropical moisture into New Mexico and Colorado by the existing Southwesterly flow, contributing to record-setting precipitation in both states over the period 9-18 September (Figure 15).

3 - Flooding in Climate Context

The source and cause of precipitation and extreme precipitation events in the Albuquerque District varies by season (U.S. Geological Survey (USGS) 1989):

- In the summer months, the major moisture sources for the State of New Mexico are the eastern Pacific Ocean and the Gulf of Mexico. The Gulf of Mexico is also the key year-round source of moisture for the eastern Plains (Pecos, Canadian and Arkansas Basins). Beginning in late June or early July, regional heating establishes northward movement of moist tropical air into the State where it interacts with topography and local patterns of diurnal heating to create scattered thunderstorms that may be locally-intense. This regional-scale pattern is called the North American Monsoon (NAM) and persists to the end of September. Particularly in late August and September, tropical cyclones originating over the tropical eastern Pacific or the Gulf of Mexico may become entrained in the NAM, resulting in larger, more regional precipitation events (such as occurred in September 2013).

- The transition to fall puts an end to the NAM and southward-moving frontal systems become increasingly important as moisture sources, either alone or in combination with Gulf moisture. This combination is particularly important for the eastern plains and central mountain regions. During late fall to early spring, the primary moisture source is the eastern Pacific Ocean over the western half of the State. Storms are transported into the region along the circumpolar jet stream. These storms are typically broad area storms that deliver snow and rain to the region at relatively low intensities for durations of several hours to several days.

- By late-spring, the circumpolar jet stream has migrated north of the region, producing a relatively dry, windy, and warm foresummer before the onset of NAM.

Winter precipitation is controlled by the interplay between longer and shorter sea surface temperatures in the Pacific known as El Niño – Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). When both of these phenomena are in their warm phases, eastern Pacific sea surface temperatures are warm and the air mass overlying the eastern Pacific is humid and warm. Thus, there is abundant moisture available in air masses that feed into winter storm systems that originate in the eastern Pacific and move along the circumpolar jet stream into New Mexico. This results in high winter snowfall that translates into high spring runoff and large spring runoff floods. When both PDO and ENSO are in cold phases, eastern Pacific sea surface temperatures are cool, reducing the amount of moisture in the overlying air masses that can feed into winter storm systems. The result is a dry winter with reduced snowpack accumulation, low spring runoff, and small spring flood peaks. When PDO and ENSO are out of phase or one or both are in a neutral state, the effect on winter precipitation is much reduced.

The strength of the monsoon varies greatly from year to year for reasons that are not well understood. The strength of the monsoon appears to depend on 1) how hot the Southwest gets and therefore how strong the northward transport of moist air gets; 2) how warm the sea surface temperatures are in the eastern Pacific and Gulf of Mexico, which determines the amount of moisture in air masses being pulled into the Southwest; and, 3) how active the cyclone/hurricane season is in the eastern Pacific and Gulf of Mexico during the late summer and early fall. The specific controls on interannual variations in monsoon strength are not well understood.

While the intensity, amount, and duration of precipitation are critical for determining runoff, that runoff is highly regulated on the major rivers of the Albuquerque District, by both District projects and dams and levees of other Federal, State, Tribal and local agencies. For this reason, extreme weather events rarely produce catastrophic flooding along mainstem rivers in the state (although tributary flooding may be significant and locally damaging). As is evident from the table, below, despite continued extreme weather events, mainstem flooding was significantly reduced after completion of the regions' major dam projects along the Rio Grande at Abiquiu (1963) and Cochiti (1973); along the Pecos River at Santa Rosa (1979), Two Rivers (1963), Sumner (1939), and Brantley (1987); along the Arkansas at Pueblo (1975),Trinidad (1977), and John Martin (1948); and along the Canadian at Conchas (1939) and Ute Lake (1963).

Table 1 - Years since 1903 with high flood discharge, data by basin (Ruffner 1985).

Basin	**Year with High Flood Discharge since 1903**
Rio Grande	1904, 1905, 1929, 1935, and 1941
Pecos	1904, 1905, 1915, 1916, 1937, 1941, 1942, and 1966
Canadian	1904, 1913, 1937, and 1965
San Juan	1909, 1911, 1927, 1929, and 1942
Gila	1941 and 1965

Rio Grande flows are monitored at several stream gages maintained under a cooperative agreement between the USACE and the U.S. Geological Survey (USGS). The gages include the Rio Grande at Embudo, the Rio Grande at Otowi, the Rio Chama near Chamita, and the Rio Grande at San Marcial (Table 2). Figure 16 displays the USGS stream gages in the Upper Rio Grande Basin within the boundary of the Albuquerque District.

Table 2 - Select stream gages along the Rio Grande.

USGS #	**Gage Name**	**Location**
08279500	Rio Grande at Embudo	On the Rio Grande in Rio Arriba County north of Española and north of the confluence with the Rio Chama
08313000	Rio Grande at Otowi Bridge	On the Rio Grande in Santa Fe County near San Ildefonso Pueblo and downstream of Española and the confluence of the Rio Chama and upstream of White Rock Canyon
08290000	Rio Chama near Chamita	On the Rio Chama in Rio Arriba County upstream of the confluence with the Rio Grande, and the gage records the Rio Chama contribution
08358400	Rio Grande Floodway at San Marcial	On the Rio Grande in Socorro County at the downstream end of the Middle Rio Grande Valley and upstream of Elephant Butte Reservoir

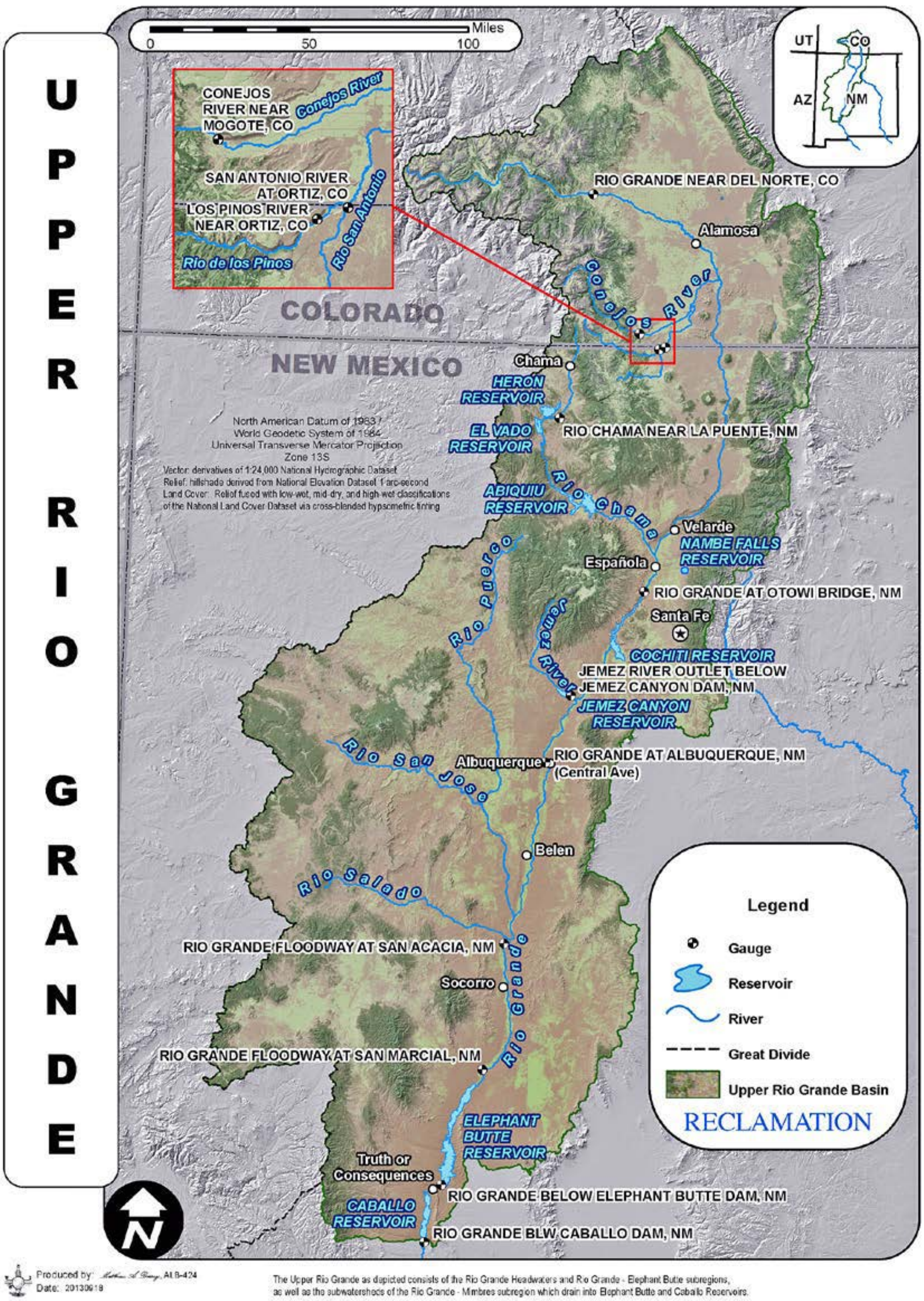


Figure 17 - Map of the Rio Grande Basin above Elephant Butte Dam [Reclamation – URGIA report p. 10].

3.1 Principle Causes of Major Flooding

Based on the above discussion, it is evident that widespread flooding in the Southwest resulting in large, mainstem floods is primarily the result of one of two types:

- Spring runoff flooding
- Tropical cyclones / cyclone remnants entrained in the NAM

In addition to these two mechanisms, which are further described below, more localized storm events are able to cause record floods in tributary drainages. For example, on Thursday, 16 August 2012, a large thunderstorm developed over the eastern Jemez Mountains and moved east-southeastward, causing damages in the vicinity of Santo Domingo Pueblo (Diven 2012). The August 16 storm passed below Galisteo Dam, causing Galisteo Creek to flood unchecked, overtopping the Rail Runner railroad bridge near the Kewa station. The damage was highly localized, and the storm rapidly dissipated: despite the high flows, the event did not register as a significant peak on the gage below Galisteo Dam because that gage was upstream of the storm event. Although lower Galisteo Creek is ungaged, it is evident that flows were lower during the September 2013 event than the previous year as no damage to the bridge was recorded in 2013. Despite this, the September 2013 event produced the flood of record for Galisteo Dam: on 16 September 2013, a new "peak flow" of 11.7 feet (4.6 ft above the previous record set in 1981) was recorded at the gage just below Galisteo Dam (Jadmak 2013). Despite producing high tributary flows, localized storm events produce low flow volumes and consequently are not a significant cause of mainstem flooding in the region.

3.1.1 <u>Spring Runoff Flooding</u>

Since the initiation of streamflow records in 1889, the notable spring floods occurred in New Mexico in 1903, 1920, 1941, and 1942. These were caused by snowmelt runoff and were large-volume, long-duration floods. Additional floods of note occurred in 1958, 1973, 1979, 1985, 1986 and 1987.

3.1.1.1 May 1903 Flood

In 1903, the upper Rio Grande watershed received an excessive amount of snowfall before May, and the snow melted slowly during May. Two separate floods occurred. The first occurred in May and originated in the Rio Chama Basin. The May flood reached a peak discharge on 15 May of 10,900 cfs at the Rio Grande at Otowi Bridge gage below the Rio Grande-Rio Chama confluence. By contrast, the Embudo Gage at this time recorded a discharge of just 3,640 cfs, indicating that the mountainous regions in Colorado had contributed very little water to this flood event. The peak flow on the Rio Grande attenuated to 8,950 cfs by the time the flow reached San Marcial on 18 May. There was no apparent flood inflow below Otowi. A second flood occurred in June and originated from both the Rio Grande and the Rio Chama watersheds.

3.1.1.2 May-June 1920 Flood

The high runoff lasting from May through July 1920 was caused primarily by rapid melting of the abnormally high snowpack of southern Colorado and northern New Mexico. Prevailing high temperatures and general warm rains induced a high rate of runoff. Several heavy rainfall events augmented the flood. During the 12 days in May of the 1920 flood, the flow at the Otowi gage exceeded 20,000 cfs, and the flow exceeded 25,000 cfs for seven consecutive days.

3.1.1.3 May 1941 Flood

Following the drought of 1931-1941, snowfall during the winter and spring of 1941 was the heaviest on record at some locations. Abnormal temperatures and rainfall during the runoff period, combined with excessive snow cover, produced a flood having a maximum peak of 22,500 cfs at the Otowi gage on 16 May and 24,600 cfs at San Marcial on 17 May. The duration of the flood was in excess of two months, with flows exceeding 20,000 cfs for five days at Otowi and ten days at San Marcial. The peak discharge on the Rio Chama at Chamita, which was partially controlled by El Vado Reservoir, was 9,910 cfs on 14 May. The next year, spring flooding occurred due to snowmelt in the mountainous regions of northern New Mexico and southern Colorado and augmented by rain in April. Although flow above 5,000 cfs occurred over a longer period of time than during the 1941 flood, the peaks were lower. A peak of 16,400 cfs at Otowi was caused by rainfall. A peak of 18,400 cfs was measured at San Marcial on 26 April. 1941 is unique in having had significantly above average precipitation throughout the year, earning it the title of “wettest year on record” (NOAA/NWS 2013u).

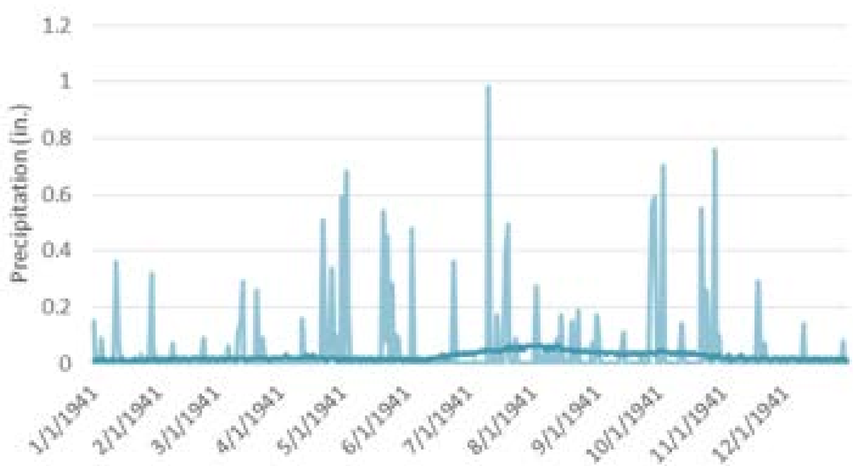


Figure 18 - Precipitation in Albuquerque during 1941 (light blue line) and average precipitation for those dates (darker blue-green line) (NOAA/NWS 2013u).

3.1.1.4 Other Notable Spring Floods

An extended period of drought affected the area from 1942 to 1979. However, in the spring of 1958, a heavy snowpack runoff from the mountainous areas of the Rio Grande Basin produced peaks of 11,000 cfs and 11,800 cfs at Otowi and Bernalillo, respectively. A peak discharge of 9,100 cfs at Albuquerque was produced by the runoff of another heavy snowpack in the mountains of Colorado and northern New Mexico in May 1973. The flood flows stressed sections of the existing levees.

In 1979, higher than average snow accumulation was augmented by two late storms in May, and lower than normal temperatures through the winter delayed runoff peaks. Average daily flows in the Rio Grande at the Otowi gage exceeded 5,000 cfs from 24 April through 5 July, with a peak discharge of 12,300 cfs recorded on 9 July. Albuquerque experienced a peak flow of 8,650 cfs on 1 June. All USACE reservoirs were storing flood water during this period; flows would have been higher under unregulated conditions.

In 1985, the basin experienced an above average snowpack, and above average precipitation resulted in the snowmelt runoff exceeding 250 percent of normal in many areas of the basin. For the first time, USACE flood control projects in the upper basin (Abiquiu, Cochiti, and Jemez Canyon Dams) were used to provide flood management for the area below Elephant Butte Dam. A 50,000 acre-foot reserve was maintained in Elephant Butte Reservoir to provide space for a 1.0%-chance flood event. In 1986, the observed snowmelt runoff in the Rio Grande Basin was approximately 200 percent of normal. Again, a 50,000 acre-foot reserve was maintained in Elephant Butte Reservoir. Another heavy snowpack and above normal runoff occurred in 1987. The peak discharge at Albuquerque of 7,840 cfs occurred on 24 July. Due to the successive years of full reservoir storage at Elephant Butte Reservoir, a significant amount of sediment deposition created a sediment plug at the headwaters of the reservoir.

3.1.2 Tropical Cyclones / Cyclone Remnants Entrained in the NAM

The combination of southwesterly flow and moisture from tropical storms/storm remnants has long been recognized as a key cause of regional flooding:

> The southern part of the study region, from the Mexican border to approximately 37°N [CO-NM border], has been affected by the remnants of several tropical storms. Throughout this southern portion of the study region [which is the area between the continental divide and the 105th meridian] these storms are a major producer of heavy rainfall, and could be considered a prototype for the PMP storm (NOAA 1988).

In addition to the September 2013 flood event, major region-wide floods where tropical cyclones played a major role include floods on 26 September to 5 October 5, 1904; 1 September 1942; 17 June 1965; and 30 September – 3 October 1983.

3.1.2.1 26 September – 5 October 1904

The 26 September – 5 October 1904 flood was associated with intense, widespread rainfall (Paulson et al. 1989) and resulted in property damages in excess of $1 million dollars [1904 dollars], (Sloan 1904:468). Circumstantial evidence points to tropical storm, storm remnant, or trough as the primary moisture source: large area affected (New Mexico and southern

Colorado)[1], multi-day event, and time of year. A hurricane was present in the western Gulf of Mexico: known simply as Hurricane #3, the storm originated in the western Caribbean on 28 September and moved northwestward, making landfall in the Belize on October 3[2]. Moisture from the antecedent tropical easterly wave that spawned this hurricane would also have been present over northern Mexico. Finally, the October 1919 Monthly Weather Review places this event in its category of large fall flood events where moisture fueling the precipitation is an "aftermath of the tropical storms or West Indian hurricanes which occasionally strike the coast in the vicinity of the mouth of the Rio Grande" and that "generally dissipate in torrential rains over northern Mexico" (Henry 1919:742).

The area affected by the September-October 1904 event included the northern, eastern, and northeastern parts of the State. Anecdotal and limited gage records indicate that this flood was larger than the 1965 flood, and possibly larger than the flood in 1942. From 26-30 September, total precipitation in the upper Canadian River basin ranged from 4 to 7.38", with greatest 24-hour totals ranging from 2.17 to 3.98 inches (Murphy 1905). At Logan, NM, the gage rose from 0.80 ft on 26 September to 30.00 ft on 1 October, after which the gage was destroyed (Murphy 1905). The estimated peak discharge for the Canadian River at Logan was 149,396 cfs (Murphy 1905). The peak may have been reached on 3 October 1904. Anecdotally, this flood is estimated to have been larger than the prior major flood in 1885. Flooding was also recorded on the Rio Mora during the period 29 September – 10 October, coming as two peaks (29 September and 7-8 October) with extensive damage in the entire Mora Valley (Murphy 1905).

Concurrently, the Pecos Basin experienced the "heaviest and most destructive flood in its recorded history" as of 1904 (Murphy 1905). From 26-30 September, more than 5 inches of rain was recorded at Arabela, Cloudcroft, Fort Stanton and Las Vegas, but less than an inch in Carlsbad and just over 1 inch in Roswell. Precipitation 5-8 October was 2-3 inches at Arabela, Cloudcroft and Fort Stanton. The gage at Santa Rosa exceeded 23 ft on 30 September and washed out; the gage at Roswell peaked at 16.45 ft on 30 September 30 and 1 October (Murphy 1905).

Flooding was pronounced on the Gallinas River near Las Vegas, NM, on the night of September 30, with four timber dams on the Gallinas River washing out, "liberating about 6 acre-feet of water". The dam timbers caused a log-jam that contributed to flooding in Hot Springs and Las Vegas. Flooding also occurred on the Hondo River at the same time. Avalon Dam near Carlsbad failed on 1 October 1904, with the flood wave causing extensive damage downstream (Murphy 1905).

The same system also brought frequent and heavy rain to the Rio Grande Basin, including 2.88 inches in Taos, 4.15 inches in Los Lunas, and 5.48 inches in Socorro. Two flood peaks were recorded on the Rio Grande, the first beginning 2-4 October and the second beginning 11-12

[1] No major Texas hurricanes are reported with impacts to communities in 1904 (Roth n.d.); however this list does not include other tropical storms or hurricane remnants capable of funneling moisture northward.

[2] See Unisys Corp. (2011) ; data are not available for the eastern north Pacific coast of Mexico for the period 1893-1909 (Hurd 1929).

October and being larger and longer than the first (Murphy 1905). The runoff peak was estimated at 17,700 cfs at Buckman and 33,000 cfs at San Marcial (Scurlock 1998: 37).

3.1.2.2 1 September 1942

The 1 September 1942 flood primarily impacted the Canadian and Pecos Rivers and was most severe in the lower reaches of streams. This flood was caused by moderately widespread rainfall. Peak discharges at many gaging stations had recurrence intervals of 50-75 years. On 1 September, the peak discharge of the Pecos River near Puerto de Luna was 48,600 cfs, which has a recurrence interval in excess of 100 years (U.S. Geological Survey (USGS) 1989). This flood was caused by a tropical storm that moved inland from the Gulf of Mexico on the morning of 30 August. Precipitation began in New Mexico on 29 August as moisture from this advancing cyclone was entrained in southwesterly monsoonal air flow. The storm crossed into New Mexico in the vicinity of Roswell on the 31^{st} and then moved north-northeastward, reaching the Tucumcari area on the morning of 1 September. A cold front moving across New Mexico and Texas from the northwest put an end to the precipitation. As much as 8 in of rain fell in the 84-hr storm at Rancho Grande (near Santa Rosa), Maxwell, and Chico, NM. The maximum average depth of rainfall over a 1,000 mi^2 area for 24 hr was 6.8 in (NOAA 1988:47-50).

3.1.2.3 17 June 1965

In the 17 June 1965 flood, moisture from a hurricane from the Gulf of Mexico led to intense, widespread rainfall and damage in the tens of millions of dollars across northeastern, southeastern and parts of the northern areas of New Mexico. This was estimated as a 25 to more than 100-year flood event (U.S. Geological Survey (USGS) 1989). It is unusual to have flooding this early in the monsoon season due to a tropical storm both because June storms relatively rare in the western Gulf of Mexico and the southwesterly flow that typically advects such moisture is typically not yet in place.

3.1.2.4 30 September – 3 October 1983

This flood primarily affected the Gila River Basin, including the San Francisco River, as well as the Mimbres River(U.S. Army Corps of Engineers (USACE) 1983). In this flood event, a closed low developed east of Baja California on September 29. This low was stationary between 29 September and 2 October, steering numerous shortwave troughs rapidly northeastward across Arizona and New Mexico. Beginning 1 October, but possibly as much as 24 hours earlier, moisture from the decaying tropical cyclone Octave became entrained in the flow. On 2 October, the low moved northeastward across Arizona, triggering the last heavy burst of rain in southwestern New Mexico before southerly flow was suppressed and the rains tapered off on 3 October.

This storm produced flood peaks on the San Francisco river that are considered the maximum of record and in the frequency of the 100-year event. However, flood peaks on the Gila and Mimbres rivers were only in the frequency of the 5-year to 35-year event.

Table 3 - Streamflow data for the 30 September – 3 October 1983 flood (USACE 1983).

Gage Location	Peak Flows (cfs)
San Francisco River at U.S. Highway 180 Bridge	30,000
Mineral Creek at U.S. Highway 180 Bridge	1,600
San Francisco River, Gage near Alma	56,600
Whitewater Creek at the U.S. Highway 180 Bridge	5,000
San Francisco River, Gage near Glenwood	37,100
San Francisco River, Gage at Clifton, AZ	90,000

3.2 Frequency of Tropical Cyclone Impacts to New Mexico

Tropical cyclones regularly impact New Mexico. Between 1980 and 2012, at least 43 tropical cyclones or cyclone remnants impacted the state (Wikipedia 2014). However, in most cases the impacts were slight or localized.

3.2.1 East Pacific Basin Tropical Cyclones

East Pacific tropical cyclones recurve and enter the Southwest United States, typically in August to late September/October. For the 21-year period 1989-2009, 20 Eastern Pacific named storms recurved northeastward, interacted with a midlatitude trough, and produced a large swathe of precipitation across the Southwestern U.S. (Wood and Ritchie 2013). The distribution is clustered, with multiple storms moving into the Southwest in some years (1992, 2004, 2006, 2008, and 2009) and none in others (e.g., 1990) (Wood and Ritchie 2013). The reason for this variation is not clear, although some research suggests a link to ENSO cycles (Carter 2002).

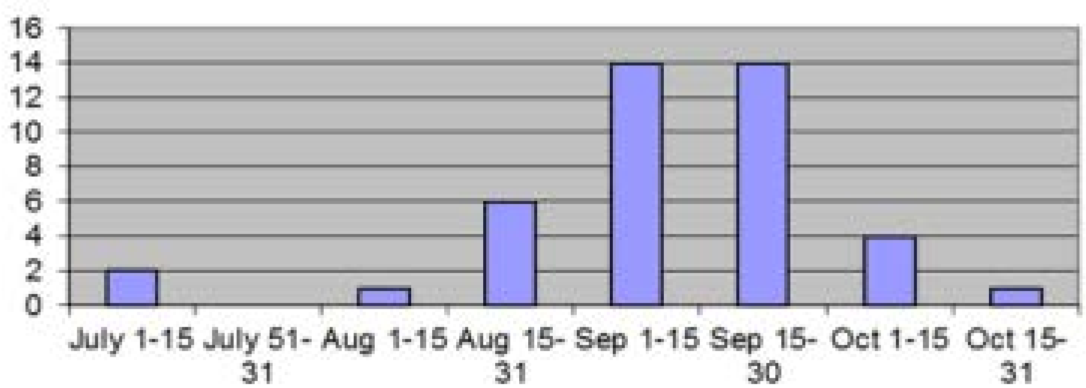


Figure 19 - Average number of eastern Pacific hurricanes affecting New Mexico (NOAA/NWS 2013u).

3.2.2 Atlantic Basin Tropical Cyclones

Remnants of Atlantic Basin tropical cyclones (hurricanes) infrequently impact New Mexico and adjacent areas. These storms typically impact the eastern and central parts of the state (Carter 2002). The frequency with which Gulf Hurricanes impact New Mexico has not been assessed, but seem to be much lower than for cyclones in the eastern Pacific Basin. Examples include:

- August 1970. Moisture from Hurricane Celia moved into southern New Mexico on 15 August 1970 after the hurricane had traversed Texas beginning 3 August (Roth n.d.).

- July 2008. Hurricane Dolly moved northwestward into southeastern New Mexico and the El Paso, TX area on 26-27 July 2008, dropping 1-5" of rain over the region before dissipating (Roth n.d.).

3.3 Changing Extreme Event Frequencies Under a Changing Climate

Three essential ingredients contribute to tropical cyclone-related extreme widespread precipitation events in late summer-early fall in New Mexico: baseline monsoon conditions; tropical storm occurrence (frequency and intensity); and the location of the jet stream responsible for the presence and position of troughs of low pressure that redirect cyclone movement towards New Mexico and adjacent areas.

3.3.1 Observed Trends

This section reviews observed regional trends in monsoon precipitation, tropical cyclone intensity and frequency, and changes to the jet stream. The main monsoon core region lies in western Mexico, extending to the Phoenix-Tucson area of Arizona, and weakening to the north and northeast. Monsoon behavior is defined by its start and end date, rainfall intensity and duration of wet and dry spells (Kunkel et al. 2008). Long term data in southern Sonora indicates that the onset of summer rains has been increasingly delayed (1.57 days/decade or approximately 9.89 days over the 63-year period 1943-2005), resulting in a longer, dry "foresummer" (Kunkel et al. 2008). In addition, the duration of the average wet spell has decreased by almost a day, with wet spells typically lasting slightly more than 3 days instead of just under 4. The same study also showed that precipitation intensity has increased from approximately 5.6 mm/day to 7.5 mm/day (a 17% increase) (Kunkel et al. 2008).

Tropical storm rainfall in western Mexico, an indication of tropical storm moisture availability for the Southwest U.S., has experienced a long-term upward trend (Kunkel et al. 2008). Moisture from tropical storms constitutes an increasing share of summer/fall precipitation. Combined with a downward trend in monsoon precipitation, this suggests a pattern of longer dry spells interspersed with wetter wet spells. Tropical cyclones also appear to be producing more rain per event in recent decades compared to the period 1949-1975.

There has not been a significant change in tropical cyclone-derived rainfall along the southeastern coast of the United States despite increases in total annual precipitation of more than 20% since the 1990s (Kunkel et al. 2008).

Although globally, the number of tropical cyclones has remained unchanged during the satellite era, warmer ocean temperatures have contributed to measurable increases in hurricane intensity, driving an increase in the frequency of powerful hurricanes as a fraction of the total number of hurricanes in a season (Kunkel et al. 2008).

There has been a significant northward shift in the midlatitude storm track, which is responsible for the movement of extratropical (midlatitude) storms, ridges of high pressure, and troughs low pressure across the U.S. (Kunkel et al. 2008). This has resulted in a reduction in storm frequency across midlatitude North America. In recent years, changes to Arctic Sea Ice cover have led to reduced summer temperature difference between the Arctic and subtropics, which may be contributing to the development of a slower, more meandering jet stream, particularly in the fall months (Francis and Vavrus 2012). These changes result in a slower west-to-east progression of such important weather features as storms, ridges, and troughs.

3.3.2 Model Projections

Under a warmer climate, the jet stream is anticipated to shift farther north, which is likely to reduce winter precipitation across the Southwest. The resulting strengthening of the subtropical high over New Mexico, producing increased subsidence and drying, could negatively impact NAM precipitation, but impacts to NAM extremes are unclear (Gershunov et al. 2013). Recent analysis of model projections by Cook and Seager (2013) indicate that warming by the end of the century may result in less precipitation in June and July, but more in September-October, with little or no major shift in the total amount of precipitation received. Precipitation may become less frequent but more intense (Gershunov et al. 2013). Significant challenges to understanding and model future changes to NAM remain (Gershunov et al. 2013).

There are no specific studies looking at the frequency of tropical cyclone impacts in New Mexico and how this will trend in the future in response to warming. However, both Pacific and Atlantic Basin tropical cyclones have been studied using climate modeling data. Model projections suggest that wind speeds and core rainfall rates are likely to increase for both the Pacific and Atlantic Basin tropical cyclones in response to climate warming. The anticipation is that for each 1°C (1.8°F) increase in tropical sea surface temperatures, hurricane surface wind speeds will increase by 1 to 8% and core rainfall rates by 6 to 18% (Gutowski et al. 2008) Overall storm frequencies may decline, but the proportion of storms that are large (Category 4, 5) is expected to increase. The data are insufficient for assessing whether there will be changes in tropical cyclone frequencies in a warmer world (Gutowski et al. 2008).

3.3.3 Implications for Future Tropical Storm-Related Flood Events

In sum, the observed trends over recent decades are a decrease in NAM precipitation frequency but an increase in intensity. Tropical cyclones in both the Atlantic and Pacific Basins show no change in frequency but an increase in precipitation intensity and an increase in frequency of more intense tropical cyclones as a fraction of the total. The midlatitude storm track has moved northward and, possibly in response to a warming Arctic, is slower and more sinuous. Model projections under future warming scenarios suggest that these trends are likely to continue.

Intuitively, the implications of the trends and model projections suggest that, in the future, more intense storms may be available to be entrained in the August-September monsoonal flow. In addition, once a trough of low pressure forms over the Great Basin, its eastward progress is likely to be slower. The implication is that once the right conditions “set up” (trough over the Great Basin, high pressure over the southern Plains/Southeast, one or more tropical cyclones over northern Mexico), there may be a longer period during which conditions are ideal for funneling moisture from increasingly more intense tropical cyclones into the region. Additional research and modeling to address future and projected trends for such extreme precipitation events is urgently needed.

4 - Rio Grande Basin

4.1 Rio Grande Basin Overview

The Rio Grande stretches approximately 2,000 miles from its headwaters along the Continental Divide in the San Juan Mountains of southwestern Colorado to its terminus in the Gulf of Mexico near Brownsville, Texas. The watershed measures approximately 336,000 square miles, but only about half of the total area, 176,000 square miles, contributes to the river’s flow. The major tributaries in Colorado and New Mexico are, from north to south, the Conejos River (821 square miles), Rio Chama (3,150 square miles), Galisteo Creek (670 square miles), Jemez River (1,038 square miles), Rio Puerco (6,057 square miles), and Rio Salado (1,394 square miles). The Rio Grande watershed upstream of El Paso, Texas, contains five closed basins: San Luis in Colorado; and the Llano de Albuquerque, North Plains, San Augustin Plains, and Jornada del Muerto in New Mexico. The Pecos River joins the Rio Grande at Amistad Reservoir, and is treated as a separate basin with respect to analysis of the September 2013 Event [see next major section].

The Rio Grande originates in the Southern Rocky Mountains, a region of high mountains interspersed with high plains and narrow mountain valleys. Mountain peak elevations range from approximately 8,000 feet to over 14,000 feet, and the high plains elevations range from 6,000 feet to 8,000 feet. The Rio Grande flows roughly east to the San Luis Valley before turning south and entering New Mexico below the confluence of the Conejos River. Downstream of the San Luis Valley, the river becomes entrenched in the narrow, deep canyon known as the Rio Grande Gorge, thence through a wider basin at the confluence of the Rio Chama. Flows on the Rio Chama are stored at three projects, including the non-USACE El Vado and Heron Lakes, and the District’s Abiquiu Lake. Below the Rio Chama confluence, the Rio Grande passes through White Rock Canyon along the eastern margin of the Jemez Mountains. The USACE Cochiti Dam and Lake project, the primary mainstem flood control dam, is located at the mouth of White Rock Canyon. Immediately downstream of Cochiti, flood control structures are present on Galisteo Creek to the east and the Jemez River that enters from the west.

Below Albuquerque, tributaries are fewer, with the primary tributaries being the Rio Puerco and Rio Salado, both of which enter from the west above Socorro, NM. These are both ephemeral, as are tributaries further south such as Palomas and Animas Creeks, which join the Rio Grande at Truth or Consequences, just below the last major irrigation storage reservoirs in New Mexico: Elephant Butte and Caballo Lakes.

Although dams along the Rio Grande and tributaries serve a range of flood control and irrigation storage functions, during flood emergencies the facilities are operated in concert to maximize flood control and minimize flood damage within the basin. During the September 2013 Event, daily and more frequent coordination occurred between USACE, Reclamation, the Middle Rio Grande Conservancy District, US Geological Survey, tribal partners, local flood control authorities (such as the Albuquerque Metropolitan Area Flood Control Authority, and the Southern Sandoval County Area Flood Control Authority), local governments, and others.

4.2 Meteorological Event in the Rio Grande Basin

In the Rio Grande Basin, rain began to fall late in the day on Monday, 9 September. Approximately 1 to 2 in of rain fell in the Mimbres Basin and flooding was reported from downtown Silver City to Pinos Altos (NOAA/NWS 2014e). Rain became more widespread on 10 September, particularly in the Mimbres Basin and along the Rio Grande from between Elephant Butte and the Colorado Border. The heaviest precipitation occurred in and around Socorro, Grant and Dona Ana Counties, with Grant County receiving 3.5 in near Tyrone and Dona Ana County receiving almost 2 in of rain at Santa Teresa (U.S. Army Corps of Engineers (USACE) 2013a, NOAA/NWS 2014e). Precipitation over the Las Conchas wildfire burn scar led to flooding along Frijoles Canyon in Bandelier National Monument, with a peak stage of 2.36 ft observed at the Upper Crossing Stream Gage and 3.49 ft at the Lower Frijoles Stream Gage (National Park Service, unpublished data).

Precipitation was widespread and extensive Tuesday afternoon into the early morning of Wednesday, 11 September, but became much lighter along the Rio Grande during the day on Wednesday. Several reaches of the Rio Grande approached channel capacity (such as the Socorro, NM area where flows were estimated up to 6,000 cfs), but flooding was not reported. The Las Conchas burn scar rain gages reported up to 2.8 in in some areas, but a significant increase of flow into Cochiti Lake was not observed and Rangers reported that the lake was murky but clear of debris (U.S. Army Corps of Engineers (USACE) 2013a).

While the Rio Grande in New Mexico and Colorado received a break, the areas east of the Rio Grande received significant rainfall, including in Hudspeth and El Paso Counties, TX, and Dona Ana County, NM and in the Pecos Basin (see Pecos Basin chapter). Up to 7 in of rain fell around Dell City, TX, flooding the Salt Flats in the Salt Basin. In West Texas, almost 4 in of rain fell at Fort Hancock, 3.3 in at Horizon City and 2.3 in at Socorro (NOAA/NWS 2014e).

Widespread rainfall resumed on Thursday, 12 September, with the strongest precipitation in the closed basins east of El Paso, TX and in southern Dona Ana County, NM. In El Paso, 4 inches of rain resulted in flooding and rockslides that led to the closure of Interstate 10 and Transmountain Road. In La Union, NM, a suburb on the NW side of El Paso, severe damage occurred after an earthen dam breached, flooding the community. In Sierra County, NM 3 to 4 in of rain fell in the vicinity of Truth or Consequences causing flash floods in both Palomas and Animas that flooded part of Truth or Consequences; 200 homes had to be evacuated, bridges washed out along Highway 187 and a motorist driving along Highway 54 in Ash Canyon was killed when his vehicle was swept off the road by floodwaters (NOAA/NWS 2014e). Rain also fell on saturated soils in northern New Mexico, producing a flash flood along Frijoles Canyon that measured 6.4 ft at the Upper Crossing Stream Gage and 7.04 ft at the Lower Frijoles Stream Gage (National Park Service, unpublished data).

Widespread and extensive rainfall returned to the Rio Grande on Friday, 13 September. Rain was particularly intense over the Middle Rio Grande south of Cochiti Lake, in the Grants area, in and around Sierra County, and area east of El Paso, TX. Upstream of Cochiti Lake, precipitation was low, but in the Jemez Mountains immediately west of the lake intense precipitation over the already-saturated soils led to flooding in Frijoles and Santa Clara Canyons. At Cochiti Dam, reservoir control staff kept releases to a minimum in order to reduce downstream flood risk:

consequently, primarily flooding of tributaries downstream of the dam was responsible for peak flows at the San Felipe gage of 9,000 cfs. Rain falling on saturated soils in Peralta Canyon led to a large flash flood that carried enough sediment to dam the Rio Grande, diverting flows into an abandoned river channel and severely restricting potential flood control releases at Cochiti Dam. Damage to arroyos was also reported in the City of Rio Rancho, with the Harvey Jones Channel overflowing into Corrales.

Particularly heavy rain fell in the Rio Puerco drainage, with arroyos flowing in McKinley County. Navajo Nation Tohajiilee reported damage to 15 tribal roads and flooding of the community school, Indian Health Services, housing, and the fire department. Along Interstate-40 in the vicinity of the Tohajiilee exit, a sinkhole developed in the highway median. Twenty-two communities on the reservation reported flooding; in addition, Navajo Nation Road 562 in Fruitland was undermined. Flooding was also reported in Valencia County. Further south, in Sierra County, flooding was significant, with 1-2 feet overtopping State Route 187. Channel capacity of the Rio Grande was exceeded entering Elephant Butte and between Elephant Butte and Caballo Reservoirs, according to Bureau of Reclamation monitors. In the El Paso area, extensive flooding led to closure of both Transmountain Road and I-10 (New Mexico Emergency Operations Center (NMEOC) 2013a, b).

Rain continued to fall into Saturday, 14 September. Rains were particularly heavy in the Gila Mountains, particularly in the Gila River drainage, but eased across most of the Rio Grande Basin. Peak flows along the Rio Grande at Central reached 4,320 cfs, well within the safe channel capacity, and passed downstream through Isleta and Bosque Farms. Releases at Cochiti and Jemez Dams continued to be maintained at minimal levels to minimize downstream flood risk, resulting in temporary flood water storage of 13,700 ac-ft at Cochiti and 3,000 ac-ft at Jemez Dam. Damage was reported in the vicinity of San Ysidro, along the Jemez River, as floodwaters raised the previous day receded. Flood flows were reported on the Rio Grande, Rio Puerco and Rio Salado affecting the small farming communities of Luis Lopez, San Antonio, and Escondida near Socorro, NM.

Sunday, 15 September 2013, was the last day that widespread rain fell across the Rio Grande basin. High flows were recorded in tributaries, but the main focus was on the Rio Grande flood peak as it moved downstream through the San Acacia reach and the anticipated coincidence of peak flows on the Rio Grande and Rio Puerco. Reservoir staff continued to minimize flows through Cochiti and Jemez Dam, resulting in flood storage reaching 18,000 ac-ft behind Cochiti Dam and 3500 ac-ft behind Jemez Dam (New Mexico Emergency Operations Center (NMEOC) 2013c, U.S. Army Corps of Engineers (USACE) 2014a). The heaviest rain fell in a band extending from southwest of Truth or Consequence to the northeast, including Cloudcroft (where over 5 in of rain fell (NOAA/NWS 2014e)). Damage assessments were conducted throughout the state, resulting in reporting of damages that had occurred on prior days.

Isolated rainfall characterized the weather on Monday 16 September continuing into Tuesday, 17 September, with notable storms occurring along the Rio Salado and Rio Puerco watersheds, and within the Galisteo watershed above Galisteo Dam where more than 3 in of rain fell. Further downstream, at the San Acacia gage, the peaks coming down the Rio Grande, Rio Puerco and Rio Salado coincided, producing peak flows in excess of 8,000 cfs almost all day on Monday. A peak surge on the Rio Puerco breached a spoilbank levee, flooding some homes near Bernardo.

Monday also saw heavy rains in the vicinity of Alamogordo, NM, which resulted in some flood damage. Rainfall continued to diminish into Tuesday and dry weather began to move into the region on Wednesday 18 September.

The final major storm occurred late in the day on Wednesday, 18 September, when a thunderstorm northwest of the City of Española, NM, produced flood flows on the Rio Chama downstream of Abiquiu Dam. Releases from Abiquiu were cut by project staff; however, flows entering the Rio Chama below the dam resulted in the flooding of several homes in the town of Hernandez. There were no reports of flooding on the mainstem of the Rio Grande through the Española Valley (U.S. Army Corps of Engineers (USACE) 2013d).

Throughout the 9-18 September event, precipitation largely missed the headwaters region, although both the Middle Rio Grande and Denver-Boulder, CO regions were hard hit. Precipitation in San Luis Valley for the period 9-15 September averaged about an inch, with sites in the San Juan Mountains receiving 2-4 in over this period (Petty 2013). No major flooding was reported in the Rio Grande Basin in southern Colorado [but see the Arkansas Basin, where minor flooding was recorded along Fountain Creek] (Hagerty and Hsu 2013).

4.3 Rainfall Data in the Rio Grande Basin

Rainfall data were obtained from the National Weather Service and the Western Regional Climate Center. Data come from a variety of sources, including the NWS Cooperative Observer (COOP) stations (Western Regional Climate Center (WRCC) 2014b), remote automated weather station sites (RAWS) (Western Regional Climate Center (WRCC) 2014a), the automated surface observing system (ASOS) network, the historical climatology network (HCN) and the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) (NOAA/NWS 2013a). COOP and RAWS data were available at daily time steps, the others were obtained as sums for the period 10-18 September. For the COOP sites only, the NOAA Atlas 14 provides recurrence intervals (RI) for precipitation(NOAA/NWS 2014c).

The major precipitation event in the northern portion of the Rio Grande basin occurred on 13 September in the eastern Jemez Mountains, where approximately 3.5in (50- to 100-year event) of rain was recorded at the Los Alamos COOP site, 3.02 in at the nearby Tower RAWS site, and 2.50 in (25-year event) down slope at the COOP site at Cochiti Dam. Parts of the Albuquerque Metropolitan Area also received more than 3 in. On the same day, significant precipitation also fell in the greater Truth or Consequences area, with the Hot Springs CAA Airport COOP site recording 3.28 in (no RI data available) and the Hillsboro COOP site recording 2.65 in (10-year event). Major flooding occurred as a result of both of these events (see below).

A number of localities had significant 7-day rain totals as heavy rains fell repeatedly on increasingly saturated soils. The Los Alamos COOP site recorded 7.05 (RI = 500 years) in for the seven days 10-16 September while the Cochiti Dam COOP site recorded 6.97 in (RI>1,000) for the same period. Comparable and larger totals were observed at CoCoRaHS, Mesonet, HCN, AWOS, CRN, and DRI sites throughout the Jemez Mountains for the period 10-18 September[3].

[3] Because very little rain fell in northern New Mexico before 10 September or after 16 September, the numbers are roughly comparable despite the differences in date ranges being compared.

Roughly 4 to 5.5 in of precipitation fell in the Albuquerque Metropolitan area over the period 10-18 September. In the Truth or Consequences area, 6.27 in of rain fell at the Hot Springs Airport COOP site over the seven day period 10-16 September, while the Hillsboro area received 6.27 in (RI=50 years) over the same seven-day period. Despite significant flooding in the El Paso area, precipitation on the heaviest day was only 1.90 in (RI=2-5 years), indicating the flooding had more to do with infrastructural deficiencies than an extraordinary precipitation event.

Table 4 - Precipitation totals 9-18 September 2013 in the Rio Grande Basin (NOAA/NWS 2014c, Western Regional Climate Center (WRCC) 2014a, b).

Location (source)	10-day Precipitation Total (in) (9-18 Sept)	Highest Daily precip (in) (date)	COOP site Av. Recurrence interval (24-hr event)	Highest 7-day precip (in) (dates)	COOP site Av. Recurrence interval (7-day event)
COLORADO					
Big Bear Park (RAWS)	4.81	1.12	--	3.49	--
Crestone 1 SE (COOP)	2.28	0.81 (13 Sept)	<1 year	2.03 (9-15 Sept)	2 years
Alamosa WSO AP (COOP)	1.53	0.68 (14 Sept)	<1 year	1.52 (11-17 Sept)	5 years
Manassa (COOP)	2.23	1.46 (13 Sept)	10 years	2.21 (11-17 Sept)	10 years
NEW MEXICO					
Red River (COOP)	2.19	0.51 (14 Sept)	<1 year	2.19 (11-17 Sept)	1 year
Truchas (RAWS)	3.58	1.23 (13 Sept)	--	3.58 (10-16 Sept)	--
Jarita Mesa (RAWS)	3.76	1.50 (13 Sept)	--	3.68 (10-16 Sept)	--
Abiquiu Dam (COOP)	3.00	1.06 (13 Sept)	1-2 years	2.99 (10-16 Sept)	25 years
Coyote (RAWS)	2.94	1.11 (13 Sept)	--	2.66 (10-16 Sept)	--
Deadman Peak (RAWS)	1.90	0.63 (10 Sept)	--	1.85 (10-16 Sept)	--
Chama (COOP)	2.00	0.77 (13 Sept)	<1 year	1.72 (10-16 Sept)	<1 year
Dulce #2 (RAWS)	2.03	0.71 (18 Sept)	--	1.29 (12-18 Sept)	--
Stone Lake (RAWS)	1.85	0.53 (14 Sept)	--	1.48 (9-15 Sept)	--
Los Alamos (COOP)	7.66	3.52 (13 Sept)	50-100 years	7.05 (10-16 Sept)	500 years
Cochiti Dam (COOP)	6.97	2.50 (14 Sept)	25 years	6.97 (10-16 Sept)	>1000 years
Tower (RAWS)	7.42	3.02 (13 Sept)	--	7.35 (10-16 Sept)	--
Cuba (RAWS)	1.76	0.67 (10 Sept)	--	1.63 (10-16 Sept)	--
Sandia Lakes (RAWS)	3.33	1.27 (14 Sept)	--	3.33 (10-16 Sept)	--
Corrales (COOP)	3.58	1.10 (13 Sept)	No data	3.58 (9-15 Sept)	No data

Location (source)	10-day Precipitation Total (in) (9-18 Sept)	Highest Daily precip (in) (date)	COOP site Av. Recurrence interval (24-hr event)	Highest 7-day precip (in) (dates)	COOP site Av. Recurrence interval (7-day event)
Petroglyph NM (COOP)	4.44	1.71 (14 Sept)	No data	4.44 (9-16 Sept)	No data
Golden (COOP)	4.84	2.03 (10 Sept)	5 years	4.79 (10-16 Sept)	50-100 years
Albuquerque Foothills (COOP)	4.13	3.19 (15 September)	No data	4.10 (9-15 Sept)	No data
Albuquerque Valley (COOP)	3.12	1.38 (14 Sept)		3.12 (9-15 Sept)	
Albuquerque WSFO Airport (COOP)	3.12	1.12 (15 Sept)	2 years	3.12 (10-16 Sept)	50 years
Mountainair (RAWS)	2.87	1.56 (10 Sept)	--	2.87 (10-16 Sept)	--
Los Lunas 3 SSW (COOP)	1.97	1.00 (11 Sept)	1 year	1.97 (9-15 Sept)	2 years
Gran Quivira (COOP)	3.86	1.11 (13 Sept)	<1 year	3.86 (10-16 Sept)	10 years
Sevilleta (RAWS)	3.62	1.98 (10 Sept)	--	3.62 (10-16 Sept)	--
Chupadera (RAWS)	3.41	1.73 (10 Sept)	--	3.41 (10-16 Sept)	--
San Andres (RAWS)	3.22	1.37 (13 Sept)	--	3.13 (10-16 Sept)	--
Dripping Springs (RAWS)	3.95	1.28 (13 Sept)	--	3.95 (9-15 Sept	--
Hot Springs CAA Airport (COOP)	6.27	3.28 (13 Sept)	No data	6.27 (10-16 Sept)	No data
Hillsboro (COOP)	5.37	2.65 (13 Sept)	10 years	5.11 (10-16 Sept)	50 years
Deming FAA Airport (COOP)	3.01	1.35 (10 Sept)	2 years	2.99 (10-16 Sept)	10 years
TEXAS					
El Paso WSO Airport (COOP)	3.21	1.90 (12 Sept)	2-5 years	3.19 (10-16 Sept)	5-10 years
Van Horn (COOP)	1.61	1.32 (10 Sept)	1 year	1.50 (10-16 Sept)	<2 years
Fort Davis (RAWS)*	0.17	0.11 (10 Sept)	--	.11 (10-16 Sept)	--
Chisos Basin (RAWS)*	0.28	0.23 (18 Sept)	--	0.28 (12-18 Sept)	--

COOP = National Weather Service Cooperative Observer Station; RAWS = Remote Automated Weather Station.
**The Big Bend area of West Texas received 1-2 inches of precipitation on 19-20 September as well.*

Table 5 - Precipitation totals 10-18* September 2013 at additional sites in the Rio Grande Basin (NOAA/NWS 2013l, r, i, o, p, b, t, s, q).

**Data sources excluded precipitation on 9 September 2014.*

Location (source)	**Precipitation Total (in)**
Valdez 1.5 NNW (CoCoRaHS)	3.75
Taos 11.2 E (CoCoRaHS)	3.60
Taos 1.6 SSE (CoCoRaHS)	3.15
Ranchos de Taos 2.4 W (CoCoRaHS)	3.15
Taos Pueblo 2.8 NW (CoCoRaHS)	3.00
Taos 1.5 ENE (CoCoRaHS)	2.93
Taos 0.4 SSW (CoCoRaHS)	2.90
Taos 4.3 NNW (CoCoRaHS)	2.85
Questa 2.2 NNE (CoCoRaHS)	2.62
Taos Airport (AWOS)	2.10
Abiquiu 7.5 WNW (CoCoRaHS)	4.38
Espanola 1.1 SE (CoCoRaHS)	3.86
El Rito 2.3 NW (CoCoRaHS)	3.65
Espanola 5.4 WNW (CoCoRaHS)	3.52
Tres Piedras (HCN)	2.57
Jicarilla Ranger Station (HCN)	1.47
Bandelier National Monument (HCN)	7.93
Los Alamos 2.6 W (CoCoRaHS)	7.67
LANL (Mesonet)	7.56
Los Alamos 6.1 SE (CoCoRaHS)	7.27
White Rock 1.5 NNE (CoCoRaHS)	6.71
Los Alamos 0.9 SW (CoCoRaHS)	6.68
Los Alamos Airport (AWOS)	7.05
Los Posos (DRI)	7.33
Redondo (DRI)	7.26
Valles Caldera (CRN)	6.67
Valles Headquarters (DRI)	6.57
Valle Toledo (DRI)	5.18
San Antonio (DRI)	4.59
Rio Rancho 3.3 ENE (CoCoRaHS)	4.52
Rio Rancho 2.2 SSE (CoCoRaHS)	4.52
Rio Rancho 2.1 ENE (CoCoRaHS)	4.42
Rio Rancho 2.5 S (CoCoRaHS)	4.41
Rio Rancho 5.6 NE (CoCoRaHS)	4.19
Rio Rancho 5.8 NNW (CoCoRaHS)	4.11
Placitas 2.1 SE (CoCoRaHS)	3.91
Jemez Springs (DRI)	3.21
Edgewood 3.4 NW (CoCoRaHS)	5.23
Edgewood 6.4 N (CoCoRaHS)	4.69
Pojoaque 1 E (CoCoRaHS)	4.31
Santa Fe 7.7 WNW (CoCoRaHS)	4.20
Stanley 4.9 SSE (CoCoRaHS)	4.15
Edgewood 2.1 WNW (CoCoRaHS)	4.12
Lamy 1.3 WNW (CoCoRaHS)	3.88
Cerrillos 4.5 WSW (CoCoRaHS)	3.80
Santa Fe Airport (ASOS)	3.72
Santa Fe 1.1 ENE (CoCoRaHS)	2.98

Location (source)	**Precipitation Total (in)**
Tesuque 0.7 SSW(CoCoRaHS)	2.47
Tijeras 5 E (CoCoRaHS)	5.49
Albuquerque 8.1 ESE (CoCoRaHS)	5.37
Albuquerque 8.2 ENE (CoCoRaHS)	5.23
Albuquerque 5.9 WNW (CoCoRaHS)	5.00
Albuquerque 6.8 WNW (CoCoRaHS)	4.86
Paradise Hills 1.4 SSE (CoCoRaHS)	4.76
Sandia Park 3.7 ESE (CoCoRaHS)	4.74
Tijeras 9.1 SE (CoCoRaHS)	4.64
Albuquerque 7.7 ENE (CoCoRaHS)	4.64
Tijeras 4.2 NE (CoCoRaHS)	4.42
Albuquerque 9 ENE (CoCoRaHS)	4.38
Albuquerque 8 NNW (CoCoRaHS)	4.38
Albuquerque 8.1 ENE (CoCoRaHS)	4.38
Albuquerque 2.4 E (CoCoRaHS)	4.34
Albuquerque 8 NNW (CoCoRaHS)	4.31
Albuquerque 7.8 ENE (CoCoRaHS)	4.22
Albuquerque 4.4 WNW (CoCoRaHS)	4.20
Albuquerque 1.7 SSE (CoCoRaHS)	4.12
Albuquerque International Sunport (ASOS)	3.14
Edgewood 7.0 SSW (CoCoRaHS)	4.54
Moriarty 4.3 E (CoCoRaHS)	4.47
Mountainair 1.0 S (CoCoRaHS)	3.68
Mountainair 16.7 SW (CoCoRaHS)	3.09
Moriarty Airport (AWOS)	3.00
Mountainair Ranger (HCN)	2.74
Clines Corners (AWOS)	2.70
Belen 9.3 SE (CoCoRaHS)	2.59
Bosque Farms 1 N (CoCoRaHS)	2.48
Los Lunas 3.5 E (CoCoRaHS)	2.45
Belen 5.1 SSE (CoCoRaHS)	2.36
Belen 1 NE (CoCoRaHS)	2.01
Belen Airport (AWOS)	1.56
Socorro 9.9 SSE (CoCoRaHS)	5.72
Socorro Airport (AWOS)	4.17
Lemitar 0.7 NNE (CoCoRaHS)	3.50
Polvadera 0.5 S (CoCoRaHS)	3.09

CoCoRaHS = Community Collaborative Rain, Hail and Snow Network; ASOS=Automated Surface Observing System; HCN = Historical Climatology Network; DRI=Desert Research Institute; AWOS =Automated Weather Observing System

4.4 Event Hydrology in the Rio Grande Basin

The discussion that follows comes from (USACE 2014a). High flows occurred throughout the Rio Grande Basin during the rainfall events of 9-18 September 2013, with the majority of floods occurring in tributary reaches. These high flows contributed to high river stages were recorded in the regulated and unregulated reaches of the main stem Rio Grande. Notable high flows and resulting flooding that occurred and was relevant to Corps of Engineers projects is included below (see Also Appendix 2).

Embudo Creek at Dixon (an east-side tributary to the Rio Grande upstream of Santa Fe) had a peak discharge of 470 cfs at 12:15pm MDT 13 September 2013. No significant flooding was observed immediately along Embudo Creek. Action stage is 12 feet, minor flood stage 13 feet, and moderate flood stage 14 feet. No designation has been made for major flood stage.

The Rio Grande at Otowi Bridge (upstream of Cochiti Dam) crested at 8.09 feet (8,080 cfs) at 1030am MDT 13 September 2013. This crest compares to a previous crest of 8.44 feet on 6 July 1995 and 7.76 feet on 8 June 1997. No flooding was observed along the Rio Grande however significant flows into the area from nearby creeks and arroyos created flooding around NM 502 and NM 30. Action stage is 8 feet, minor flood stage 9 feet, moderate flood stage 13 feet, and major flood stage 17 feet.

The Rio Grande at San Felipe (downstream of Cochiti Dam) crested at 7.73 feet (9,490 cfs) at 1:30 pm MDT 13 September 2013. This is now the 7th highest crest observed at this location and compares to a previous crest of 7.55 feet on 17 August 1943 and 8.59 feet on 24 April 1942. The record crest is 11.13 feet set back on 26 June 1937. No significant flooding was observed immediately along the Rio Grande however several nearby creeks and arroyos leading into this basin produced damaging floods to nearby residential and commercial structures. Action stage is 8 feet, minor flood stage 8.5 feet, moderate flood stage 9.5 feet, and major flood stage 11 feet.

The Jemez River at Jemez (upstream of Jemez Canyon Dam) crested at 6.54 feet (1,010 cfs) at 745am MDT 13 September 2013. This crest is now the 10th highest on record for this location and compares to a previous crest of 6.48 feet on 10 October 2003 and 7.14 feet on 4 August 2008. The record crest is 11.94 feet set back on 16 August 2006. Flooding was reported along the Jemez River primarily downstream toward the community of San Ysidro were homes were flooded and portions NM 4 were flooded. Action stage is 8 feet, minor flood stage 8 feet, moderate flood stage 10 feet, and major flood stage 12 feet.

The Galisteo Creek at Rosario crested at 11.65 feet (2,920 cfs) at 200am MDT 16 September 2013. This crest is the highest crest on record for this location. The previous record crest was 7.11 feet set back on 26 July 1981. Significant attention was drawn by this crest as thousands of commuters along Interstate 25 were able to observe bank full and over bank flows in Galisteo Creek. Many people reported they had never seen the creek that high before. Action stage is 9 feet and minor flood stage 9 feet. There has been no determination of moderate and major flood stages for Galisteo Creek.

The Rio Grande at Albuquerque crested at 5.74 feet (4,350 cfs) at 1130pm MDT 13 September 2013. This crest compares to a previous crest of 5.79 feet on 28 May 1999 and 5.83 feet on 22 May 2001. No flooding was observed along the Rio Grande in Albuquerque. Action stage is 8 feet, minor flood stage 8 feet, moderate flood stage 10 feet, and major flood stage 12 feet.

The Rio Grande at San Acacia crested at 18.69 feet (8,780 cfs) at 1130am MDT 16 September 2013. This crest is the second highest on record for this location and compares to a previous crest of 16.16 feet on 25 May 2010. The record crest is 20.1 feet set back on 1 August 2006. Action stage is 21 feet, minor flood stage 23 feet, and moderate 25 feet. There has been no determination of major flood stage.

Table 6 - Summary of flood and high flow conditions 9-18 September at selected gages in the Rio Grande Basin (U.S. Geological Survey (USGS) 2014l).

USGS station number	USGS STATION NAME	Drain. area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	**Stage [ft]**	**Stream flow (date) [ft^3/s]**	**Rank**	**No. of years**	**Max. (year) [ft^3/s]**
08252500	COSTILLA CREEK ABOVE COSTILLA DAM, NM	25.1	2013-09-13	2.12	13	73	74	3870 (1954)
08253000	CASIAS CREEK NEAR COSTILLA, NM	16.6	2013-09-15	3.68	17 (2013-09-13)	75	76	196 (1994)
08253500	SANTISTEVAN CREEK NEAR COSTILLA, NM	2.15	2013-09-13	0.7	4.2	66	74	20.0 (2005)
08253900	COSTILLA RESERVOIR NEAR COSTILLA, NM	54.6	2013-09-09	51.26	--	--	--	--
08254000	COSTILLA CREEK BELOW COSTILLA DAM, NM	54.6	2013-09-12	1.9	35 (2013-09-11)	<	39	301 (1979)
08255500	COSTILLA CREEK NEAR COSTILLA, NM	195	2013-09-14	2.64	82	76	76	1150 (1942)
08261000	COSTILLA CREEK NEAR GARCIA, CO	200	2013-09-17	2.1	1.4	<	56	514 (1991)
08263500	RIO GRANDE NEAR CERRO, NM	8440	2013-09-17	3.14	302	<	64	9740 (1949)
08265000	RED RIVER NEAR QUESTA, NM	113	2013-09-13	2.72	61	80	81	886 (1942)
08266820	RED RIVER BELOW FISH HATCHERY, NEAR QUESTA, NM	185	2013-09-14	4.7	140	31	34	755 (1979)
08267500	RIO HONDO NEAR VALDEZ, NM	36.2	2013-09-15	1.89	53	73	78	541 (1941)
08269000	RIO PUEBLO DE TAOS NEAR TAOS, NM	66.6	2013-09-13	1.05	37	73	78	1050 (1979)
08271000	RIO LUCERO NEAR ARROYO SECO, NM	16.6	2013-09-15	2.43	53	73	84	310 (1979)
08275500	RIO GRANDE DEL RANCHO NEAR TALPA, NM	83	2013-09-14	4.84	26	53	56	644 (1991)
08276300	RIO PUEBLO DE TAOS BELOW LOS CORDOVAS, NM	380	2013-09-13	7.24	140	52	55	2380 (1957)
08276500	RIO GRANDE BLW TAOS JUNCTION BRIDGE NEAR TAOS, NM	9730	2013-09-17	3.96	501	<	87	9730 (1949)

USGS station number	USGS STATION NAME	Drain. area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
08277470	RIO PUEBLO NR PENASCO, NM	101	2013-09-16	4.09	173	18	21	2200 (1994)
08279000	EMBUDO CREEK AT DIXON, NM	305	2013-09-13	10.27	340	66	75	4200 (1977)
08279500	RIO GRANDE AT EMBUDO, NM	10400	2013-09-13	3.47	721	113	114	16200 (1903)
08284100	RIO CHAMA NEAR LA PUENTE, NM	480	2013-09-18	3.39	539	57	57	11200 (1979)
08285500	RIO CHAMA BELOW EL VADO DAM, NM	877	2013-09-13	3.16	728	<	84	9000 (1920)
08286500	RIO CHAMA ABOVE ABIQUIU RESERVOIR, NM	1600	2013-09-14	8.7	2270	38	50	6680 (1985)
08287000	RIO CHAMA BELOW ABIQUIU DAM, NM	2147	2013-09-09	2.69	311	<	51	2990 (1965)
08289000	RIO OJO CALIENTE AT LA MADERA, NM	419	2013-09-14	4.72	190	80	80	3990 (1998)
08290000	RIO CHAMA NEAR CHAMITA, NM	3144	2013-09-18	9.82	8220	6	94	15000 (1920)
08291000	SANTA CRUZ RIVER NEAR CUNDIYO, NM	86	2013-09-15	4.2	648	17	82	2420 (1931)
08294200	NAMBE FALLS RESERVOIR NEAR NAMBE, NM	34.1	2013-09-18	6822.5 asl*	--	--	--	--
08294210	RIO NAMBE BELOW NAMBE FALLS DAM NEAR NAMBE, NM	34.1	2013-09-18	0.72	7.4	<	34	312 (1979)
08302500	TESUQUE CREEK ABOVE DIVERSIONS NEAR SANTA FE, NM	11.7	2013-09-17	4.55	9.6	42	49	632 (1957)
08313000	RIO GRANDE AT OTOWI BRIDGE, NM	14300	2013-09-13	8.09	8080	51	109	24400 (1920)
08313350	RITO DE LOS FRIJOLES IN BANDELIER NAT MON, NM	17.5	2013-09-13	13.61	9500	1	36	7000 (2011)
08313500	COCHITI EAST SIDE MAIN CANAL AT COCHITI, NM	--	2013-09-09	4.2	79 (2013-09-10)	<	1	102 (2012)
08314000	SILI MAIN CANAL (AT HEAD) AT COCHITI, NM	--	2013-09-10	3.21	47	<	1	62 (2012)

USGS station number	USGS STATION NAME	Drain. area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
08315480	SANTA FE R ABV MCCLURE RES (8 FT), NR SANTA FE, NM	--	2013-09-14	3.06	142	1	12	113 (2005)
08315500	MCCLURE RESERVOIR NEAR SANTA FE N MEX	17.4	2013-09-18	7873.55 asl*	--	--	--	--
08316000	SANTA FE RIVER NEAR SANTA FE, NM	18.2	2013-09-15	1.64	4.8	<	96	1500 (1921)
08316500	NICHOLS RESERVOIR NEAR SANTA FE N MEX	22.8	2013-09-09	133.74 asl *	--	--	--	--
08317200	SANTA FE RIVER ABOVE COCHITI LAKE, NM	231	2013-09-15	4.48	1250	14	38	11400 (1971)
08317400	RIO GRANDE BELOW COCHITI DAM, NM	14900	2013-09-18	2.27	536	<	42	10300 (1971)
08317950	GALISTEO CREEK BELOW GALISTEO DAM, NM	596	2013-09-16	11.65	3240	2	42	3460 (1997)
08319000	RIO GRANDE AT SAN FELIPE, NM	16100	2013-09-13	7.73	9490	25	86	27300 (1937)
08324000	JEMEZ RIVER NEAR JEMEZ, NM	470	2013-09-13	6.54	1010	40	67	4540 (1985)
08328950	JEMEZ RIVER OUTLET BELOW JEMEZ CANYON DAM, NM	1034	2013-09-13	4.56	1230	1	2	1010 (2012)
08329900	NORTH FLOODWAY CHANNEL NEAR ALAMEDA, NM	87.9	2013-09-15	7.29	6170	10	40	12300 (1980)
08329918	RIO GRANDE AT ALAMEDA BRIDGE AT ALAMEDA, NM	--	2013-09-13	14.27	4950	6	9	6610 (2005)
08329928	RIO GRANDE NR ALAMEDA, NM	17263	2013-09-15	5.57	3830	12	13	9520 (1994)
08330000	RIO GRANDE AT ALBUQUERQUE, NM	17440	2013-09-13	5.74	4350	53	70	25000 (1942)
08330600	TIJERAS ARROYO NR ALBUQUERQUE, NM	128	2013-09-15	3.37	762	24	52	2930 (1988)

USGS station number	USGS STATION NAME	Drain. area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
08330775	SOUTH DIV CHANNEL ABV TIJERAS ARROYO NR ALBQ., NM	11	2013-09-15	5.93	998	3	18	1960 (1990)
08330875	RIO GRANDE AT ISLETA LAKES NR ISLETA, NM	--	2013-09-14	7.27	4440	4	8	6740 (2005)
08331160	RIO GRANDE NEAR BOSQUE FARMS, NM	--	2013-09-14	17.7	5060	3	6	5620 (2010)
08331510	RIO GRANDE AT STATE HWY 346 NEAR BOSQUE, NM	--	2013-09-16	19.71	4210	4	7	5420 (2009)
08332010	RIO GRANDE FLOODWAY NEAR BERNARDO, NM	19230.00	2013-09-16	17.72	4010	2	2	6140 (2005)
08334000	RIO PUERCO ABV ARROYO CHICO NR GUADALUPE, NM	420	2013-09-13	11.31	1400	37	60	6940 (1967)
08340500	ARROYO CHICO NR GUADALUPE, NM	1390	2013-09-10	9.45	5100	17	50	15200 (1972)
08341400	BLUEWATER LAKE NEAR BLUEWATER, NM	201	2013-09-18	7368.5 asl*	--	--	--	--
08343500	RIO SAN JOSE NEAR GRANTS, NM	2300.00	2013-09-17	3.25	210	34	69	1400 (1963)
08353000	RIO PUERCO NEAR BERNARDO, NM	7350	2013-09-15	21.42	9020	7	73	18800 (1941)
08354900	RIO GRANDE FLOODWAY AT SAN ACACIA, NM	26770	2013-09-16	18.69	9020	2	53	9420 (1985)
08355050	RIO GRANDE AT BRIDGE NEAR ESCONDIDA, NM	--	2013-09-16	32.15	6850	2	7	8140 (2006)
08355490	RIO GRANDE ABOVE US HWY 380 NR SAN ANTONIO, NM	--	2013-09-17	34.28	7110	2	6	9530 (2006)
08358300	RIO GRANDE CONVEYANCE CHANNEL AT SAN MARCIAL, NM	--	2013-09-11	10.95	305	2	2	343 (2011)
08358400	RIO GRANDE FLOODWAY AT SAN MARCIAL, NM	27700	2013-09-18	19.05	4380	16	38	8110 (1985)

USGS station number	**USGS STATION NAME**	**Drain. area (mi^2)**	**Highest peak from 2013-09-09 to 2013-09-18**				**Historical Peaks**	
			Date	**Stage [ft]**	**Stream flow (date) [ft^3/s]**	**Rank**	**No. of years**	**Max. (year) [ft^3/s]**
08359500	RIO GRANDE AT NARROWS IN ELEPHANT BUTTE RES., NM	28500.00	2013-09-18	8.5	2430	--	--	--
08361000	RIO GRANDE BELOW ELEPHANT BUTTE DAM, NM	29450	2013-09-13	8.06	633	<	95	8220 (1942)
08374550	RIO GRANDE NR CASTOLON, TX	--	2013-09-18	10.35	5290	<	6	46500 (2008)
08375300	RIO GRANDE AT BOQUILLAS CPGD, BIG BND NP, TX	--	2013-09-18	7.57	3680	<	6	49700 (2008)

**Reservoir stages are given in elevation above sea level while stream channel stages are in feet above channel bottom.*

4.5 Flooding in the Rio Grande Basin

Many sites where significant damages occurred have been reported by local, regional, State and Tribal authorities throughout New Mexico and far west Texas. Flood damage was particularly severe in the Rio Grande Basin at:

- The eastern Jemez Mountain tributary basins, including Santa Clara, Frijoles and Peralta Canyons.
- Truth or Consequences, NM, including the Palomas and Las Animas drainages.
- The greater El Paso, TX area, including La Union, NM and extending through Socorro, TX.
- Town of Santa Clara, NM, in Grant County.
- The lower Rio Puerco in NM.
- The Rio Chama below Abiquiu Dam in NM.

Damages to these areas are described below.

4.5.1 <u>Flooding in the Eastern Jemez Mountain Tributary Basins, NM</u>

Flooding in the eastern Jemez Mountains was influenced by the pattern of severe burning resulting from the 2011 Las Conchas fire: flooding was particularly problematic along Santa Clara, Frijoles, and Peralta Canyons where the upper catchments had large areas with high burn severity and the lower canyon reaches have significant development (Santa Clara Pueblo, Bandelier National Monument, and Cochiti Pueblo, respectively).

Rainfall beginning on 10 September saturated soils in the eastern Jemez Mountains, enabling more intense rainfall events to precipitate floods in local drainages. Rain gages in the creek's watershed recorded total precipitation along Santa Clara Creek for the entire precipitation event (Figure 19). The largest rainfall amounts were located in the western third (highest part) of the watershed.

Table 7 - 4-day rainfall accumulations 10-13 September 2013 for the gages located in the Santa Clara Creek watershed [USACE MOR 3 October 2013].

Site Name	Latitude (dd)	Longitude (dd)	Rainfall Accumulation (in)
Heaven	35.964861	-106.330917	6.90
Pond 4	35.977400	-106.388000	6.74
West Canyon	35.999528	-106.426889	6.52
Saddle	35.962967	-106.421666	6.02
Stove	35.975983	-106.440267	5.62
Deer Pond	36.010250	-106.306111	4.50
Pond 2	36.005980	-106.289070	2.77

Flooding in Santa Clara Canyon filled and breached detention ponds up canyon, compromising their future flood mitigation effects. The flood waters moved downstream and the stage gage recorded a maximum stage of 9.59 ft. Based on observed high water marks along the Creek and downstream of the Highway 30 box culverts, this series of floods at a minimum equaled the peak flow rates of the 20 July 2013 flood event (for which a separate FEMA Disaster Declaration was issued), with a much larger volume of sustained flood flows.

Figure 20 - Damage at the Village of Santa Clara, NM (Grant County), included 5 feet of downcutting immediately downstream of this box culvert.

Flooding occurred at several locations in Santa Clara Pueblo. Damage occurred to culverts at road crossings (Figure 19), including scour below the Kee Street box culvert and destruction of culverts at the check-in station on the road leading up Santa Clara Canyon. Flood waters from localized rain events at the village were diverted into irrigation ditches, where the floodwaters overwhelmed the ditch and culverts on the ditch. As a result, floodwaters left the ditch and flowed into the old village, saturating the ground around historic structures and cracking walls. The foundation around the historic church and other structures was damaged. Floodwaters also damaged the non-engineered berm around the Indian Health Clinic, allowing some 2 feet of water to enter the building and cause substantial damage to the building and its contents. Other berms in the community also failed, resulting in local erosion and flood damage.

Moving south from Santa Clara Pueblo along the eastern Jemez Mountains, severe flooding also occurred several times in Frijoles Canyon (data from Bandelier National Monument, personal communication, fall 2013). The largest flood occurred on the morning of 13 September, producing a discharge of approximately 9,000 cfs in the Lower Frijoles Canyon area. Erosion and aggradation occurred along Frijoles Creek, and significant debris transport was evident. Flooding overtopped access roads and trails in the Lower Canyon and damaged some developed roads. Damage to historic (CCC) structures at the Visitor Center and damage to the campground was prevented through extensive flood proofing efforts (Figure 20).

Figure 21 - Sandbags and Jersey barriers used to prevent flood damage to historic buildings at Bandelier National Monument.

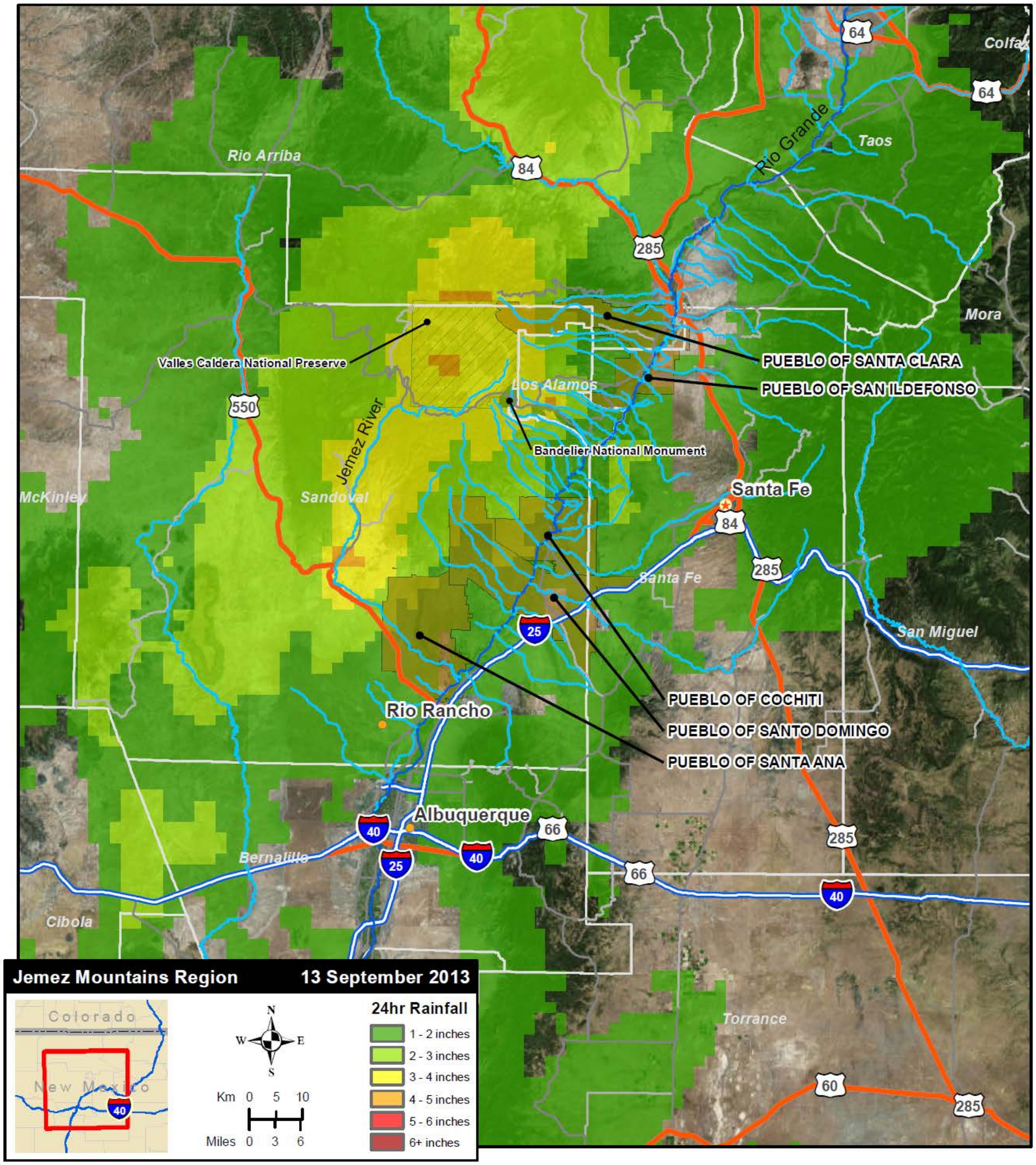


Figure 22 - Doppler radar precipitation >1 inch on 13 September 2013 in the Jemez Mountains.

Table 8 - Flood flows in Frijoles Canyon, Bandelier National Monument, 10-14 September 2013.

	Upper Crossing Stream Gauge				Lower Frijoles Stream Gauge				
Date	**Flood start time**	**Flood end time**	**Peak time**	**Max Stage (ft)**	**Flood Start**	**Flood End**	**Peak Time**	**Max Stage (ft)**	**Max Discharge (cfs)**
9/10/13	1831	?	1847***	2.36	1910	0510	2000***	3.49	157
9/12/13	1524	1653	1616	6.4	1645	2045	1710	7.04	>1200
9/13/13	0727	0918	0800	9.77	0755	1040	0830	13.61	~9000
9/14/13	NA	NA	NA	NA	2310	0320	0030	5.76	1220

*** *This event had 3 peaks. The one that generated the highest peak at the lower gauge is noted here.*

Significant flooding also occurred in Peralta Canyon, resulting in damage around the Pueblo Route 85 bridge at Peralta Creek and in the windmill area. Berms near the village held well, reflecting the success of improvements to the berms made after the Las Conchas Fire (CESPA CAT coordination team meeting notes, 16 September 2013). Sediment transport down Peralta Canyon was significant enough to plug the Rio Grande at the confluence with Peralta Creek. The plug forced the Rio Grande into an abandoned channel on the east side of the flood plain. This plug has since been partly removed and the river channel restored to its original location.

At Santo Domingo (Kewa) Pueblo, floodwaters damaged more than 100 homes (Ron Kneebone, personal communication, 26 Feb 2014) as well as irrigation works. Flood damage was also reported at San Felipe and Santa Ana Pueblos (Ron Kneebone, personal communication, 26 Feb 2014). Additional information on these damages was not available from the Pueblo.

4.5.2 Flooding in the Vicinity of Truth or Consequences, NM

Flooding occurred in and near Truth or Consequences, NM as a result of precipitation along tributaries that confluence with the Rio Grande downstream of Elephant Butte Dam (Figure 20). People in approximately 200 households in the area were evacuated on the morning of Friday, 13 September due to flash floods and overflowing creeks, but were able to return home the same night (Dyson 2013). Particularly hard hit were areas along Palomas Creek, which is normally a dry wash but was overflowing its banks in places. Palomas Creek was running high enough to threaten a bridge on U.S. Highway 187 between Williamsburg and Las Palomas. Nearby Animas Creek was also flooding. The flooding impacted not only the town of Truth or Consequences (including Ralph Edwards Park), but also the smaller communities of Williamsburg and Las Palomas. Local dikes in King Canyon broke, causing some loss of property.

Tragically, 53-year-old Steven Elsley of Phoenix died when the rental car he was driving was caught up in flood waters in Ash Canyon, a tributary of the Rio Grande (Associated Press 2013).

4.5.3 Flooding in the Greater El Paso Region in NM and TX

Significant flooding occurred in southern Dona Ana County, New Mexico, and the greater El Paso metropolitan area. The flooding took place in two pulses. During the first round, the region received between 2 and 4” of rain by Thursday, 12 September (Staley 2013a)(Figure 21). The main effects were to saturate the ground. Flooding occurred in Vado, NM, where several mobile homes located in an arroyo were flooded, affecting 25-30 people. These people had been evacuated from the area as a precaution, since it is an area that has previously flooded. The predominantly low-income residents are financially unable to move their houses to safer ground (Soular 2013b). Flooding also occurred in Sunland Park , where 3-4 homes and an apartment complex were affected by flooding, and some flooding occurred in La Union, NM (Staley 2013a).

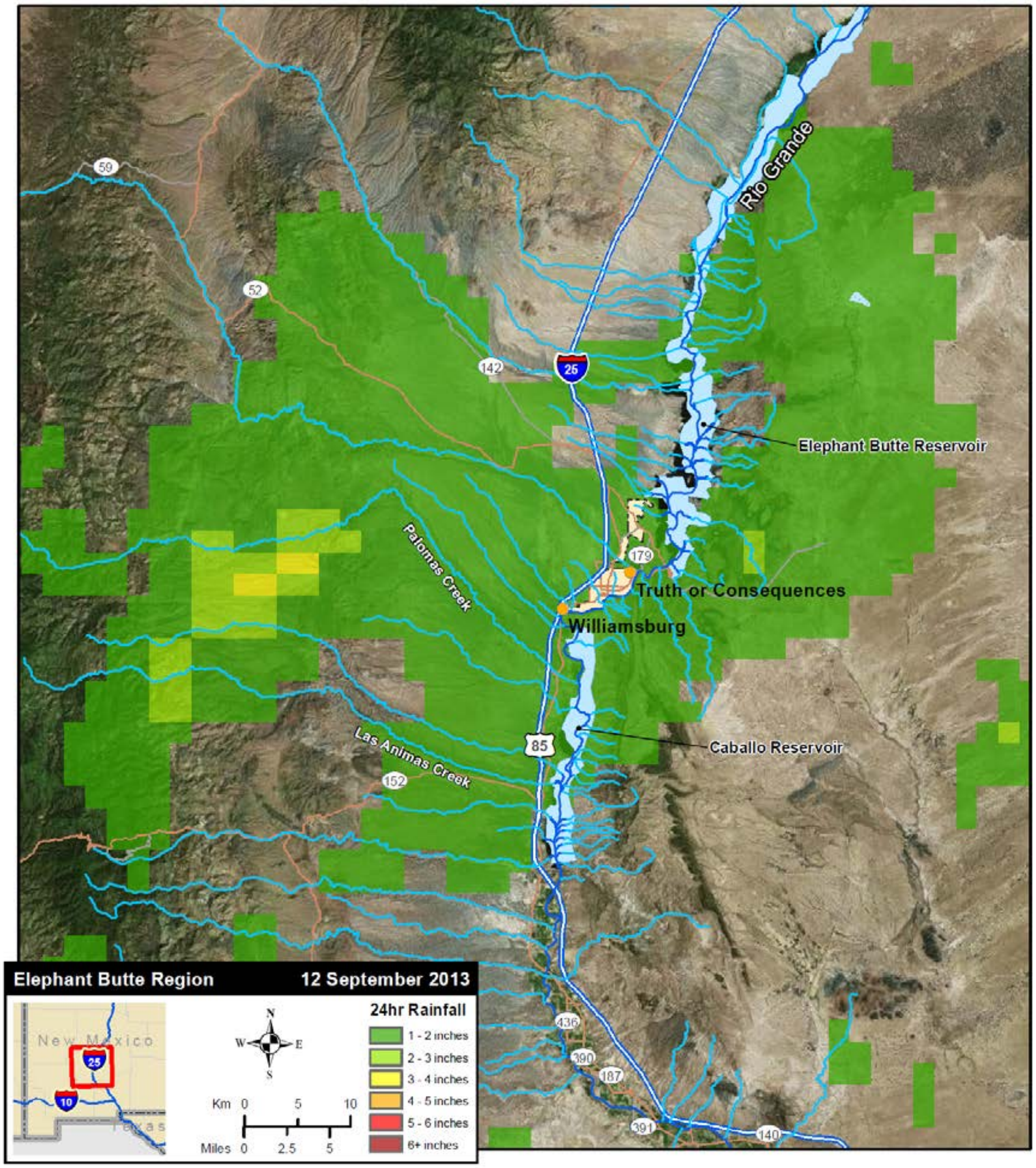


Figure 23 - Doppler radar map showing precipitation > 1inch in the vicinity of Elephant Butte Reservoir and Truth or Consequences, NM, 12 September 2013.

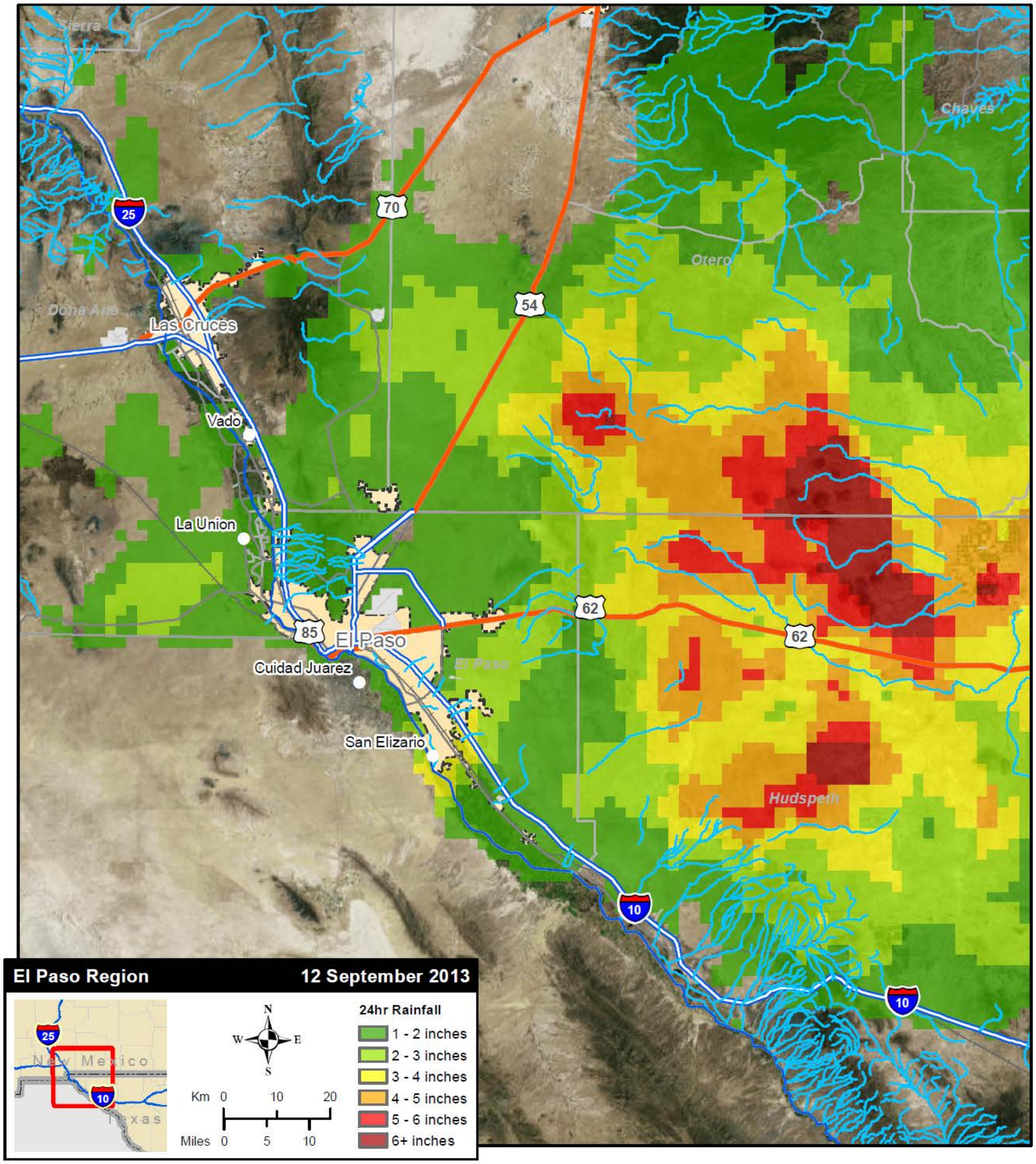


Figure 24 - Doppler radar map showing precipitation >1inch in the El Paso, TX, area on 12 September 2013.

At the same time, flooding occurred in El Paso, Texas, causing closure overnight of Interstate 10 West at Piedras Street, the filling of flood control ponds, and flooding in the vicinity of Altura Avenue and Lackland Street (Steele 2013c). Downstream of El Paso, in the Lower Valley community of San Elizario, Texas, where some residents were evacuated as ponds and levees reached their capacities on Thursday, 12 September (Kreighbaum 2013).

More damage was caused by rainfall that continued to fall on already saturated soils all day Thursday into Friday, 13 September. In Dona Ana County, NM, a 50-year-old earthen agricultural dam was breached, washing out roads and leaving some 300 residents without water and natural gas (Staley 2013b). At least seven homes were damaged, although none were destroyed (Soular 2013a). The breached dam was designed to withstand a 2-in event, but precipitation was estimated at 3 in above the dam (Soular 2013a).

Downstream of La Union, flooding recurred in El Paso, briefly closing Interstate 10 West at Cotton Road and again causing flooding near Altura Avenue and Lackland Street. In addition, Trans Mountain Road was closed, and street flooding occurred in the downtown area (Bracamontes 2013a).

Major flooding occurred in the Lower Valley communities of Socorro and San Elizario, Texas, where more than 200 families suffered some kind of flood damage (Gonzalez 2013a). In Socorro, arroyo banks overflowed, causing flooding along Horizon Boulevard, south of Interstate-10, and impacting homes along Patti Jo Drive, Arlene Circle (Bracamontes 2013a) and Corker and Worsham Roads (Gonzalez 2013a). Approximately 4 families were displaced along Corker Road and an additional 10-15 people were evacuated from a trailer park on Thunder Road (Gonzalez 2013b).

In San Elizario, the community downtown was flooding, including the Old County Jail, and Los Portales Museum, and causing flooding along Socorro Road, Main Street, San Elizario Road and Alarcon Road (Bracamontes 2013a). Veterans Memorial Plaza was also flooded (Gonzalez 2013a). Significant damage also occurred at the San Elizario cemetery, where saturated ground allowed several headstones to sink and break, and created at 100-foot wide pond. Gravesites at cemeteries at Canutillo and Sierra Blanca were also damaged by flooding, as were approximately 1,300 gravesites at Fort Bliss National Cemetery (Bracamontes 2013b).

Flooding was not confined to the U.S. side of the border. The city of Juarez, Mexico, the drainage system was overwhelmed, causing streets to flood and sink holes to develop (Figueroa 2013b). Flooding occurred at the Mexicanidad Plaza (where the “X” sculpture stands) (Figueroa 2013b). Approximately 70 families were evacuated after La Presa reservoir in southeast Juarez flooded and spilled on Thursday, 12 September (Figueroa 2013a). In addition, reservoirs in the Las Flores, Nueva Galeana, Luis Olague and El Barrial neighborhoods reached capacity and were at risk of spilling, evacuation notices were issued for these communities (Figueroa 2013a).

Flooding eased in the days following Friday, 13 September, allowing for clean up and damage assessment of affected areas.

4.5.4 Flooding in Santa Clara, Grant County, NM

Santa Clara is a village located along Central Creek, a tributary of the Mimbres River near Silver City. A flash flood struck the town on 20 September due to rain falling on previously saturated ground. Around 4PM, the flood hit the town (Steele 2013a). It overtopped a foot bridge, flooded several homes, destroyed a mobile home and an outbuilding, damaged several vehicles, caused gas leaks, and broke water and sanitary sewer lines (Steele 2013a). There was approximately a foot of water on Maple Street. The flood lasted about 2 hours (Steele 2013a).

According to damage assessments made by USACE staff (USACE 2013f), Cameron (Central) Creek at New Mexico Highway 180 on the north side of town likely is estimated to have flowed at 12,000 cfs during the flood. Downstream, at the Maple Street Bridge, the floodwater overtopped the rail during peak flow and closed the road for approximately 4 hours. In the vicinity of Oak Street, flow during the flood exceeded the top of the bank during the flood, stress cracking was observed as much as 10 ft back from the bank, and bank erosion imperiled adjacent mobile homes. Homes on the right bank at Mill Street received flood damage, as did structures near Morrow Street, Boulder Road, and Fellner Road. Pre-flood channel capacity at Fellner Road was estimated at 1,630 cfs, approximately 14% of the channel capacity in Cameron Creek where it crosses under Highway 180.

USACE staff also assessed flood damage on Twin Sisters Creek, which parallels Cameron Creek along the western side of Santa Clara (USACE 2013g). Observations at the time of flooding indicate that the box culverts at Highway 180 were running near full, yielding an estimated discharge of 7,500 cfs at this point. An upstream drinking water facility was not damaged. During the flood, the channel of Twin Sisters Creek appears to have downcut approximately 5 feet in the area downstream of the culvert apron and eroded away grouted riprap protection in this area. On the south side of town, at Old Racetrack Road, flows topped 5 feet, flooding some properties but no homes.

According to weather records accessed online (www.weatherunderground.com, accessed 11 April 2014), Fort Bayard and the high elevation sites of MesoWest Signal Peak and MesoWest McKnight Cabin, precipitation was unremarkable: Fort Bayard received 0.39 in precipitation on 20 September, with the other two sites measuring 0.02 in and 0.01 in , respectively. Silver City reported 0.37 in on 20 September, while the site of Dos Griegos near Pinos Altos (above Silver City) reported rainfall of 0.85 in. Thus, the data suggest that flooding in Santa Clara resulted from a combination of localized storm(s) in the mountain foothills region immediately north of Silver City and Santa Clara and already saturated soils that favored rapid runoff and limited infiltration.

4.5.5 Flooding Along the Rio Puerco in NM

Shortly after midnight on 16 September, flows in the Rio Puerco at the old bridge west of Interstate 25 measured in excess of 9,000-10,000 cfs, washing out the USGS stream gauge. The flood flows rose slowly through the night. At about 3 a.m., floodwater overtopped U.S. Highway 60 at the railroad tracks, and by 6 a.m. the water on the highway was as deep as 18 inches and was some 50 to 75 yards across. The highway had to be closed. Water also flowed north and crossed over the railroad tracks, and down Ramon Lopez Road into the small community of San

Francisco, NM, located south of Highway 60 and east of Interstate 25. Flooding damaged several homes in the community (Bailey-Bowman 2013).

A USACE team visited the small community of San Francisco, NM, on 7 November 2013, and observed that the Rio Puerco had overtopped its bank from Interstate 25 to its confluence with the Rio Grande (USACE, Memorandum for Record, 12 Nov 2013). This flooding, resulting in severe damage to at least 4 homes, including septic systems, drain fields, cars and trucks. Flow backed up to the railroad bridge and debris could be seen on the low chord of the bridge. The left spoil bank just downstream of the railroad bridge had breached, and a Middle Rio Grande Conservancy District irrigation siphon was also damaged. In San Francisco a diversion berm built in 2008 to protect the community was overtopped and disintegrated, allowing floodwater into the community. Irrigation canals inside the berm acted to trap floodwaters locally, allowing water to reach greater depth. Flooding was extensive, many homes were severely damaged, and irrigation canals were breached either by flood waters or intentionally breached to allow floodwaters to exist.

In Socorro County south of San Francisco, Rio Grande flows at San Acacia Diversion Dam also topped 9,000 cfs (approximately 400 times the typical September rate of 20-23 cfs) (Bailey-Bowman 2013). The river overtopped its channel in Socorro and flowed into its floodplain east of Socorro south through San Antonio and the Bosque del Apache National Wildlife Refuge. Around midnight on Monday morning U.S. Highway 380 flooded east of San Antonio when a berm broke. The highway was re-opened 6 a.m. on Monday. Flooding also occurred at the Sevilleta National Wildlife Refuge (Uyttebrouck 2013).

4.5.6 Flooding Along the Lower Rio Chama, NM Below Abiquiu Dam

On the afternoon of Wednesday, 18 September, heavy, localized precipitation occurred in the lower Chama River basin northeast of Española, NM and in nearby tributary basins. Falling on already saturated soils, the runoff produced a sharp spike in excess of 3,000 cfs on the Chamita gauge before the gauge washed out. There were likely two high flow pulses, one around 4:30 pm and the other around 7 pm, with the latter reflecting storm activity higher in the catchment. The Rio Chama overflowed its banks near Chamita, flooding about homes near the junction of U.S. Highways 84 and 285, and reducing traffic on U.S. Highway 84 to one lane (Peterson 2013, Peterson and Uyttebrouck 2013). USACE maintained minimum flows through Abiquiu Dam of <300 cfs during this time in order to not exacerbate flooding.

4.6 Reservoir Operations and Damages Prevented in the Rio Grande Basin

The discussion that follows comes from (USACE 2014a).

4.6.1 Cochiti Dam and Lake

On 13 September, heavy rainfall within the Jemez Mountains to the west of Cochiti Dam produced flood flows within all of the drainages feeding tributaries to the Rio Grande both upstream and downstream of Cochiti Dam. The flow at the Otowi gage on the Rio Grande upstream of Cochiti peaked at 8,080 cfs at 10:30am and combined with other contributing flows for an estimated peak inflow into Cochiti Lake of approximately 10,000 cfs. Downstream of Cochiti Dam the flow at the San Felipe gage on the Rio Grande peaked at 9,490 cfs. The release from Cochiti Dam remained at 350 cfs throughout this event so as not to contribute to any downstream flooding conditions. Without regulation, the timing of the peak inflow into Cochiti was such that it would have combined with and contributed to the peak seen at San Felipe.

Flood control operations began at Cochiti Dam on 13 September when the inflow into the reservoir exceeded the release of 350 cfs and the Dam began detaining floodwaters. Over the course of the following weeks the lake level rose by approximately 15 feet and detained approximately 25,000 acre-feet of floodwater. This equates to approximately 5% of the flood control storage space.

Cochiti remained in flood control operations until 24 October due to a sediment plug that formed within the channel of the Rio Grande a short distance downstream of Cochiti. The sediment plug forced flows out of the channel of the Rio Grande and against the levee to the east of the channel, thereby reducing the safe channel capacity. The US Bureau of Reclamation partially cleared the sediment plug in mid October which allowed for an increased release from Cochiti. All detained flood waters were evacuated by 24 October.

4.6.2 Jemez Canyon Dam and Reservoir

On 13 September, heavy rainfall within the Jemez Mountains to the north and west of Jemez Canyon Dam produced flood flows within all of the drainages feeding tributaries to the Jemez River upstream of Jemez Canyon Dam. The flow at the Jemez River at Jemez gage peaked at 1,010 cfs at 7:45am and combined with other contributing flows for an estimated peak inflow into Jemez Canyon Reservoir of approximately 3,000 cfs. Jemez Canyon Dam is normally operated as a dry dam with its gates fully opened to pass all inflow. In anticipation of the flood flows entering the reservoir the gates were set so as to pass no more than 1,000 cfs. In response to downstream flood conditions on 13 September, the gates were set to pass no more than 400cfs. Without regulation, the timing of the peak inflow into Jemez Canyon Reservoir was such that it would have combined with and contributed to the peak traveling downstream along the mainstem Rio Grande.

Flood control operations began at Jemez Canyon Dam on September 13th when the inflow into the reservoir exceeded the release and the Dam began detaining floodwaters. Over the course of the following days the lake level rose by approximately 30 feet and detained approximately 3,500 acre-feet of floodwater. This equates to approximately 3% of the flood control storage space. The release was maintained at approximately 400 cfs until all floodwaters were evacuated on September 26.

4.6.3 Galisteo Dam and Reservoir

An intense thunderstorm on the evening of 15 September within the Galisteo watershed produced significant flood flows upstream of Galisteo Dam. Galisteo Dam has an ungated outlet works. As such, the release through the dam is controlled only by the capacity of the outlet works themselves. Any inflow into the reservoir above this capacity is detained as flood water. The flow at the Galisteo Creak at Rosario gage downstream of the dam peaked at 2,920 cfs at

2:00 am on 16 September. This was the highest peak on record for this location. On the morning of 16 September Corps staff reported a high water lake elevation staff reading of 5220 ft. for a detained flood storage volume of 2250 acre-feet. This was a new record pool elevation, beating the previous record from July of 1971 of 5516.91 ft. The calculated inflow into the reservoir had a peak of 12,000 cfs. If unregulated, this peak would have combined with already high flows on the mainstem Rio Grande, contributing to flooding downstream.

4.6.4 Flow Reductions

Flow reductions were estimated at key locations within the basin. These figures are provided in the table, below.

Table 9 - Flow reductions at key locations on the Rio Grande.

Location	Observed Peak Stage (ft)	Observed Peak Flow (cfs)	Unregulated Flow(cfs)
San Felipe, NM	7.73	9,490	17,400
Albuquerque, NM	5.74	4,350	13,000
San Acacia, NM	18.69	8,780	16,000

Data were not available to calculate stage reduction.

The amount of acreage protected from inundation during this event is unknown. The flood event ranged from a 10% to a 2% Annual Chance Exceedance depending on location within the watershed.

The number of structures kept from being flooded is not known for all reaches. For known reaches over 10,000 structures were kept from being flooded. There were no lives lost during the flood event on the Rio Grande mainstem, although one individual died during flooding along Ash Canyon, a tributary arroyo to the Rio Grande below Elephant Butte Dam (Associated Press 2013).

The amount of damages prevented for this flood event totaled $196,111,400 within the Rio Grande basin in New Mexico. Flood control benefits accrued at Cochiti, Jemez Canyon and Galisteo dams.

Table 10 - 2013 damages prevented on the Rio Grande.

Project	Flood Control Benefits ($)
Cochiti	113,088,400
Jemez Canyon	37,696,200
Galisteo	45,326,800
TOTAL	**$196,111,400**

Data: USACE Albuquerque District Reservoir Operations Branch 2014.

4.7 USACE Flood Response Efforts in the Rio Grande Basin

USACE is does not function as a first responder during flood events; however, USACE authorities enable the agency to provide vital services before and after a flood event. These activities are coordinated by the Readiness and Contingency Operations branch (RCO) within the USACE Albuquerque District. Flood response efforts in the Rio Grande Basin that fall within its flood risk authorities:

- Requests for sandbags and sandbagging training were received from the Valles Caldera National Preserve. Approximately 400,000 sandbags were delivered to the State of New Mexico to assist in its flood fighting efforts throughout the state.

- Requests for post-flooding technical assistance were made by communities affected by flooding. These requests resulted in site visits by USACE staff (see Table 11, Appendix 4). In addition, public meetings were held in Pecos and Truth or Consequences, New Mexico.

Table 11 - USACE post-flood site visits in the Rio Grande Basin.

Date	Locality	Community Representatives Met	USACE Team Members (Disciplines)
13 Sep 2013	Santa Clara Pueblo, NM	Santa Clara Pueblo EOC	Don Gallegos (RCO); Stephen Scissons (H&H)
19 Sep 2013	Santa Clara Pueblo, NM	Matthew Tafoya (Santa Clara Pueblo); Arsany Thomas (FEMA)	Donald Gallegos (RCO)
24 Oct 2013	Española region, NM	No data	Donald Gallegos (RCO)
11 Oct 2013	Ohkay Owingeh Pueblo, NM	No data	Christopher Parrish (RCO); Donald Gallegos (RCO); Vince Vigil (H&H)
18 Oct 2013	San Felipe Pueblo, NM	No data	Jeffrey Daniels (RCO); Tamara Massong (H&H)
1 Nov 2013	Isleta Pueblo/Pottery Mound, NM	Henry Walt (Tribal Historic Preservation Officer); Valentino Jaramillo (Director, Department of Cultural and Historical Resources, Isleta Pueblo); Daniel Waseta (Isleta Pueblo Cultural Committee)	Jeffrey Daniels (RCO); Theresa Rogers (RCO); Lisa DeBettignies (H&H)
7 Nov 2013	Near Bernardo, NM	No data	Donald Gallegos (RCO)
8 Nov 2013	Santa Clara, NM	Richard Branch (Mayor); Gabriel Ramos (Grant County); Dinisha Lucero (Grant County)	Donald Gallegos (RCO); Steve Boberg (H&H)
	Madrid, NM	No data	Jeff Daniels (RCO)
3 Feb 2014	Sierra County, NM	Mark Huntzinger (Sierra County Manager); Barry Ragsdale (Sierra County Flood Director)	Donald Gallegos and Theresa Rogers (RCO); Michael Fies (Civil Works)

RCO= USACE Readiness and Contingency Operations Branch, Albuquerque District; H&H = USACE Hydrology and Hydraulics Section, Albuquerque District

- USACE has been actively involved in planning and implementing Advance Measures at Santa Clara Pueblo to mitigate the ongoing flood risk in Santa Clara Canyon.
- Inspections were also made of USACE Galisteo and Jemez Dam projects.

4.8 FEMA Damages Assessments in the Rio Grande Basin

Two Federal Disaster Declarations were made for areas in the Rio Grande Basin affected by the 9-18 September Flood Event:

- FEMA-4151-DR Santa Clara Pueblo – Severe Storms and Flooding, declared October 24, 2013. Preliminary damages were estimated at $1,984,960. Damages identified were primarily to roads and bridges.
- FEMA-4152-DR New Mexico – Severe Storms, Flooding, and Mudslides, declared October 29, 2013. Preliminary damages were estimated at $16,598,503. Damages identified were primarily to roads and bridges.

Beginning in November 2013, FEMA initiated field studies to evaluate actual damages, preliminary to the distribution of Federal funds to communities. As of February 2014, there were 146 applications for assistance had been made by communities throughout New Mexico. Damage assessments are anticipated to be completed in late summer 2014.

5 - Pecos Basin

5.1 Pecos Basin Overview

The following description of the Pecos River basin and water control facilities is derived from Reclamation (2005). The Pecos River is a principal tributary of the Rio Grande, flowing south approximately 440 miles through eastern New Mexico into Texas where it joins the Rio Grande at Amistad Reservoir. The Pecos River rises in the Truchas Peak area of the Sangre de Cristo Mountains of northern New Mexico at elevations near 13,000 feet (ft) and drains 19,000 square miles in New Mexico and 14,000 square miles in Texas. In the upper basin the river flows through steep canyons and gorges, dropping in elevation to about 4,600 feet at Santa Rosa, New Mexico and a further 300 feet to the southern end of the upper basin at Sumner Dam near Fort Sumner, New Mexico. Between Santa Rosa Dam and Lake Sumner, the Pecos River flows through alternating narrow canyons and slightly wider valleys. The agricultural community of Puerto de Luna is located along this stretch of river.

The Middle Basin extends from Fort Sumner to Carlsbad. From Lake Sumner, the river flows south through the broad rolling plains of eastern New Mexico to Carlsbad, NM. The major tributaries of the Middle Basin are Taiban Creek, Yeso Creek, the Rio Hondo, the Rio Felix, the Rio Peñasco, Macho Draw, Salt Draw, and Seven Rivers. From Sumner Dam downstream for 113 river miles to the Pecos River near-Acme gage site (Acme), the channel is generally wide, sandy and unstable, and water from springs and irrigation returns provide flows in the channel during times when no bypasses occur from Sumner Dam. The Sumner to Acme stretch of the river is hydrologically characterized as a losing reach. Surface water is lost both through seepage and evaporation. Depending on the time of year, the amount of water flowing and local weather conditions, water losses in this portion of the river can be as much as 100 percent. Thus, this area is subject to drying and flow intermittence.

Downstream of Acme, the river gains water from artesian aquifer leakage and irrigation returns in the Roswell basin, so it is characterized as a gaining reach. In addition, the stream channel narrows and deepens. The reach from near Roswell to the headwaters of Brantley Reservoir is deeply incised and the river is confined to a single channel. Base flows maintain permanent flow throughout this reach and it is not subject to intermittent conditions.

Downstream of Carlsbad, the Pecos River runs primarily through canyon country through West Texas to its junction with the Rio Grande near Del Rio, Texas at an elevation of 1,000 feet.

Federal facilities on the Pecos River are critical for flood control and irrigation storage. These include: Santa Rosa Dam, Sumner Dam, FSID Diversion Dam, Brantley Dam and Avalon Dam. In addition, the USACE Two Rivers project provides flood control along the Rio Hondo and Rocky Arroyo, tributaries to the Pecos River at Roswell, NM.

- Santa Rosa Dam, the northern most facility on the Pecos River, is a Corps flood control facility. Construction of this facility was completed in 1980 and the reservoir stores some irrigation water for the Project. The total storage for this facility is approximately 98,000 ac-ft of Project storage.

- Sumner Dam is a Reclamation dam which was completed in 1938 and was the primary storage facility on the Pecos River for the Carlsbad Project until Santa Rosa Dam was completed in 1980. Total storage for Lake Sumner is approximately 40,000 ac-ft of Project storage.

- FSID Diversion Dam is a Reclamation-owned dam, completed in 1951. This facility is approximately 14 river miles downstream of Sumner Dam and diverts the FSID's senior direct flow diversion water right into their canal. This facility replaced an earlier, privately-owned dam and is operated and maintained by FSID. This diversion dam is not a part of the Carlsbad Project and does not store water for either project of Project storage.

- Brantley Dam is a Reclamation-owned dam, completed in 1989. This facility is approximately 225 river miles downstream from Sumner Dam. The total storage for this facility is approximately 40,000 ac-ft of Project storage.

- Avalon Dam is a Reclamation-owned dam, which Reclamation rebuilt in 1907 for the Carlsbad Project. Total storage for this facility is approximately 3,800 ac-ft of Project storage.

- Two Rivers is a USACE project consisting of two dams: Diamond "A" and Rocky. The Diamond "A" Dam is an earth fill structure with a gated outlet. The Rocky Dam is an earth fill structure with an uncontrolled outlet. No provision is made for water storage, except for flood control. Flood releases are controlled so that flows through Roswell will not exceed 1,000 cfs, which is the Rio Hondo channel capacity within the City of Roswell. The capacity of the Two Rivers Reservoir at its spillway crest is 163,773 acre-feet of which 13,775 ac-ft are provided for sediment reserve. Together, these dams regulated runoff from 1,027 square miles of drainage area.

Irrigation agriculture is the primary use for Pecos Basin water. Approximately 130,000 acres (ac) of land are under irrigation in the Middle Basin, primarily near the mainstem of the Pecos River. Approximately 35,000 acres of these irrigated acres are served fully or partially from surface water supplies and the remainder from artesian or shallow wells. Irrigated lands occur primarily around Fort Sumner and Carlsbad, and in the Roswell Artesian Basin (between Roswell and Brantley Dam).

The Fort Sumner Irrigation District (FSID) is located in DeBaca County on the east bank of the Pecos River and is served by a concrete diversion dam, canals, and laterals. The diversion dam is located approximately 14 river miles below Sumner Dam. The FSID includes 8,035 acres, of which 6,500 are classified as irrigable.

The Carlsbad Project is a Reclamation project located in southeastern New Mexico near the city of Carlsbad. The Carlsbad Project irrigates 25,055 acres of the Carlsbad Irrigation District (CID) from just below Avalon Dam to the Black River area. Other Project features include Sumner

Dam, Brantley Dam, and Avalon Dam which all divert and store water for the Project. The Pecos River from Santa Rosa Dam to Brantley Dam has a drainage area of approximately 15,220 square miles and traverses 225 miles.

5.2 Meteorological Event in the Pecos Basin

Unlike the Rio Grande Basin, in the Pecos Basin rainfall occurred primarily on 10-12 September across most of the basin, and then again on Monday, 16 September, with the second round of precipitation concentrated in the upper Pecos Basin above Santa Rosa Dam.

The precipitation on 10-12 September was the result of tropical moisture transported into the region, funneled between the ridge of high pressure to the east and the trough of low pressure to the west. Rainfall was widespread and steady. At Santa Rosa Dam, the 48-hour precipitation total was 2.81 inches. By 12 September, the lake had risen 18 feet with an estimated increase in volume of 17,400 ac-ft (U.S. Army Corps of Engineers (USACE) 2013b). Computed inflow to Santa Rosa peaked on 11 Sep 2013 at 25,289 cfs.

Although all floodwaters were retained at the dam, downstream precipitation was heavy enough to produce significant flooding south of Santa Rosa. The Pecos River steam gage at Puerto de Luna recorded peak flows of 21,000 cfs. At the West Puerto de Luna (Giddings Baca) diversion dam, located on a tributary stream, flows estimated at 12,000 cfs caused erosion damage and scour to the irrigation diversion dam [MOR dated 4 Oct 2013]. While still operational, the diversion dam was significantly damaged requiring emergency repairs. Peak flows were reached later in downstream locations, reflecting the downstream movement of flood waters originating higher in the basin:

- Pecos River at Sumner Dam and Lake: 22,000 cfs (11 Sep)
- Rio Hondo, Diamond A Ranch Gage: 29,500 cfs (11 Sep)
- Brantley Dam inflow: 23,000 cfs (11 Sep)
- Rocky Arroyo at the highway bridge near Carlsbad: 29,700 cfs (11 Sep)
- Pecos River below Avalon Dam at Carlsbad: 7,510 cfs (12 Sep)
- Pecos River in Dark Canyon: 19,900 cfs (12 Sep)

5.3 Rainfall Data in the Pecos Basin

Rainfall data were obtained from the National Weather Service and the Western Regional Climate Center. Data come from a variety of sources, including the NWS Cooperative Observer (COOP) stations (Western Regional Climate Center (WRCC) 2014b), remote automated weather station sites (RAWS) (Western Regional Climate Center (WRCC) 2014a), the automated surface observing system (ASOS) network, the historical climatology network (HCN) and the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) (NOAA/NWS 2013a).

COOP and RAWS data were available at daily time steps, the others were obtained as sums for the period 10-18 September. For the COOP sites only, the NOAA Atlas 14 provides recurrence intervals (RI) for precipitation(NOAA/NWS 2014c).

On Wednesday, 11 September, the Las Vegas Airport COOP site recorded 2.69 in of rain (10-year RI). For the period 10-16 September, the airport COOP site recorded 6.12 in of rain (100-year RI). Greater precipitation totals were recorded at regional CoCoRaHS sites, ranging from 7.49 in to 9.78 in for the period 10-18 September , the majority of which likely fell during the period 10-16 September. Significant precipitation also fell around Capitan and Roswell on 11 September.

Significant rainfall fell in the vicinity of Pecos, NM, on Thursday, 12 September and Friday, 13 September. The Pecos Ranger Station COOP site recorded 1.06 in on the first day and 2.56 (10-year recurrence interval) on the second. Comparable precipitation amounts were documented at the Pecos RAWS station (2.15 on the first day and 1.39 on the second). For the 7-day period 10-16 September, the Pecos Ranger Station recorded 5.95 in (200-year recurrence interval) while the RAWS station recorded 6.67 in. On 12 September, storms also dumped rain on the Bitter Lakes Wildlife Refuge, which recorded 5.00 in (50-year RI) of precipitation.

The last significant rainfall in the region was received at Capitan, NM, where the COOP site recorded 3.95 in (50-year RI) on 17 September.

Table 12 - Precipitation totals 9-18 September 2013 in the Pecos River Basin (NOAA/NWS 2014c, Western Regional Climate Center (WRCC) 2014a, b).

Location (source)	10-day Precipitation Total (in) (9-18 Sept)	Highest Daily precip (in) (date)	COOP site Av. Recurrence interval (24-hr event)	Highest 7-day precip (in) (dates)	COOP site Av. Recurrence interval (7-day event)
NEW MEXICO					
Pecos (RAWS)	6.86	2.15 (12 Sept)	--	6.67 (10-16 Sept)	--
Pecos Ranger Station (COOP)	5.95	2.56 (13 Sept)	10 years	5.95 (10-16 Sept)	200 years
Las Vegas FAA Airport (COOP)	6.01	2.69 (11 Sept)	10 years	6.12 (10-16 Sept)	100 years
Fort Sumner 5 S (COOP)	4.91	3.66 (11 Sept)	10 years	4.88 (10-16 Sept)	10 years
Eight Mile Draw (RAWS)	3.65	2.40 (11 Sept)	--	3.63 (10-16 Sept)	--
Smokey Bear (RAWS)	5.63	1.93 (11 Sept)	--	5.62 (10-16 Sept)	--
Capitan (COOP)	4.85	3.95 (17 Sept)	50 years	4.55 (11-17 Sept)	10 years
Picacho (COOP)	7.05	2.54 (11 Sept)	No data	5.47 (11-17 Sept)	No data
Roswell FAA Airport (COOP)	3.55	2.02 (11 Sept)	2 years	3.55 (11-17 Sept)	5 years
Bitter Lakes Wildlife Refuge (COOP)	6.57	5.00 (12 Sept)	50 years	6.47 (11-17 Sept)	25-50 years
Mescal (RAWS)	4.20	1.27 (13 Sept)	--	4.02 (10-16 Sept)	--
Mayhill (RAWS)	6.25	1.56 (11 Sept)	--	5.73 (9-15 Sept)	--
Dunken (RAWS)	5.52	2.47 (13 Sept)	--	5.41 (10-16 Sept)	--
Artesia 6S (COOP)	3.36	2.12 (12 Sept)	2 years	3.31 (9-15 Sept)	2-5 years
Carlsbad FAA Airport (COOP)	3.61	1.69 (11 Sept)	10 years	3.61 (10-16 Sept)	5 years
Queen (RAWS)	7.83	4.19 (12 Sept)	--	7.83 (10-16 Sept)	--
Paduca (RAWS)	0.18	0.11 (16 Sept)	--	0.18 (11-17 Sept)	--
TEXAS					
Bakersfield 2 NW (COOP)*	0	0	< 1 year	0	< 2 years
Amistad Dam (COOP)*	1.19	0.57 (17 Sept)	< 1 year	1.15 (12-18 Sept)	< 2 year2

COOP = National Weather Service Cooperative Observer Station; RAWS = Remote Automated Weather Station.
**Additional significant precipitation fell at these sites in the days immediately following.*

Table 13 - Precipitation totals 10-18* September 2013 at additional sites in the Pecos River Basin (NOAA/NWS 2013n, g, f, h, d).

**Data sources excluded precipitation on 9 September 2014.*

Location (source)	Precipitation Total (in)
Las Vegas 8.4 NW (CoCoRaHS)	9.78
Las Vegas 12.1 W (CoCoRaHS)	9.74
Las Vegas 10.3 N (CoCoRaHS)	9.27
Las Vegas 4.6 SSW (CoCoRaHS)	8.10
Las Vegas 2.6 SE (CoCoRaHS)	7.49
Rociada 5.6 E (CoCoRaHS)	7.04
Las Vegas Airport (ASOS)	6.24
Vaughn (HCN)	2.55
Skyview Bonito Lake 2 S (HADS)	8.34
Buck Mountain (HADS)	8.21
Lincoln 4.6 SSE (CoCoRaHS)	6.54
Bluefront Crest Trails Bonito Lake 6 WSW (HADS)	6.23
Ruidoso 1.7 WNW (CoCoRaHS)	5.53
Runnels Stables Bonito Lake 4 W (HADS)	5.46
Nogal Peak Crest Bonito Lake 5 WNW (HADS)	5.36
Capitan (COOP)	4.85
Bonito Lake (HADS)	4.66
Lincoln 1.4 ESE (CoCoRaHS)	4.41
Sierra Blanca Regional Airport (AWOS)	4.24
Roswell 17.4 N (CoCoRaHS)	4.56
Roswell Airport (ASOS)	3.98
Hagerman (HCN)	3.06
Elida (CRN)	1.94

CoCoRaHS = Community Collaborative Rain, Hail and Snow Network; ASOS=Automated Surface Observing System; HCN = Historical Climatology Network

5.4 Event Hydrology in the Pecos Basin

The discussion that follows comes from (USACE 2014a). Major flooding occurred on the Pecos River and virtually all its tributaries from a historic rain event which impacted the entire basin on 11-20 September 2013. The Pecos River flooding event began on 11 September 2013. Flooding problems were reported for the town of Santa Rosa. Law enforcement and emergency management reported major flooding along El Rito Creek. State road NM 91 was closed between mile markers 0-9. Overtopping occurred on the previously breached and damaged Janes Wallace Memorial Dam, causing further deterioration to the existing structure sending and large chunks of concrete from the dam downstream. The railroad bridge over El Rito Creek was compromised and engineers closed the traffic to assess damages. Localized flooding was occurring along the Pecos River between Santa Rosa to Fort Sumner. On 11 September, the Pecos River near Puerto de Luna crested at 15.57 feet which is second highest recorded measurement for a flow of 21,100 cfs. Channel Capacity for the Pecos River at this reached is surveyed to be 13,000 cfs.

The upper Pecos River basin experienced flooding during 13-17 September. Gallina Creek near Las Vegas recorded major flooding requiring evacuations along the river from Montezuma east to Las Vegas. NM State highways 63 and 283 were closed due to flooding. A major breach occurred on the Storrie Lake Diversion Channel allowing additional flows to be released. It was estimated one year's worth of drinking water supply was lost due to the breach. This volume of water would increase the volume of Santa Rosa Lake.

The Pecos River flooded between Acme and Lake Arthur on 12-14 September. Roads were closed in the area due to high water, some homes were flooded, and large areas of farmland were inundated. New Mexico National Guard and other rescue crews evacuated 70 campers and residents who were stranded by floodwaters along the Pecos River in the community of Lakewood. The Pecos River at Acme crested at 14.05 feet for a flow of 6,550 cfs on September 12th. This crest is the 3rd highest on record. The Pecos River at Artesia peaked on September 17th at 11.99 feet (3,490 cfs). Channel capacity for this reach is surveyed to be 8,500 cfs.

The Rio Hondo and Berrendo Creek flooding problems occurred on 11 September. Rio Hondo at Diamond A Ranch river gage recorded its 5th highest crest of 29,500 cfs and the Rio Hondo at Roswell river gage recorded 2nd highest crest of 1,920 cfs. Channel Capacity in the Rio Hondo within Roswell area is surveyed to be 1,000 cfs. Vehicles were rescued along US 70 relief route due to Rio Hondo flooding. Water rescue occurred along NM 246 near Berrendo Creek. Communities were evacuated near Roswell along Pecos River with 3 homes inundated. Numerous low water crossing were flooded across Roswell with minor flooding in the city.

The Pecos River below Brantley Dam, reported flash flooding in the Dark Canyon, Rocky Arroyo and Black River tributary basins on 12 September. Avalon Dam's emergency spillway was releasing 7,150 cfs. Due to the spillway releases of the dam, Bureau of Reclamation and Carlsbad Irrigation District activated Emergency Action Plan of a Level 1 until flow receded the following day. The Pecos River at Dark Canyon Draw at Carlsbad river gage recorded 2nd highest crest of 15.42 feet for a flow of 30,700 cfs. Channel Capacity for this reach is surveyed to be 20,000 cfs. The city of Carlsbad closed US 285 bridge as a precaution. The Guadalupe Mountains National Park Visitor Center recorded 15.76 inches of rainfall during 9-13 September.

Table 14 - Summary of flood and high flow conditions 9-18 September at selected gages in the Pecos River Basin (U.S. Geological Survey (USGS) 2014l).

USGS station number	**USGS Station Name**	**Drainage area (mi^2)**	**Highest peak from 2013-09-09 to 2013-09-18**				**Historical Peaks**	
			Date	**Stage [ft]**	**Stream flow (date) [ft^3/s]**	**Rank**	**No. of years**	**Max. (year) [ft^3/s]**
08377900	RIO MORA NEAR TERRERO, NM	53.2	2013-09-13	3.75	713	5	49	937 (1991)
08378500	PECOS RIVER NEAR PECOS, NM	189	2013-09-13	6.19	2290	3	90	4500 (1929)
08379500	PECOS RIVER NEAR ANTON CHICO, NM	1050	2013-09-17	8.85	9000	--	93	73000 (1904)
08380500	GALLINAS CREEK NEAR MONTEZUMA, NM	84	2013-09-13	7.59	3160	--	96	7120 (1966)

USGS station number	**USGS Station Name**	**Drainage area (mi^2)**	**Highest peak from 2013-09-09 to 2013-09-18**				**Historical Peaks**	
			Date	**Stage [ft]**	**Stream flow (date) [ft^3/s]**	**Rank**	**No. of years**	**Max. (year) [ft^3/s]**
08382000	GALLINAS RIVER NEAR LOURDES, NM	313	2013-09-14	10.25	8860	1	18	6680 (1961)
08382500	GALLINAS R NR COLONIAS, NM	610	2013-09-17	28.41	22000	2	62	26700 (1937)
08382600	PECOS R ABV CANON DEL UTA NR COLONIAS, NM	2330	2013-09-17	19.07	30800	1	37	12700 (2006)
08382650	PECOS RIVER ABOVE SANTA ROSA LAKE, NM	2340	2013-09-17	26.12	28000	1	36	16000 (1996)
08382830	PECOS RIVER BELOW SANTA ROSA DAM, NM	2430	2013-09-11	4.07	253	<	31	2140 (1997)
08383500	PECOS RIVER NEAR PUERTO DE LUNA, NM	3970	2013-09-11	15.57	21000	--	75	48600 (1942)
08384500	PECOS RIVER BELOW SUMNER DAM, NM	4390	2013-09-09	2.15	117	<	97	42800 (1942)
08385000	FORT SUMNER MAIN CANAL NEAR FORT SUMNER, NM	--	2013-09-11	4.97	92	<	1	100 (2011)
08385503	SAND GATE DIV FROM FT SUMNER CANAL AT FT SUMNER,NM	--	2013-09-09	0.44	6.5 (2013-09-10)	<	3	33 (2011)
08385522	PECOS RIVER BELOW TAIBAN CREEK NEAR FORT SUMNER,NM	--	2013-09-12	10	7800	1	15	6500 (2004)
08385630	PECOS RIVER NEAR DUNLAP, NM	--	2013-09-13	7.8	7010	1	15	6470 (2002)
08386000	PECOS RIVER NEAR ACME, NM	11380	2013-09-12	14.03	21700 (2013-09-13)	6	76	53000 (1937)
08386505	RIO RUIDOSO AT RUIDOSO, NM	--	2013-09-13	2.9	192	4	13	3380 (2008)
08387000	RIO RUIDOSO AT HOLLYWOOD, NM	120	2013-09-13	5.39	191	31	58	3400 (2008)
08387550	NORTH FORK EAGLE CREEK NEAR ALTO, NM	003.16	2013-09-14	4.32	357	1	5	262 (2008)
08387575	SOUTH FORK EAGLE CREEK NEAR ALTO, NM	--	2013-09-13	2.4	12	4	5	160 (2008)
08387600	EAGLE CREEK BELOW SOUTH FORK NEAR ALTO, NM	8.14	2013-09-12	7.17	3.6	<	36	340 (2008)

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
08390020	RIO HONDO ABOVE CHAVEZ CANYON NEAR HONDO, NM	587.876	2013-09-14	8.08	595	1	4	1340 (2011)
08390500	RIO HONDO AT DIAMOND A RANCH NR ROSWELL, NM	947	2013-09-11	25.95	29500	5	71	54800 (1965)
08390800	RIO HONDO BLW DIAMOND A DAM NR ROSWELL, NM	963	2013-09-18	3.36	275	29	47	659 (1965)
08393610	RIO HONDO NEAR ROSWELL, NM	2900	2013-09-12	13.81	1920	2	5	2310 (2010)
08394024	PECOS R N BOUNDARY (BLM WETLANDS) NR DEXTER, NM	--	2013-09-14	17.69	9720	1	7	5230 (2004)
08394033	PECOS R S BOUNDARY (BLM WETLANDS) NR DEXTER, NM	--	2013-09-14	15.27	7410	1	7	4570 (2004)
08394500	RIO FELIX AT OLD HWY BRD NR HAGERMAN, NM	932.00	2013-09-12	--	14300	--	56	74000 (1954)
08395500	PECOS RIVER NEAR LAKE ARTHUR, NM	14760	2013-09-13	17.85	5690	21	74	51500 (1937)
08396500	PECOS RIVER NEAR ARTESIA, NM	15300	2013-09-17	11.99	3490	51	100	45000 (1937)
08397600	RIO PENASCO NEAR DUNKEN, NM	583	2013-09-15	12.48	3420	16	56	70000 (1941)
08397620	RIO PENASCO NEAR HOPE, NM	675	2013-09-15	13.83	7010	3	7	9000 (2005)
08398500	RIO PENASCO AT DAYTON, NM	1060	2013-09-15	0.29	1340	--	--	--
08399500	PECOS RIVER (KAISER CHANNEL) NEAR LAKEWOOD, NM	--	2013-09-18	21.06	2840	2	60	2920 (1960)
08400000	FOURMILE DRAW NR LAKEWOOD, NM	265	2013-09-12	10.01	4030	7	58	29300 (1966)
08401200	SOUTH SEVEN RIVERS NR LAKEWOOD, NM	220	2013-09-11	13.11	22600	10	44	25500 (1965)
08401500	PECOS RIVER BELOW BRANTLEY DAM NEAR CARLSBAD, NM	17650	2013-09-12	10.01	1040	5	21	1200 (1992)
08401900	ROCKY ARROYO AT HWY BRD NR CARLSBAD, NM	285	2013-09-12	14.33	29700	3	47	31600 (1966)

USGS station number	**USGS Station Name**	**Drainage area (mi^2)**	**Highest peak from 2013-09-09 to 2013-09-18**				**Historical Peaks**	
			Date	**Stage [ft]**	**Stream flow (date) [ft^3/s]**	**Rank**	**No. of years**	**Max. (year) [ft^3/s]**
08402000	PECOS R AT DAMSITE 3 NR CARLSBAD, NM	17980	2013-09-12	13.45	18200	9	68	69000 (1966)
08403500	CARLSBAD MAIN CANAL AT HEAD NEAR CARLSBAD, NM	--	2013-09-11	1.08	--	--	--	--
08404000	PECOS RIVER BELOW AVALON DAM, NM	18080	2013-09-12	10.91	8480	13	59	55500 (1966)
08405105	DARK CANYON DRAW NEAR WHITES CITY, NM	327	2013-09-12	17.16	24500	2	10	44500 (2004)
08405150	DARK CANYON AT CARLSBAD, NM	451	2013-09-12	17.85	50400	1	22	27000 (1980)
08405200	PECOS RIVER BELOW DARK CANYON AT CARLSBAD, NM	18550	2013-09-12	15.42	30700	2	41	35400 (1986)
08405450	BLUE SPRINGS ABOVE DIVERSIONS NR WHITES CITY, NM	--	2013-09-12	4.11	24	--	--	--
08405500	BLACK RIVER ABOVE MALAGA, NM	343	2013-09-12	6.98	2800	25	65	74600 (1966)
08406000	BLACK RIVER AT MALAGA, NM	350	2013-09-13	19.63	2120	1	9	1800 (2009)
08406500	PECOS RIVER NEAR MALAGA, NM	19190	2013-09-13	19.96	13200	19	90	120000 (1966)
08407000	PECOS RIVER AT PIERCE CANYON CROSSING, NM	19260	2013-09-12	8.96	2420 (2013-09-14)	1	10	2280 (2000)
08407500	PECOS RIVER AT RED BLUFF, NM	19540	2013-09-13	15.96	11900	15	73	111000 (1966)
08408500	DELAWARE RIVER NR RED BLUFF, NM	689	2013-09-12	12.9	23000	10	73	81400 (1955)
08410000	RED BLUFF RES NR ORLA, TX	24495	2013-09-18	2808.64 asl*	--	--	--	--
08412500	PECOS RV NR ORLA, TX	25070	2013-09-14	1.32	25	74	74	23700 (1941)
08420500	PECOS RV AT PECOS, TX	26236	2013-09-16	0.04	--	--	--	--
08427000	GIFFIN SPGS AT TOYAHVALE, TX	--	2013-09-10	4.71	3.9 (2013-09-12)	--	--	--
08433000	BARRILLA DRAW NR SARAGOSA, TX	612	2013-09-13	1.97	--	--	--	--

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
08437710	PECOS RV AT RR 1776 NR GRANDFALLS, TX	34740	2013-09-18	4.52	0.49	--	--	--
08444500	COMANCHE SPGS AT FT STOCKTON, TX	--	2013-09-09	2	--	--	--	--
08446500	PECOS RV NR GIRVIN, TX	37300	2013-09-10	1.04	3.9	<	74	20000 (1941)
08447000	PECOS RV NR SHEFFIELD, TX	40685	2013-09-18	3.89	4.4	<	13	13800 (1941)
08447020	INDEPENDENCE CK NR SHEFFIELD, TX	763	2013-09-18	1.98	15	<	24	79300 (2004)
08447300	PECOS RV AT BROTHERTON RH NR PANDALE, TX	42169	2013-09-18	4.78	40 (2013-09-12)	--	--	--
08456300	LAS MORAS SPGS AT BRACKETTVILLE, TX	--	2013-09-12	1.81	8	<	1	50.0 (2013)

**Reservoir stages are given in elevation above sea level while stream channel stages are in feet above channel bottom.*

5.5 Flooding in the Pecos Basin

Many sites where significant damages occurred have been reported by local, regional, and State authorities in the Pecos Basin. Flood damage was particularly severe at:

- In Las Vegas, New Mexico
- Near Puerto de Luna, New Mexico
- North of Carlsbad, New Mexico

Damages to these areas are described below.

5.5.1 Flooding in Las Vegas, New Mexico

Heavy rainfall in western Mora County (Figure 22) either late Thursday 12 September or early Friday 13 September resulted in significant flooding along the Gallinas River in Las Vegas, New Mexico (Las Vegas Optic 2013). Precipitation in town was estimated at 3 to 5 inches over the previous 4 days, with as much as 5 to 7 inches in higher elevation areas to the west during the same period. In the Las Vegas area, road closures included New Mexico Highway 65 through Gallinas Canyon, New Mexico Highway 283 up Mineral Hill, and New Mexico Highway 419 to the east of Las Vegas as well as local roads in the vicinity of the Gallinas River in Las Vegas

(Las Vegas Optic 2013). Memorial Middle School, West Las Vegas High school and West Las Vegas Middle School were closed and flooding of some businesses and homes occurred. Both the Bridge Street and Independence Street Bridges over the Gallinas River were closed for part of the day on Friday (Salazar 2013b).

Infrastructure damage in the city was estimated at $2.2 million, with approximately $6-$7 million throughout San Miguel County (Salazar 2013a).

Breach of the Storrie Lake Diversion Channel, an earthen canal that transports water from the Gallinas River to Storrie Lake, exacerbated flooding downstream because floodwaters were not captured and diverted to storage in the lake (Salazar 2013b). Instead, water from the breach flowed through property near the village of Los Vigiles before returning to the river, contributing to high water levels downstream. It is anticipated that if the canal had not breached, downstream flows would have been reduced by as much as 1,100 cfs (Salazar 2013b). Flood flows on the Gallinas moved south-southeast to the confluence with the Pecos River upstream of Santa Rosa, contributing to the remarkable rise in reservoir levels behind Santa Rosa Dam.

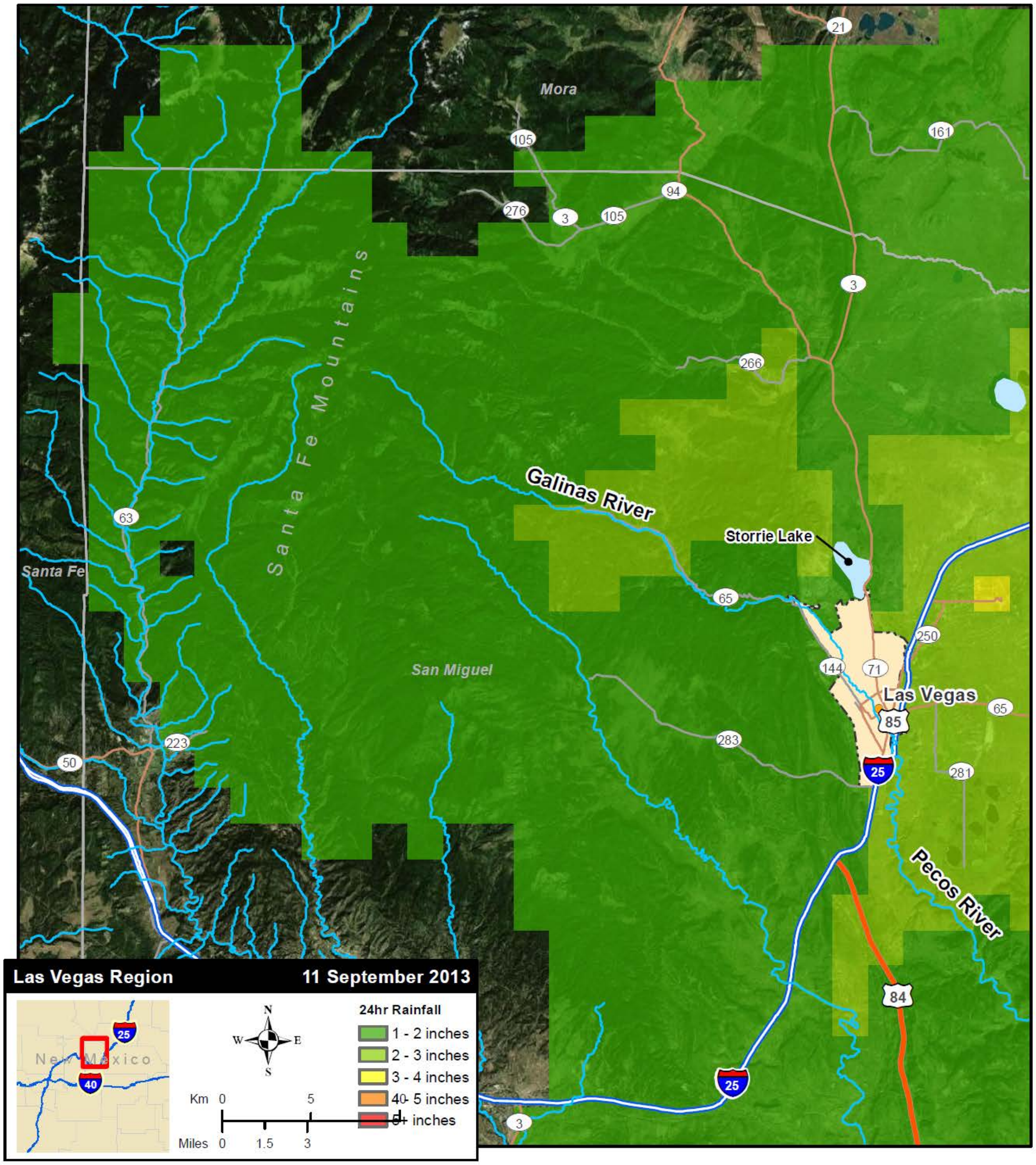


Figure 25 - Doppler radar map showing precipitation >1 inch in the Las Vegas, NM, area on 11 September 2013.

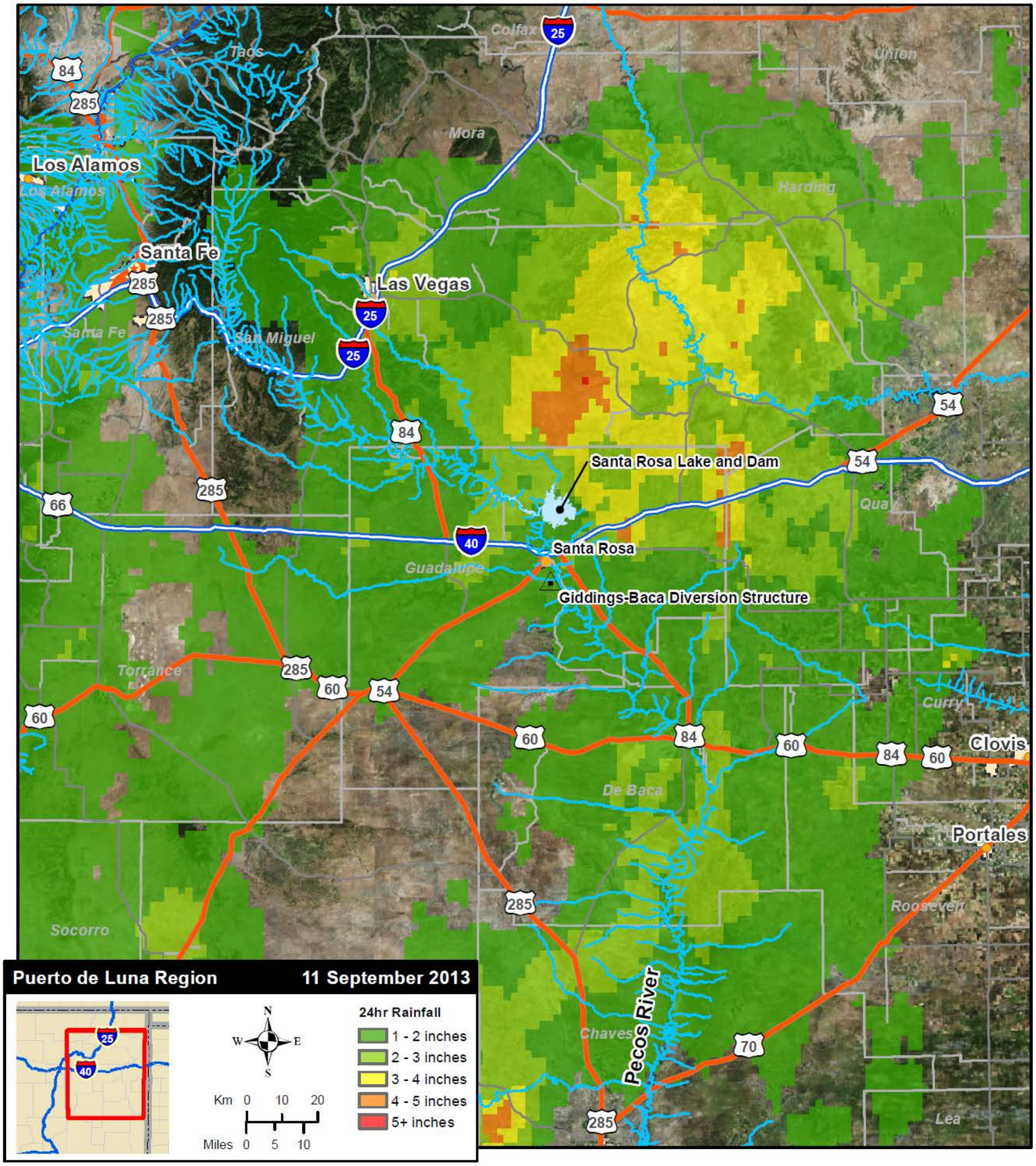


Figure 26 - Doppler radar map showing precipitation >1 inch in the vicinity of Puerto de Luna and Santa Rosa, NM, on 11 September 2013.

5.5.2 Flooding near Puerto de Luna, New Mexico

Puerto de Luna is a small community along the Pecos River downstream of Santa Rosa Dam. Despite the fact that Santa Rosa Dam was storing all upstream floodwaters during the event (and therefore upstream flood flows were NOT contributing to flooding downstream of the dam), precipitation in the catchment produced large flows along the Pecos River and its local tributaries (Figure 23). The Pecos River at Puerto de Luna crested at 15.57 feet on Wednesday, 11 September, with an estimated flow of 21,100 cfs, 8100 cfs in excess of local channel capacity.

Figure 27 - Flood damage to the Giddings-Baca Diversion Dam, including erosion damage to the stilling basin and spillway toe.

Major damage occurred to the Giddings Baca (Puerto de Luna Acequia) Diversion Dam (Figure 24) located along Agua Negra Creek (USACE 2013h, USACE 2013i). Flow at the diversion structure was estimated at least 12,000 cfs, at least 2500 cfs above the 9500 cfs design capacity. The dam spillway was overtopped and the diversion structure submerged, with floodwaters slowing around the structure on both sides. Severe erosion occurred on both the right and left banks, but the upper portion of the structure survived and the erosion protection held, leaving the dam operational. Significant scour also occurred in the stilling basin, leaving it susceptible to erosion and slope stability issues.

5.5.3 Flooding north of Carlsbad, New Mexico

Heavy rainfall (Figure 25) led to flooding in Eddy and Chaves Counties. Flooding occurred in the Lakewood area, where approximately 60 residents from the SKP RV Camp. A train was stranded on the tracks in the Lakewood area, and two people were rescued from a flooded vehicle near the Pecos River (Artesia News 2013, Mauritson 2013). Flows in Rocky Arroyo near Carlsbad may have been as high as 25,000 cfs at the highway bridge.

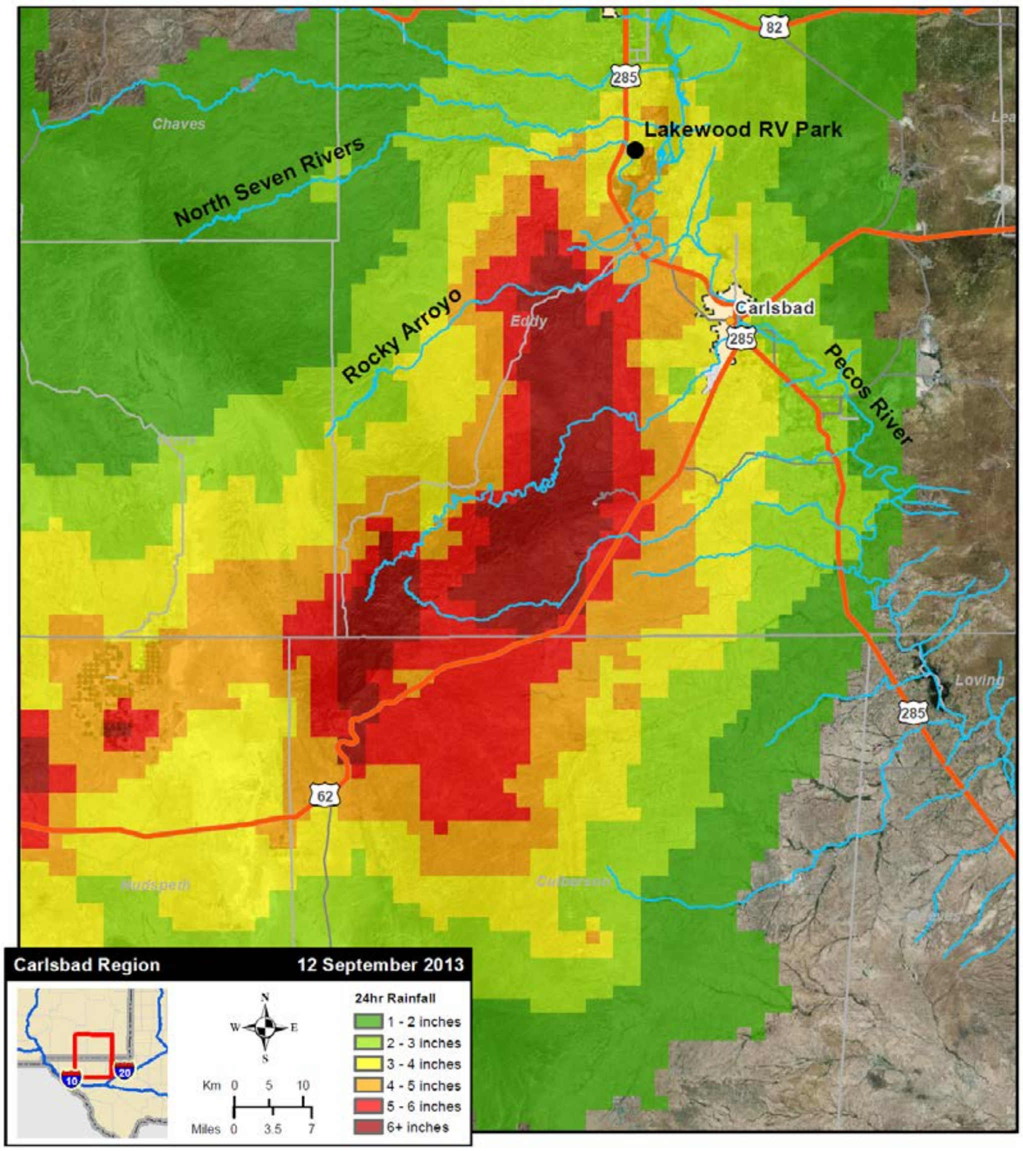


Figure 28 - Doppler radar map showing precipitation >1 inch in the Carlsbad, NM area on 12 September 2013.

5.6 Reservoir Operations and Damages Prevented in the Pecos Basin

Prior to the September 2013 Event, the Pecos Basin was in severe drought conditions and water storage volumes at area reservoirs were at near-record lows. Precipitation on 11-12 September and subsequent days led to high runoff and large peak flow volumes throughout the Basin. These flows were sufficient to nearly fill all area reservoirs, resulting in impressive gains in water storage as the flood flows worked their way downstream over the ensuing weeks. The discussion that follows comes from (USACE 2014a).

5.6.1 Santa Rosa Dam and Lake

On 10 September, Santa Rosa Project storage was at 11,100 ac-ft. Four consecutive years of drought left the majority of the reservoirs in the Pecos River with space to store flood event water (Figure 26). The reservoir began to see a significant increase in inflow by the morning of September 11th and would not subside until 26 September. A peak reservoir inflow of 25,000 cfs occurred on 11 September and again on 17 September. A peak storage of 103,474 ac-ft at Santa Rosa was reached on 27 September. This rain event resulted in a 44.4 ft vertical rise within the conservation pool.

No flood control operations at Santa Rosa took place while the reservoir was within the range of the conservation pool. No flood control space was utilized.

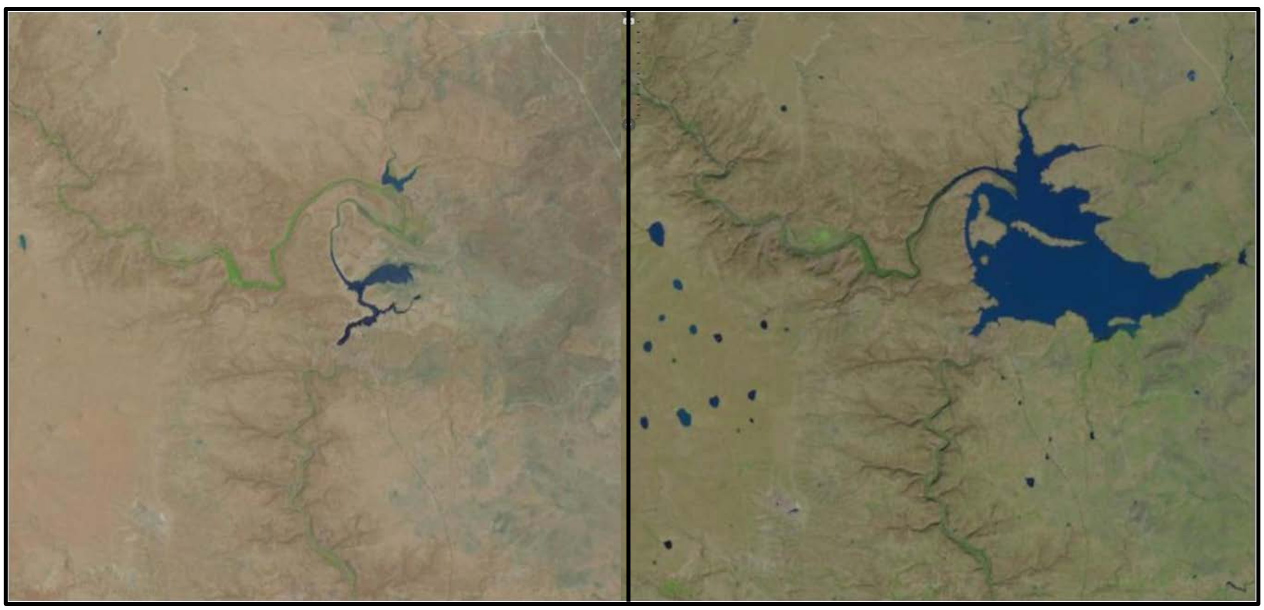


Figure 29 - Landsat satellite image showing Santa Rosa Lake and the Pecos River in early September 2013 (left) and in October 2013 (right).

5.6.2 Fort Sumner Dam and Lake

The reservoir began to see a significant increase in inflow by the morning of 11 September. A peak reservoir inflow of 23,000 cfs was recorded on 2 September. Fort Sumner storage before September rain event was 3,764 ac-ft. A peak storage of 38,274 ac-ft at the reservoir was reached on 20 September. This rain event resulted in a 26.3 ft vertical rise within the conservation pool.

No flood control operations at Fort Sumner took place while the reservoir was within the range of the conservation pool. No flood control space was utilized.

5.6.3 Two Rivers Dam and Reservoir

The reservoir began to see an increase in inflow on the morning of 11 September. The reservoir elevation continued to rise and reached a new record pool on 12 September of 3,991.58 feet at Diamond “A” for a storage volume of 1,823 ac-ft and 3,971.34 ft at Rocky Arroyo for a storage volume of 5,796 ac-ft. The previous record pool elevation at Diamond “A” was 3856.80 feet in September 1996. The previous record pool elevation at Rocky was 3,971.33 feet in July 1991.

As per flood release criteria, flows from the dam were regulated to not exceed 8,500 cfs at the Artesia, NM river gage and 1,000 cfs at the Rio Hondo at Roswell. Releases were adjusted to accommodate intervening upstream and downstream flows of the Pecos River and City of Roswell flooding situation. Flood releases from the Two Rivers project continued for the next two weeks at 270 cfs until all the floodwater was evacuated.

The following are the new record pool and storage values for Two Rivers Dam:

- New record pool elevation at Diamond A = 3,991.58 ft (1,823 ac-ft).
- New record pool elevation at Rocky = 3,971.34 ft (5,796 ac-ft).

5.6.4 Brantley Dam and Reservoir

The reservoir began to see a significant increase in inflow on the morning of 12 September as the floodwaters reached the reservoir. A maximum inflow of 22,000 cfs was recorded at early morning 12 September. Brantley storage before the September rain event was 4,473 ac-ft. Peak storage at the reservoir of 38,531 ac-ft occurred on 21 September before releasing allocated water to Texas. This rain event resulted in a 22 ft vertical rise within the conservation pool.

No flood control operations at Brantley took place while the reservoir was within the range of the conservation pool. No flood control space was utilized.

Table 15 - Storage summary for Pecos Basin reservoirs.

Reservoir	Peak Storage Date	Peak Storage Volume (ac-ft)	Rise (ft)
Santa Rosa	27 Sep 2013	103,474	44.5
Sumner Lake	20 Sep 2013	38,274	26.3
Two Rivers Dam		Rocky Dam: 5,796 Diamond A: 1,823	
Brantley Lake	21 Sep 2013	38,531	22.0
Avalon Lake	12 Sep 2013	6,535	8.6

Data: Memorandum for Commander, SPD, 31 January 2014.

5.6.5 Flow Reductions

Flow reductions were estimated at key locations within the basin. These figures are provided in the table, below.

Table 16 - Flow reductions at key locations in the Pecos Basin.

Location	Observed Peak Stage (ft)	Observed Peak Flow (cfs)	Unregulated Flow(cfs)
Puerto del Luna, NM	15.27	21,000	31,450
Acme, NM	14.05	6,520	40,500
Roswell, NM	14.75	1,910	11,915
Artesia, NM	11.99	3,480	34,060
Carlsbad, NM	15.42	30,700	37,365

Data were not available to calculate stage reduction.

The amount of acreage protected from inundation during this event is unknown. This flood event ranged from a 500 to 1,000-year event. The entire flood volume was contained at Santa Rosa, Fort Sumner, and Brantley Reservoirs in New Mexico.

Flood control operations protected structures (homes or business) from being flooded:

- Pecos River between Santa Rosa Dam and Fort Sumner Dam: 8-9 structures.
- Pecos River between Fort Sumner and Artesia (two flood surges down the Pecos River occurred on 12 September and 17 September): 84-87 structures (12 September) and 76-80 structures (17 September).
- Pecos River below Brantley Dam: 8-9 structures.

There were no lives lost during the flood events in the Pecos Basin..

The amount of damages prevented for this flood event totaled $198,808,400 within the Pecos basin in New Mexico. Flood control benefits accrued at the USACE Santa Rosa and Two Rivers Dams, as well as through Section 7 (flood control) operation of Brantley and Sumner Dams.

Table 17 - 2013 damages prevented on the Pecos River.

Project	**Flood Control Benefits ($)**
Brantley	1,948,900
Santa Rosa	4,060,800
Sumner	8,244,700
Two Rivers	185,554,000
TOTAL	**$199,808,400**

Data: USACE Albuquerque District Reservoir Operations Branch 2014.

5.7 USACE Flood Response Efforts in the Pecos Basin

USACE does not function as a first responder during flood events; however, USACE authorities enable the agency to provide vital services before and after a flood event. These activities are coordinated by the Readiness and Contingency Operations branch (RCO) within the USACE Albuquerque District. Flood response efforts in the Pecos River Basin that fall within its flood risk authorities:

- Approximately 400,000 sandbags were delivered to the State of New Mexico to assist in its flood fighting efforts throughout the state.

- Requests for post-flooding technical assistance were made by communities affected by flooding. These requests resulted in site visits by USACE staff (see Table 18, Appendix 4). In addition, public meetings were held in Pecos and Truth or Consequences, New Mexico.

Table 18 - USACE Post-Flood Site Visits in the Pecos Basin.

Date	**Locality**	**Community Representatives Met**	**USACE Team Members (Disciplines)**
18-19 September 2013	Santa Rosa Dam, Santa Rosa, New Mexico	Gary Cordova, Toni Brown, and Michael Lucey (Santa Rosa project office); Ralph Arias (FEM Technician); Richard Griego (Maxtek)	John Moreno (Engineering and Construction); Suzi-Hess-Brittelle (Dam Safety); Bruce Jordan (Engineering and Construction); Curtis McFadden (Reservoir Control).
3 October 2013	Puerto de Luna, NM	Puerta de Luna West Side Acequia Association: Tony Gallegos, Julian Salazar, Vince Cordova, Nick Raven	Theresa Rogers (RCO); Michael Fies (Civil Works); Tracy Baker (Geotechnical Engineering); Steve Boberg (H&H)
1 November 2013	Tererro, NM	Bill Borthwick (NM Homeland Security and Emergency Management); Tucker and Donna Haltom (homeowners); Matthew McCall (WS Forensic); Bob Mitchell (NFIP); Jerry Clark and Dale Hoff (FEMA Region 6)	Donald Gallegos (RCO); Stephen Scissons (H&H)

RCO= USACE Readiness and Contingency Operations Branch, Albuquerque District; H&H = USACE Hydrology and Hydraulics Section, Albuquerque District

- Places where there is a viable post-flood role for USACE in the form of Technical Assistance and other forms of assistance under USACE authorities include: West Puerto de Luna Acequia Association, NM;

- Inspections were also made of the West Puerto de Luna (Giddings-Baca) Diversion Dam, a structure previously constructed under the USACE Acequia Program but managed by the local sponsor, the West Puerto de Luna Acequia Association.

5.8 FEMA Damages Assessments in the Pecos Basin

Areas in the Pecos Basin affected by the 9-18 September event are covered under the Federal Disaster Declaration FEMA-4152-DR New Mexico – Severe Storms, Flooding, and Mudslides, declared October 29, 2013. Preliminary damages were estimated at $16,598,503. Damages identified were primarily to roads, bridges, fields, and irrigation structures, as well as to communities in low-lying areas (as in Carlsbad).

Beginning in November 2013, FEMA initiated field studies to evaluate actual damages, preliminary to the distribution of Federal funds to communities. As of February 2014, there were 146 applications for assistance had been made by communities throughout New Mexico.

6 - Upper Canadian River Basin

6.1 Upper Canadian River Basin Overview

The Canadian River has its headwaters in the eastern Sangre de Cristo Mountains near the Colorado-New Mexico border, with major tributaries heading in the New Mexico portion of this mountain range. Except in its headwaters, the Canadian flows mostly eastward across the Southern High Plains, the Texas Panhandle and Oklahoma. The Canadian River ends at its confluence with the Arkansas River in eastern Oklahoma. For the purposes of this report, the Canadian and Arkansas Rivers are treated as separate basins because their upper reaches are managed independently.

The river headwaters reach above 13,000 ft in the mountains of Las Animas County, Colorado. The river flows southeast across the New Mexico-Colorado border to a point southwest of Raton, New Mexico, where the river turns sharply south past Springer, New Mexico, where it continues southward through a steep canyon. The USACE Conchas Dam is located below the canyon at the confluence of the Canadian and Conchas Rivers. The dam impounds water for irrigation and flood control.

The catchment above Conchas Dam is 7,409 mi^2. Above Conchas Dam, the major tributaries flow easterly from the Sangre de Cristo range across a high plateau through deep canyon sections to their confluence with the Canadian River. This plateau varies in elevation from 8,000 ft asl in the mountain foothills area to 6,400 ft to the east. Major tributaries entering the river from the east above Conchas Dam include the Vermejo River, which heads in the mountains west of Raton; the Cimarron River, which heads above Eagle Nest Lake, New Mexico; the Mora River, which heads in the Sangre de Cristo mountains northwest of Mora, but flows generally east below Mora; and the Conchas River originating in the foothills east of Las Vegas, New Mexico. In the vicinity of the dam, the terrain is comprised of ridges, low hills, and sandstone-capped high mesas in the northern portion, and rolling hills in the southern portion. The confluence of the Conchas and Canadian Rivers is located at about 4,200 ft asl. The general watershed slope is southeasterly.

Below Conchas Dam, the river turns eastward and flows towards Texas. At Logan, New Mexico, the river is dammed by the New Mexico Interstate Stream Commission’s Ute Dam, which impounds water for irrigation storage and municipal water use. The major tributary below Conchas Dam is Ute River, which heads in the plains east of Springer, New Mexico, and flows generally south to meet the Canadian River above Ute Dam.

Vegetation in the watershed consists primarily of mixed conifer and Ponderosa pine forest in the higher elevation areas, grading to piñon-juniper woodland along the lower mountain slopes, opening out to grasslands in the plateau, rolling hills, and high plains east of the mountains.

6.2 Meteorological Event in the Upper Canadian River Basin

Between 11 and 13 September, portions of the Canadian River above Conchas Dam had received rainfall amounts in excess of 6 in, which resulted in a lake level rise of 4.5 ft (19,000 ac-ft) (U.S. Army Corps of Engineers (USACE) 2013a). A large culvert near Raton washed out and caused major bank erosion near County Road A6 along the Canadian River in the vicinity of Tinaja Creek (NOAA/NWS 2013e). Downstream at Maxwell, New Mexico, a bridge washed away, leading to major bank erosion near County Road A7 along the Canadian River (NOAA/NWS 2013e). The NWS reported that NM 434 closed from mile markers 17 to 24 due to flooding over roadway, and that severe flooding occurred throughout Mora County with numerous county roads washed out. (NOAA/NWS 2013j)

Additional significant rain fell in the Canadian River Basin from Sunday, 15 September to early in the morning of Monday, 16 September. The additional precipitation allowed Conchas Lake to rise to 9.18 ft (37,230 ac-ft). The percentage of the conservation pool filled reached 41% (U.S. Army Corps of Engineers (USACE) 2013c).

Significant amounts of rain do not appear to have fallen after 16 September in this basin (U.S. Army Corps of Engineers (USACE) 2013d, e).

6.3 Rainfall Data in the Upper Canadian River Basin

Rainfall data were obtained from the National Weather Service and the Western Regional Climate Center. Data come from a variety of sources, including the NWS Cooperative Observer (COOP) stations (Western Regional Climate Center (WRCC) 2014b), remote automated weather station sites (RAWS) (Western Regional Climate Center (WRCC) 2014a), the automated surface observing system (ASOS) network, the historical climatology network (HCN) and the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) (NOAA/NWS 2013a). COOP and RAWS data were available at daily time steps, the others were obtained as sums for the period 10-18 September. For the COOP sites only, the NOAA Atlas 14 provides recurrence intervals (RI) for precipitation(NOAA/NWS 2014c).

In the Upper Canadian River Basin, precipitation intensities were well-within historic ranges, with the majority of sites reporting precipitation with recurrence intervals between less than 1 year and 2 to 5 years.

Table 19 - Rainfall summary 9-18 September 2013, totals and recurrence intervals, Canadian River Basin (NOAA/NWS 2014c, Western Regional Climate Center (WRCC) 2014a, b).

Location (source)	10-day Precipitation Total (in) (9-18 Sept)	Highest Daily precip (in) (date)	COOP site Av. Recurrence interval (24-hr event)	Highest 7-day precip (in) (dates)	COOP site Av. Recurrence interval (7-day event)
Raton WB AP (COOP)	0.86	0.48 (11 Sept)	<1 year	0.86 (11-17 Sept)	<1 year
Eagle Nest (COOP)	2.30	0.74 (13 Sept)	<1 year	2.26 (11-17 Sept)	1 year
Cimarron (RAWS)	4.13	1.77 (15 Sept)	--	4.13 (10-16 Sept)	--

Location (source)	**10-day Precipitation Total (in) (9-18 Sept)**	**Highest Daily precip (in) (date)**	**COOP site Av. Recurrence interval (24-hr event)**	**Highest 7-day precip (in) (dates)**	**COOP site Av. Recurrence interval (7-day event)**
Cimarron 4 SW (COOP)	3.10	1.35 (11 Sept)	<1 year	3.10 (10-16 Sept)	2-5 years
Maxwell 3 NW (COOP)	3.20	1.98 (13 Sept)	2 years	3.18 (11-17 Sept)	2-5 years
Springer (COOP)	3.10	1.50 (12 Sept)	1 year	3.10 (10-16 Sept)	2-5 years
Mills Canyon (RAWS)	3.70	1.30 (11 Sept)	--	3.69 (10-16 Sept)	--
Tucumcari (COOP)	3.89	1.53 (11 Sept)	<1 year	3.89 (11-17 Sept)	5 years
Ragland 3 SSW (COOP)	4.20	1.80 (11 Sept)	1 year	4.05 (10-16 Sept)	5 years

COOP = National Weather Service Cooperative Observer Station; RAWS = Remote Automated Weather Station.

Table 20 - Rainfall summary 10-18* September 2013, additional sites in the Canadian River Basin (NOAA/NWS 2013n, j, e, k).

**Data sources excluded precipitation on 9 September 2014.*

Location (source)	**9-day Precipitation Total (in)**
Angel Fire 10.2 SSE (CoCoRaHS)	7.40
Angel Fire Airport (AWOS)	1.99
Rosebud 7 NW (COOP)	3.90
Mills 6 WSW (HCN)	3.55
House 0.1 S (CoCoRaHS)	5.74
Tucumcari 4.0 NW (CoCoRaHS)	5.05
McAlister 3.7 WNW (CoCoRaHS)	4.34
Tucumcari 2.7 NE (CoCoRaHS)	3.90
Tucumcari 3.4 ENE (CoCoRaHS)	3.60
Tucumcari 4.7 NNW (CoCoRaHS)	3.32
Tucumcari Airport (ASOS)	3.09
Logan 1.5 W (CoCoRaHS)	2.54
Tucumcari 9.7 ESE (CoCoRaHS)	2.54
Logan 5.2 SSW (CoCoRaHS)	2.23
Tucumcari 10.6 E (CoCoRaHS)	2.21

CoCoRaHS = Community Collaborative Rain, Hail and Snow Network; ASOS=Automated Surface Observing System; HCN = Historical Climatology Network

6.4 Event Hydrology in the Upper Canadian River Basin

The Vermejo River near Dawson crested at 4.05 feet (106 cfs) at 1030pm MDT September 13, 2013. This event does not fall within the top 9 record events for this location. The record crest is 15.25 feet set back on June 17, 1965. No significant flooding was observed immediately along the Vermejo River. Action stage is 9 feet, minor flood stage 9 feet, moderate flood stage 13 feet, and major flood stage 16 feet (NOAA/NWS 2013e).

The Cimarron River near Cimarron crested at 2.71 feet (235 cfs) at 330pm MDT September 11, 2013. This crest does not fall into the top 8 record events for this location. It compares to a previous crest of 3.29 feet on July 24, 2008. The record crest is 12.42 feet set back on June 17, 1965. No flooding was reported across this area. Action stage is 5 feet , minor flood stage 5 feet, moderate flood stage 10 feet, and major flood stage 12.5 feet (NOAA/NWS 2013e).

The Mora River at La Cueva crested at 8.08 feet (240 cfs) at 800pm MDT September 13, 2013 (NOAA/NWS 2013j). This is now the 2nd highest crest for this location. The record crest is 16 feet set back on September 29, 1904. No significant flooding was reported immediately along the Mora River. Action stage is 11 feet, minor flood stage 11 feet, moderate flood stage 13 feet, and major flood stage 14 feet.

The Mora River near Golondrinas rose above 2.50 ft on 13 September, receded, and then crested at 2.76 feet (328 cfs) at 500am MDT September 15, 2013 (NOAA/NWS 2013j). This crest does not fall into the top 12 record events for this location. The record crest is 8.7 feet set back on August 22, 1952. No flooding was reported across this area. Action stage is 5.5 feet , minor flood stage 5.5 feet, moderate flood stage 7 feet, and major flood stage 11.5 feet. Following a decline from the crest, the river peaked at just over 2.50 ft in the early morning of 17 September.

The Canadian River near Sanchez crested at 13.05 feet (10,000 cfs) at 315am MDT September 16, 2013. This is now the 17th highest crest observed at this location. This event compares to a previous crest of 13.65 feet on August 10, 1951 and 12.79 feet on August 23, 1984. The record crest is 36.6 feet set back on June 18, 1965. No significant flooding was observed immediately along the Canadian River however several nearby creeks and arroyos leading into this basin produced some flooding. Action stage is 21 feet, minor flood stage 22 feet, moderate flood stage 26 feet, and major flood stage 30 feet (NOAA/NWS 2013n).

Revuelto Creek near Logan crested at 5.27 feet (2,050 cfs) at 100am MDT September 14, 2013 then again at 6.98 feet (4,540 cfs) at 415am MDT September 20, 2013. Neither of these crests fell into the top 17 events at this location. The record crest is 14.3 feet set back on July 9, 1960. No significant flooding was observed. Action stage is 25 feet, minor flood stage 30 feet, and moderate flood stage 35 feet. No determination has been made for major flood stage (NOAA/NWS 2013k).

Table 21 - Summary of flood and high flow conditions 9-18 September at selected gages in the Upper Canadian River Basin (U.S. Geological Survey (USGS) 2014l).

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
07199450	LAKE MALOYA NR RATON NM	20.8	2013-09-15	7508.1 asl*	--	--	--	--
07202500	EAGLE TAIL DITCH NR MAXWELL, NM	--	2013-09-13	2.89	71	<	1	111 (2012)
07203000	VERMEJO RIVER NEAR DAWSON, NM	301	2013-09-13	--	137	81	84	13000 (2006)
07205500	EAGLE NEST LAKE NR EAGLE NEST, NM	167	2013-09-18	103.54a sl*	--	--	--	--
07206000	CIMARRON RIVER BELOW EAGLE NEST DAM, NM	167	2013-09-09	0.93	27 (2013-09-10)	<	63	303 (1994)
07207000	CIMARRON RIVER NEAR CIMARRON, NM	294	2013-09-11	2.71	235	30	62	15500 (1965)
07207500	PONIL CREEK NEAR CIMARRON, NM	171	2013-09-15	2.24	23	68	68	14700 (2004)
07208500	RAYADO CREEK NEAR CIMARRON, NM	65	2013-09-13	3.23	83	64	90	9000 (1965)
07211500	CANADIAN RIVER NEAR TAYLOR SPRINGS, NM	2850	2013-09-13	7.24	1310	68	72	162000 (1965)
07214470	SIERRA DITCH NEAR CHACON, NM	--	2013-09-10	1.74	0.78	<	1	6.4 (2012)
07214680	LA SIERRA DITCH NEAR HOLMAN, NM	--	2013-09-13	4.34	16	<	1	17 (2012)
07215500	MORA RIVER AT LA CUEVA, NM	173	2013-09-13	8.08	240	64	79	1530 (1941)
07216500	MORA RIVER NEAR GOLONDRINAS, NM	267	2013-09-15	2.77	333	73	88	14000 (1952)
07218000	COYOTE CREEK NEAR GOLONDRINAS, NM	215	2013-09-13	6.93	1720	14	84	4050 (1961)

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
07221500	CANADIAN RIVER NEAR SANCHEZ, NM	6015	2013-09-16	13.05	10000	26	79	145000 (1965)
07227000	CANADIAN RIVER AT LOGAN, NM	11141	2013-09-11	1.39	4.1	<	92	278000 (1904)
07227100	REVUELTO CREEK NEAR LOGAN, NM	786	2013-09-14	5.27	2040	51	53	26700 (1960)

**Reservoir stages are given in elevation above sea level while stream channel stages are in feet above channel bottom.*

6.5 Flooding in the Upper Canadian River Basin

No significant flooding occurred in the Canadian River Basin.

6.6 Reservoir Operations and Damages Prevented in the Upper Canadian River Basin

In the Upper Canadian River basin, USACE is responsible for flood control at the USACE Conchas Dam. Conchas Dam did not enter flood control operations during the 9-18 September event. Therefore, there were no damages prevented by USACE projects or dam operations in the Upper Canadian River Basin during this period.

6.7 USACE Flood Response Efforts in the Upper Canadian River Basin

Although USACE is poised to offer flood-related emergency assistance, no requests for assistance were received from local, county, or regional government entities related to the September 9-18 flood event.

6.8 FEMA Damages Assessments in the Upper Canadian River Basin

Areas in the Upper Canadian Basin in New Mexico that were affected by the 9-18 September Flood Event are covered under FEMA-4152-DR New Mexico – Severe Storms, Flooding, and Mudslides, declared October 29, 2013. Preliminary damages for New Mexico were estimated at $16,598,503. Damages identified were primarily to roads and bridges.

Beginning in November 2013, FEMA initiated field studies to evaluate actual damages, preliminary to the distribution of Federal funds to communities. As of February 2014, there were 146 applications for assistance had been made by communities throughout New Mexico. Damage assessments are anticipated to be completed in June 2014.

7 - Upper Arkansas River Basin

7.1 Upper Arkansas River Basin Overview

The Arkansas River is an important tributary of the Mississippi River (the information in this section is primarily from USACE 1969). The Albuquerque District Area of Responsibility in the Arkansas Basin encompasses the headwaters area above the Colorado-Kansas border. The Arkansas River originates in central Colorado on the eastern face of the Rocky Mountains near Leadville, and flows southeast and east 360 miles before crossing into Kansas. Within Colorado, the subbasin of the Arkansas encompasses an area of approximately 24,615 mi^2. The watershed is approximately 25 miles wide in the headwaters area, widening to a maximum of approximately 140 miles in the vicinity of Pueblo, Colorado, then narrowing to 120 miles in the vicinity of Las Animas, Colorado, just above John Martin Dam close to the border with Kansas.

The principal tributaries of the Arkansas River above John Martin Dam and Reservoir are Fountain Creek, which joins the Arkansas River at Pueblo; Horse Creek, which joins the Arkansas upstream from Las Animas; Huerfano and Apishapa Rivers entering from the south and the Purgatoire River, the largest tributary above John Martin Dam, which enters the main stem at the head of the reservoir about 3 miles downstream from Las Animas. Below John Martin Dam, the major tributaries are Big Sandy, Wolf, and Two Buttes Creeks. The Canadian River, treated as a separate stream in this report, joins the Arkansas River in eastern Oklahoma after traversing the Texas Panhandle region.

Central Colorado, with 54 mountain peaks above 14,000 feet in elevation, is one of the highest regions in North America. At least 25 of these peaks are in and around the headwaters area of the Arkansas River. The river drops rapidly from its mountain headwaters, descending more than 6,000 feet in under 130 miles, with gradients in excess of 50 feet per mile. The river emerges from the mountains through Royal Gorge, a steep-sided canyon with walls over 1,000 ft high. Cañon City (5,342 ft asl) is located immediately downstream of the gorge, at the transition to the mountain foothills area. Below Cañon City, the river gradient shallows rapidly, and crosses onto the High Plains at Pueblo, Colorado. Gradients in this reach are approximately 10 ft per mile near Pueblo and then decline gradually to 7.5 ft per mile below John Martin Dam. Stream gradients decrease and valley widths increase moving downstream, with agricultural development increasingly common on the floodplains.

Pueblo Reservoir, a Bureau of Reclamation project, provides flood control and water storage for the Arkansas River upstream of Pueblo. USACE's John Martin Dam and Reservoir provides flood control and water storage for the Arkansas River Basin in Colorado, including the Purgatoire River.

The headwaters of the Purgatoire River are in the Sangre de Cristo Range, west of Trinidad, Colorado, where several peaks exceed 13,000 ft asl. The mountain area above Trinidad encompasses approximately 22% of the Purgatoire River watershed. From Trinidad, the river flows through an alluvial valley about 35 miles long and then becomes entrenched in a rugged canyon for a distance of 105 miles. Below the canyon, the river flows through another alluvial valley for 17 miles to the confluence with the Arkansas River. USACE's Trinidad Dam, located upstream of Trinidad, is the major flood control facility on the Purgatoire. The area of the watershed upstream of Pueblo has an area of $4670mi^2$ while that above Trinidad is $671mi^2$.

Vegetative cover in the Arkansas River subbasin is highly diverse due to the large relief in the basin. High mountain peaks extend above treeline and are devoid of cover. Mixed conifer forest characterizes the highest elevation areas, grading down slope into Ponderosa Pine forest, and below this, piñon-juniper woodland characterized piñon pine, juniper, scrub oak, and sagebrush, with scattered bunch grasses. On the plains, grasses dominate except in the vicinity of washes where riparian trees and shrubs dominate.

7.2 Meteorological Event in the Upper Arkansas River Basin

The Fountain Creek watershed, a northern tributary to the Arkansas River, received considerable rainfall between Tuesday, 10 September, and the morning of Thursday, 12 September that was responsible for downstream flood damage in the vicinity of Colorado Springs and Pueblo, Colorado. Substantial precipitation was concentrated in the mountains west of the southward-trending Fountain Creek, including over the Waldo Canyon Fire burn scar.

The RAWS station at Rampart Range, Colorado, just west of Colorado Springs within the Waldo Canyon Fire burn scar, showed precipitation of 1.93 in on 11 September and 3.70 in on 12 September (Western Regional Climate Center (WRCC) 2014a), resulting in large flood flows on Fountain Creek and its tributaries.

Heavy rain also fell along the Front Range to the south, between Colorado Springs and Pueblo: the RAWS station at Fort Carson, Colorado, recorded 1.77 and 4.14 in, on 11 and 12 September, respectively (Western Regional Climate Center (WRCC) 2014a). Precipitation at lower elevations was considerably less. The airport at Colorado Springs, for instance, received 0.19 and 1.61 in, on those two dates (Weather Underground 2014). Precipitation of 1.61 in does not rank as one of the top ten extreme precipitation events for Colorado Springs (NOAA/NWS 2014a).

7.3 Rainfall Data in the Upper Arkansas River Basin

Rainfall data were obtained from the National Weather Service and the Western Regional Climate Center (Table 22, Figure 29). Data come from a variety of sources, including the NWS Cooperative Observer (COOP) stations (Western Regional Climate Center (WRCC) 2014b), remote automated weather station sites (RAWS) (Western Regional Climate Center (WRCC) 2014a), the automated surface observing system (ASOS) network, the historical climatology network (HCN) and the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) (NOAA/NWS 2013a). COOP and RAWS data were available at daily time steps, the others were obtained as sums for the period 10-18 September. For the COOP sites only, the NOAA Atlas 14 provides recurrence intervals (RI) for precipitation(NOAA/NWS 2014c).

Precipitation along the Rocky Mountain Front Range at the Cañon City, Fort Carson, and Rampart Range weather stations was significant. The recurrence interval for precipitation at Cañon City is 25 to 50 years. Although recurrence interval information was not available for the other two sites, 24-hour precipitation was comparable, while 7-day totals were greater than at Cañon City. Down slope of these high elevation sites, however, precipitation was modest, with recurrence intervals of 1 year or less for the 24-hour and 7-day precipitation events at most sites.

Table 22- Rainfall Summary 9-18 September 2013, Arkansas River Basin (Western Regional Climate Center (WRCC) 2014a, b).

Location (source)	10-day Precipitation Total (in) (9-18 Sept)	Highest Daily precip (in) (date)	COOP site Av. Recurrence interval (24-hr event)	Highest 7-day precip (in) (dates)	COOP site Av. Recurrence interval (7-day event)
Rampart Range, CO (RAWS)	7.01	3.70 (12 Sept)	--	6.97	--
Ft. Carson, CO (RAWS)	7.14	4.14 (12 Sept)	--	7.13	--
Colorado Springs WSO AP, CO (COOP)	2.57	1.53 (15 Sept)	1 year	2.57 (10-16 Sept)	1 year
Cañon City, CO (COOP)	4.93	3.40 (12 Sept)	Between 25-50 years	4.93 (11-17 Sept)	Between 25-50 years
Pueblo Reservoir, CO (COOP)	1.76	0.52 (16 Sept)	<1 year	1.76 (11-17 Sept)	<1 year
Pueblo WSO AP, CO (COOP)	0.96	0.63 (16 Sept)	< 1 year	0.96 (11-17)	< 1 year
John Martin Dam, CO (COOP)	1.50	0.92 (16 Sept)	< 1 year	1.50 (11-17 Sept)	< 1 year
Trinidad FAA ARPT, CO (COOP)	1.40	0.60 (13 Sept)	< 1 year	1.40 (11-17 Sept)	< 1 year

COOP = National Weather Service Cooperative Observer Station; RAWS = Remote Automated Weather Station.

7.4 Event Hydrology in the Upper Arkansas River Basin

In the Arkansas River Basin, flooding occurred on tributary streams, but was not significant on the mainstem due in large part to flood control facilities along the mainstem.

Fountain Creek, which captures runoff from the Waldo Canyon Wildfire burn scar, was particularly impacted on 12-13 September. A total of 4.63 inches of precipitation fell over the burn scar between Wednesday, 11 September and Thursday, 12 September. Multiple high flows were observed at the Fountain Creek at Colorado Springs, CO, steam gage (U.S. Geological Survey (USGS) 2014b): Thursday morning around 03:30 MDT, peak flows reached 8,670 cfs (compared to just 28 cfs 48 hours previously), and rose again to 8,080 cfs again around 23:00 the same day. High flows continued into the morning of 13 September, declined, then peaked again around 07:00 at 7,860 cfs. A second round of precipitation led to flood flows on Sunday, 15 September, which peaked at 5,670 cfs at 14:45 MDT. The peak at 8,670 is the third highest peak in the period of record (1976-2013).

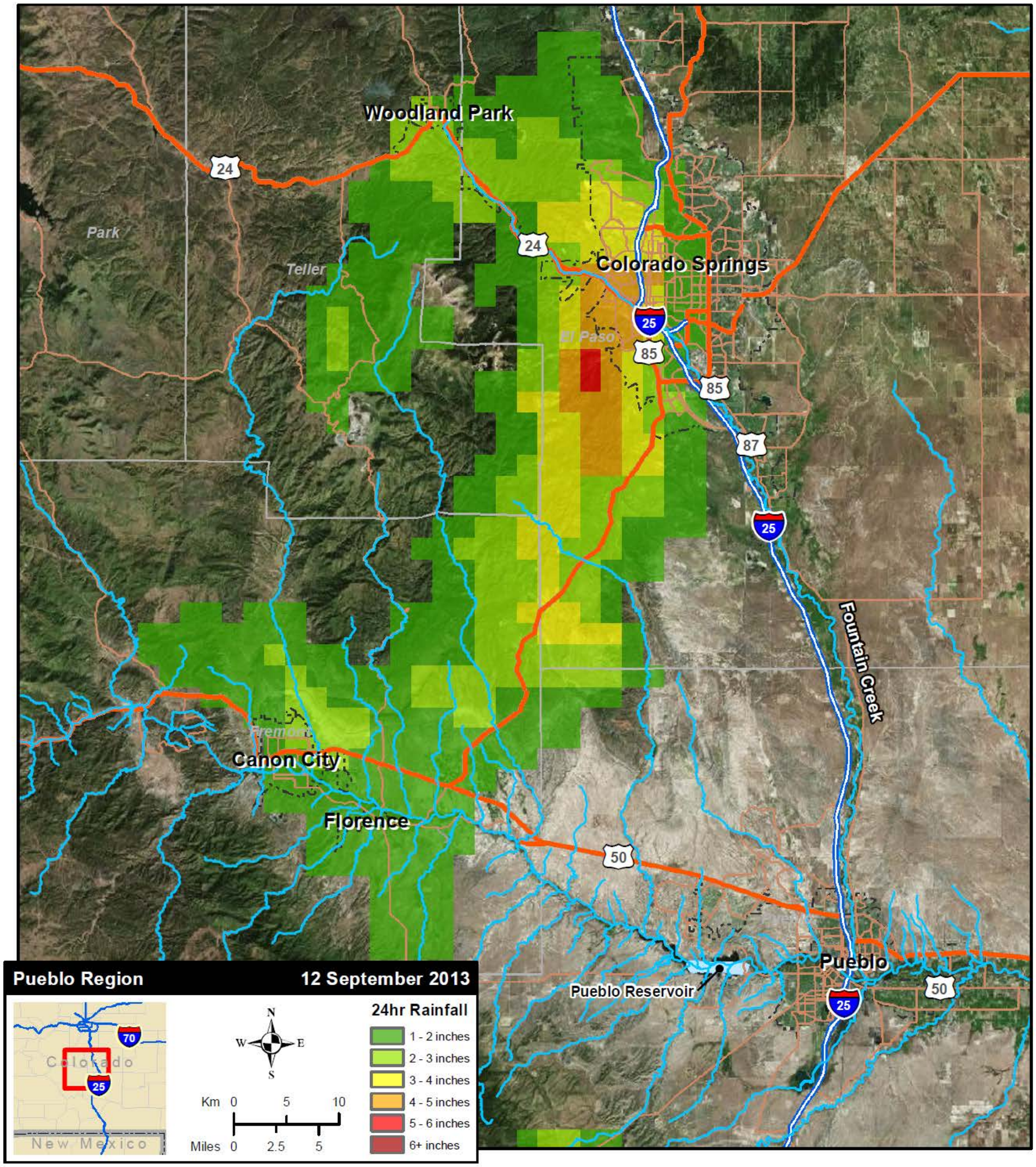


Figure 30 - Doppler radar map showing areas receiving precipitation >1 inch on 12 September 2013 near Colorado Springs, CO.

Fountain Creek flows southward to its confluence with the Arkansas River at Pueblo, receiving tributary flows from precipitation on the front range. The Fountain Creek near Fountain gage (U.S. Geological Survey (USGS) 2014c), which is in the valley just east of the Fort Carson RAWS weather station, recorded peak flows in separate pulses of 10,800 cfs just after dawn on 12 September and 15,300 cfs in the early morning hours of 13 September. A third peak flow of 10,700 cfs was observed on 15 September. The flow of 15,300 cfs (10.06 ft) is the third highest flow for the gage in a period of record extending back to 1939. Higher flows included 20,100 cfs in April 1999 and 22,100 cfs in May 1940.

At Pueblo, the Fountain Creek at Pueblo, CO gage had two major peaks were observed (U.S. Geological Survey (USGS) 2014d): Fountain Creek flows peaked at an estimated 11,800 cfs around 13:55 MDT on Friday, 13 September, and then peaked again at 5,370 cfs on Monday, 16 September. High flows on 13 September caused flood damage in Pueblo. The peak flow of 11,800 cfs (8.62 ft) is the thirteenth highest peak flow at this gage since records began in 1921.

The Apishapa River near Fowler, Colorado gage (U.S. Geological Survey (USGS) 2014e) is located close to the river's confluence with the Arkansas, approximately one third of the distance along the Arkansas River between Pueblo and John Martin Reservoir. The Apishapa River had a single peak flow of 4340 cfs on Monday, 16 September. This was smaller than the peak flow of 4,690 cfs set on 4 August 2013, which was the 28th highest peak flow since records began in 1922.

Finally, the Purgatoire River near Las Animas, Colorado gage, located just above John Martin Reservoir, recorded two peak flows during the 9-18 September Event. The largest of these was 628 cfs during the late morning of Friday, 13 September and the second of these measured 180 cfs in the late afternoon of Tuesday, 17 September. The flows did not rise to flood stage (NOAA/NWS 2014d).

Table 23 - Summary of flood and high flow conditions 9-18 September at selected gages in the Upper Arkansas River Basin (U.S. Geological Survey (USGS) 2014l).

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
07079300	EF ARKANSAS R AT US HIGHWAY 24, NR LEADVILLE, CO.	49.9	2013-09-13	3.05	113	23	24	1010 (1997)
07081200	ARKANSAS RIVER NEAR LEADVILLE, CO.	98.8	2013-09-13	5.04	136	<	40	1360 (1997)
07083000	HALFMOON CREEK NEAR MALTA, CO.	23.6	2013-09-18	2.28	67	<	66	615 (1984)
07083200	HALFMOON CR BL HALFMOON DIVERSION NR LEADVILLE, CO	--	2013-09-18	2.85	91	5	5	275 (2011)

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
07083710	ARKANSAS RIVER BELOW EMPIRE GULCH NEAR MALTA, CO	237	--	--	--	--	--	--
07087050	ARKANSAS RIVER BELOW GRANITE, CO	546	2013-09-13	4.36	467	<	15	4070 (2010)
07091200	ARKANSAS RIVER NEAR NATHROP, CO.	1060	2013-09-13	4.62	677	43	43	5540 (1995)
07094500	ARKANSAS RIVER AT PARKDALE, CO.	2548	2013-09-16	3.42	840	59	59	6830 (1995)
07096250	FOURMILE CREEK BELOW CRIPPLE CREEK NEAR VICTOR, CO	272	2013-09-17	3.57	37	20	21	3620 (2010)
07099050	BEAVER CR ABV UPPER BEAVER CEMETERY NR PENROSE, CO	122	2013-09-13	5.7	745	1	19	745 (2013)
07099060	BEAVER CREEK ABOVE HIGHWAY 115 NEAR PENROSE, CO	138	2013-09-12	6.24	499	6	23	6960 (2006)
07099215	TURKEY CREEK NEAR FOUNTAIN, CO	13.0	--	--	--	--	--	--
07099970	ARKANSAS RIVER AT MOFFAT STREET AT PUEBLO, CO	4778	2013-09-15	11.16	3080	21	25	10400 (1994)
07099973	ARKANSAS RIVER TRIBUTARY ABOVE HWY 227 AT PUEBLO	--	2013-09-13	6.51	107 (2013-09-14)	--	--	--
07103700	FOUNTAIN CREEK NEAR COLORADO SPRINGS, CO.	103	2013-09-12	7.44	1540	6	56	2630 (1964)
07103703	CAMP CREEK AT GARDEN OF THE GODS, CO	9.45	2013-09-12	4.88	339	2	22	430 (1999)
07103755	MONUMENT CREEK BELOW MONUMENT LAKE NR MONUMENT, CO	30.3	2013-09-18	3.42	68	4	8	150 (2007)

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
07103780	MONUMENT C AB N.GATE BLVD AT USAF ACADEMY, CO.	81.7	2013-09-13	4.17	227	12	29	1790 (1999)
07103797	WEST MONUMENT CREEK BELOW RAMPART RESERVOIR, CO	7.29	2013-09-12	5.15	26	7	19	46 (1997)
07103800	WEST MONUMENT CREEK AT U.S. AIR FORCE ACADEMY, CO	14.9	2013-09-12	3.62	151	2	44	194 (2012)
07103970	MONUMENT CR ABV WOODMEN RD AT COLORADO SPRINGS, CO	181	2013-09-13	7.06	1280	6	17	3600 (2004)
07103980	COTTONWOOD CREEK AT WOODMEN RD NR COLO SPRINGS, CO	10.3	2013-09-13	2.28	470	10	22	3500 (2013)
07103990	COTTONWOOD CREEK AT MOUTH, AT PIKEVIEW, CO.	18.7	2013-09-13	7.83	1410	16	28	4030 (2004)
07104000	MONUMENT CREEK AT PIKEVIEW, CO.	204	2013-09-13	10.82	3330	8	50	5230 (2004)
07104905	MONUMENT CREEK AT BIJOU ST. AT COLO. SPRINGS, CO	235	2013-09-13	9.77	6150	3	11	6760 (2012)
07105000	BEAR CREEK NEAR COLORADO SPRINGS, CO	6.93	2013-09-13	6.7	222	1	22	222 (2013)
07105490	CHEYENNE CREEK AT EVANS AVE AT COLORADO SPRINGS,CO	21.7	2013-09-12	5.97	1470	1	22	1470 (2013)
07105500	FOUNTAIN CREEK AT COLORADO SPRINGS, CO	392	2013-09-12	10.66	8670	3	38	10100 (1994)
07105530	FOUNTAIN CR BLW JANITELL RD BLW COLO. SPRINGS, CO	413	2013-09-12	10.31	10300	4	24	13800 (1999)

USGS station number	**USGS Station Name**	**Drainage area (mi^2)**	**Highest peak from 2013-09-09 to 2013-09-18**				**Historical Peaks**	
			Date	**Stage [ft]**	**Stream flow (date) [ft^3/s]**	**Rank**	**No. of years**	**Max. (year) [ft^3/s]**
07105600	SAND CREEK ABOVE MOUTH AT COLORADO SPRINGS, CO	52.5	2013-09-13	2.8	171	<	11	5720 (2004)
07105800	FOUNTAIN CREEK AT SECURITY, CO	495	2013-09-12	9.29	12600	5	49	25000 (1965)
07105900	JIMMY CAMP CREEK AT FOUNTAIN, CO.	65.6	2013-09-13	7.14	272	26	39	124000 (1965)
07105940	LITTLE FOUNTAIN CREEK NEAR FOUNTAIN, CO.	26.9	2013-09-12	--	2810	1	11	1290 (1986)
07105945	ROCK CREEK ABOVE FORT CARSON RESERVATION, CO.	6.79	2013-09-12	7.3	805	1	35	805 (2013)
07106000	FOUNTAIN CREEK NEAR FOUNTAIN, CO.	681	2013-09-13	--	15300	3	46	22100 (1940)
07106300	FOUNTAIN CREEK NEAR PINON, CO	865	2013-09-13	8.68	11800	3	41	19100 (1999)
07106500	FOUNTAIN CREEK AT PUEBLO, CO.	926	2013-09-13	8.62	11800	13	74	47000 (1965)
07108900	ST. CHARLES RIVER AT VINELAND, CO.	474	2013-09-12	8.26	1480	27	35	7560 (1982)
07109500	ARKANSAS RIVER NEAR AVONDALE, CO.	6327	2013-09-14	9.46	11100	11	62	50000 (1965)
07116500	HUERFANO RIVER NEAR BOONE, CO.	1875	2013-09-15	7.54	401	31	38	19400 (1923)
07119500	APISHAPA RIVER NEAR FOWLER, CO.	1125	2013-09-16	16.42	4340	30	79	83000 (1923)
07121500	TIMPAS CREEK AT MOUTH NEAR SWINK, CO.	496	2013-09-16	11.3	1160	28	51	21400 (1965)
07124000	ARKANSAS RIVER AT LAS ANIMAS, CO.	14417	2013-09-18	9.09	2780	44	74	44000 (1955)
07124200	PURGATOIRE RIVER AT MADRID, CO.	505	2013-09-15	5.29	1780	31	41	14300 (1976)
07124400	TRINIDAD LAKE NEAR TRINIDAD, CO.	672	2013-09-16	6168.42* asl	--	--	--	--

USGS station number	**USGS Station Name**	**Drainage area (mi^2)**	**Highest peak from 2013-09-09 to 2013-09-18**				**Historical Peaks**	
			Date	**Stage [ft]**	**Stream flow (date) [ft^3/s]**	**Rank**	**No. of years**	**Max. (year) [ft^3/s]**
07124410	PURGATOIRE RIVER BELOW TRINIDAD LAKE, CO.	672	2013-09-16	6.8	409	20	37	1260 (2004)
07126200	VAN BREMER ARROYO NEAR MODEL, CO.	175	2013-09-16	6.73	1170	19	48	6240 (1967)
07126300	PURGATOIRE RIVER NEAR THATCHER, CO.	1791	2013-09-16	6.04	918	48	49	47700 (1965)
07126325	TAYLOR ARROYO BL ROCK CROSSING, NR THATCHER, CO.	48.4	2013-09-16	4.47	9.1	27	31	9090 (1998)
07126390	LOCKWOOD CANYON CREEK NEAR THATCHER, CO.	48.8	2013-09-16	8.75	185	13	31	1110 (1987)
07126415	RED ROCK CANYON CREEK AT MOUTH NR THATCHER, CO.	48.9	2013-09-14	5.2	--	--	--	--
07126480	BENT CANYON CREEK AT MOUTH NEAR TIMPAS, CO	56.2	2013-09-11	2.68	--	--	--	--
07126485	PURGATOIRE RIVER AT ROCK CROSSING NR TIMPAS, CO.	2635	2013-09-16	8.58	461	<	31	11400 (1992)
07128500	PURGATOIRE RIVER NEAR LAS ANIMAS, CO.	3318	2013-09-13	6.55	628	75	75	70000 (1955)
07130000	JOHN MARTIN RESERVOIR AT CADDOA, CO.	18915	2013-09-09	3801.14 asl*	--	--	--	--
07130500	ARKANSAS RIVER BELOW JOHN MARTIN RESERVOIR, CO.	18915	2013-09-18	3.61	1110	74	76	40000 (1942)
07133000	ARKANSAS RIVER AT LAMAR, CO.	19780	2013-09-14	5.5	154	94	94	130000 (1921)
07134100	BIG SANDY CREEK NEAR LAMAR, CO.	3248	2013-09-13	2.74	8.2	<	33	2850 (1999)
07134180	ARKANSAS RIVER NEAR GRANADA, CO.	23707	2013-09-18	5.82	12	<	32	4610 (1999)

USGS station number	USGS Station Name	Drainage area (mi^2)	Highest peak from 2013-09-09 to 2013-09-18				Historical Peaks	
			Date	Stage [ft]	Stream flow (date) [ft^3/s]	Rank	No. of years	Max. (year) [ft^3/s]
07134990	WILD HORSE CREEK ABOVE HOLLY, CO	270	2013-09-13	3.15	36	<	18	1270 (1996)

**Reservoir stages are given in elevation above sea level while stream channel stages are in feet above channel bottom.*

7.5 Flooding in the Upper Arkansas River Basin

Flooding in the Arkansas River Basin was primarily concentrated along Fountain Creek, in areas receiving runoff from the Waldo Fire Burn Scar. The headwaters of Fountain Creek originate in the mountains west of Colorado Springs, Colorado. Fountain Creek flows down a narrow canyon past Manitou Springs, and then, as the stream exits the mountains into the foothills area, passes through Colorado Springs to its confluence with Monument Creek. At this confluence, Fountain Creek turns to the south and flows for approximately 45 miles to the City of Pueblo, CO, where it enters the Arkansas River as a left bank tributary (U.S. Army Corps of Engineers (USACE) 2014b).

Heavy rain fell on the Waldo Canyon Fire burn scar on the morning of Wednesday, 11 September and again in the evening. The lower Waldo rain gage north of Manitou Springs reported 0.35 in of precipitation between 9 and 9:20 pm on 11 September. Flooding closed U.S. Highway 24 twice (Rogers 2013). As much as 1.81 in of rain fell in lower Waldo Canyon Tuesday through Wednesday night, with a gage in Manitou Springs registering 1.77 in of rain (Rogers 2013). The rain continued overnight into Thursday 12, September, with 2 to 3.5 in of rain falling over west Colorado Springs (Rogers 2013).

The City of Manitou Springs is located in a narrow canyon along Fountain Creek upstream of Colorado Springs and downstream of the Waldo Canyon Wildfire burn scar. Manitou Springs flooded several times in 2013, with perhaps the most devastating flooding occurring in early August. Flooding in September damaged many of the same areas. Damages due to flooding in the City included (Mendoza 2013, City of Manitou Springs 2014)[4]:

- Damages to culverts, guard rails and bridges, including Lafayette and Mayfair Bridges.
- Streambank erosion and destabilization, and damage to stream channel flood control features, including gabions along Williams Canyon.
- Damages to water mains, drainage pans, and water intakes.

[4] See also (Moix 2013), but it is not clear whether damages are for just the September floods or include all the floods of the summer (including the equally- or more-extensive flooding in August 2013).

- Damage to roads, including Canon and Park Avenues.
- Debris deposition on roads, in buildings, and in-channel, including in Schryver Pond. Nearly 3,000 cubic yards (or 4500 TONS) of debris, mud, slurry, branches, trees, and trash were removed from City roads.
- Water overtopped U.S. Highway 24, damaging and undermining the road; the Highway 24 business loop through Manitou Springs was extensively damaged.
- 8 feet of mud and water seeped into the Manitou 3 hydroelectric plant and forced an outage.
- Damages to homes and businesses, including a church.

Damages were also significant in Colorado Springs, particularly in the southwestern portion of the City which is crossed by Fountain Creek. In areas farther north in Colorado Springs, flood control structures installed after the Waldo Canyon Wildfire prevented significant damage to down slope communities and facilities (Steiner 2013).

In southwest Colorado Springs, gas lines were exposed by stream bank and road erosion, including a pipeline running underneath Flintridge Drive. Damages occurred to Cheyenne, Old Stage, Gold Camp, Rock Creek Canyon, Squirrel Creek and Milne Roads (Hellman 2013). Damage also occurred to Palmer Park and erosion and bed scoured occurred on Shooks Run, the creek near Patty Jewett, and North Douglas, South Douglas, Camp and Cottonwood Creeks (Hellman 2013). Several bridges on Cheyenne Creek were damaged (Hellman 2013). Homes along Cheyenne Creek flooded and roads, trails and slopes in North Cheyenne Park suffered hundreds of thousands of dollars in damage.. Upgrades to the city wastewater treatment facility prevented damages during the September 2013 flooding (Hellman 2013). Damages in Colorado Springs were estimated in excess of $10 million (Laden 2013).

Two people in the Colorado Springs area died in the floods. The body of a middle-age man was pulled from the flood waters in Fountain Creek in the early morning hours of Thursday, 12 September (Rogers 2013). He was later identified as Danny Davis, 54 (Bunch and Parker 2013). A second individual, 47-year old James Bettner, drowned in Sand Creek, a tributary of Fountain Creek that flows along the east side of Colorado Springs and enters Fountain Creek downstream of the city (Bunch and Parker 2013).

On September 13, 2013, the City of Pueblo sustained damages from flooding on Fountain Creek. The majority of flow originated in the Fountain Creek watershed in the Colorado Springs, Colorado and Security, Colorado areas. The peak discharge on Fountain Creek during that event was 11,800 cfs. This is the 5th highest peak flow on record at the USGS gage near the confluence with the Arkansas River. The excessive runoff from this rainfall event caused structural failure to a previously constructed wire-wrapped riprap embankment protection on the west bank of the Fountain Creek, near 13th Street and Interstate 25 (Figure 29). As a result, erosion threatens the western embankment of the flood control project as well as a Union Pacific Railroad mainline located along the embankment (U.S. Army Corps of Engineers (USACE) 2014b).

Figure 31 - Damage to railroad embankment along Fountain Creek in Colorado.

Flows on the Arkansas River continued to be elevated through 16 September due to a moderate flow on the Fountain Creek bolstered by tributaries south of the Arkansas. Specifically, the Apishapa River which discharges into the Arkansas near Fowler, Colorado was discharging over 4,200 cfs (and rising) as of 10:00 am on 16 September. The combined flows passed through the La Junta, Colorado area on Tuesday, 17 September (U.S. Army Corps of Engineers (USACE) 2013c).

7.6 Reservoir Operations and Damages Prevented in the Upper Arkansas River Basin

USACE has two flood control structures in the Upper Arkansas River Basin: Trinidad Dam on the Purgatoire River and John Martin Dam on the Arkansas River. Neither dam entered flood control operations during the 9-18 September flood event. Therefore, there were no damages prevented by USACE projects or dam operations in the Upper Arkansas River Basin during this period.

7.7 USACE Flood Response Efforts in the Upper Arkansas River Basin

USACE does not function as a first responder to flood events; however, USACE authorities enable the agency to provide vital services before and after a flood event. These activities are coordinated by the Albuquerque District RCO. Flood response efforts in the Upper Arkansas River Basin that fall within USACE flood risk authorities are shown in Table 24.

Table 24 - USACE post-flood site visits to the Arkansas River Basin.

Date	Locality	Community Representatives Met	USACE Team Members (Disciplines)
16 January 2014	Rainbow Falls near Manitou Springs, CO	Elaine Kleckner (El Paso County)	Mark Doles (Planning); Corinne O'Hara (Civil Works): Tracy Baker (Geotechnical Engineering)
2-3 April, 2014	Fountain Creek area, Pueblo, CO	USFS, Colorado DOT, City of Pueblo	Mark Doles (Planning); Corinne O'Hara (Civil Works); Tilak Gamage (H&H)

H&H = USACE Hydrology and Hydraulics Section, Albuquerque District; USFS = U.S. Forest Service; DOT = Department of Transportation

7.8 FEMA Damages Assessments in the Upper Arkansas River Basin

FEMA-4145-DR Colorado Severe Storms, Flooding, Landslides, and Mudslides was declared on 14 September 2013 for the period 11 September to 31 October 2013. FEMA public and individual assistance was granted to counties in the Arkansas Basin, including El Paso county in which Colorado Springs and Manitou Springs are located. However, FEMA damages for the September 2013 flood event were denied for Pueblo County, where the major damage along Fountain Creek downstream of Colorado Springs occurred (Tenser 2013).

8 - Upper San Juan River Basin

8.1 Upper San Juan River Basin Overview

The Four Corners region covers the Colorado Plateau and immediately adjoining regions, and encompasses the watershed of the San Juan River. The San Juan River is the major tributary entering the Colorado River above Lee's Ferry, Arizona, and is therefore considered to be part of the Upper Colorado River Basin. The San Juan River and its tributaries drain much or most of the Colorado Plateau and adjacent mountains, including the western and southern faces of the San Juan Mountains and the western face of the San Pedro Mountains. The San Juan River is the second largest tributary of the Colorado River (after the Green River). The average discharge at Bluff, Utah, near the confluence with the Colorado River is average 2,192 cfs.

The 355 mile long San Juan River Basin drains an area of approximately 24,945 mi^2 in Colorado, New Mexico and Utah. The river heads in the San Juan Mountains, where the highest peaks exceed 14,000 ft, and enters the Colorado River at an elevation of approximately 3700 ft. Mixed conifer forest and Ponderosa pine forest dominate the higher elevation areas of the catchment, with lower elevation slopes in piñon -juniper woodland. The majority of the basin outside of riparian areas consists of mesas and tablelands covered in desert scrub vegetation.

Navajo Dam (completed 1962), located east of Farmington, New Mexico, at the confluence with the Los Pinos River, is the major mainstem flood and water control structure on the San Juan River. Navajo Dam is owned and operated by the Bureau of Reclamation, but is considered a Section 7 dam, a designation that allows USACE to direct flood control operation of the dam. New Mexico receives its allotment of Colorado River water from the San Juan River via the Azotea Tunnel to the Chama River at El Vado Lake. In addition, there are approximately 7 diversions along the river between Navajo Dam and Shiprock, New Mexico that are used for irrigation, hydropower, and municipal use. The major communities along the San Juan River are Farmington, Shiprock, and Bloomfield, all in New Mexico below Navajo Dam. Large coal, oil and gas deposits occur throughout the watershed, and energy development is a key industry in the region. Most of the basin downstream of Farmington is part of the Navajo Nation. The Albuquerque District's AOR includes the San Juan and tributaries watershed upstream of the New Mexico-Arizona boundary, here termed the Upper San Juan Basin.

8.2 Meteorological Event in the Upper San Juan Basin

The 9-18 September event did not hit the San Juan Basin particularly hard: although some rain fell there most days, the major basin-wide precipitation event occurred on 9-10 September 2013.

The San Juan River at Farmington crested at 6.96 feet (11,300 cfs) at 2 AM MDT September 13, 2013. This crest is now the 14th highest on record for this location and compares to a previous crest of 7.2 feet on June 19, 1949 and 6.94 feet on June 17, 1993. The record crest is 12.3 feet set back on September 6, 1909. No significant flooding was observed along the San Juan River, however several creeks and arroyos leading into this basin experienced flooding (NOAA/NWS 2013m).

8.3 Rainfall Data in the Upper San Juan Basin

Rainfall data were obtained from the National Weather Service and the Western Regional Climate Center. Data come from a variety of sources, including the NWS Cooperative Observer (COOP) stations (Western Regional Climate Center (WRCC) 2014b), remote automated weather station sites (RAWS) (Western Regional Climate Center (WRCC) 2014a), the automated surface observing system (ASOS) network, the historical climatology network (HCN) and the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) (NOAA/NWS 2013a). COOP and RAWS data were available at daily time steps, the others were obtained as sums for the period 10-18 September. For the COOP sites only, the NOAA Atlas 14 provides recurrence intervals (RI) for precipitation(NOAA/NWS 2014c).

In the Upper San Juan Basin, precipitation intensities were well-within historic ranges, with the majority of sites reporting precipitation with recurrence intervals between less than 1 year and 2 to 5 years for 24-hour totals, and as much as 10-15 years for the maximum 7-day precipitation total.

Table 25- Rainfall Summary 9-18 September 2013, Upper San Juan Basin (Western Regional Climate Center (WRCC) 2014a, b).

Location (source)	10-day Precipitation Total (in) (9-18 Sept)	Highest Daily precip (in) (date)	COOP site Av. Recurrence interval (24-hr event)	Highest 7-day precip (in) (dates)	COOP site Av. Recurrence interval (7-day event)
Otis (COOP)	1.10	0.47 (9 Sept)	<1 year	1.10 (9-15 Sept)	<1 year
Stone Lake (RAWS)	1.71	0.53 (14 Sept)	--	1.46 (9-15 Sept)	--
Dulce #2 (RAWS)	2.03	0.71 (18 Sept)	--	1.29 (12-18 Sept)	--
Albino Canyon (RAWS)	1.82	0.67 (10 Sept)	--	1.47 (9-15 Sept)	--
Fort Lewis, CO (COOP)*	4.22	1.67 (12 Sept)	2 years	3.74 (10-16 Sept)	10 year
Aztec Ruins (COOP)	2.79	1.35 (13 Sept)	2-5 years	2.68 (10-16 Sept)	10-15 years
Farmington FAA Airport (COOP)	1.77	0.74 (10 Sept)	<1 year	1.55 (9-15 Sept)	2 years
Washington Pass (RAWS)	1.93	0.84 (9 Sept)	--	1.89 (9-15 Sept)	--

COOP = National Weather Service Cooperative Observer Station; RAWS = Remote Automated Weather Station. Fort Lewis is in Durango, Colorado – this is the only station in the table not in New Mexico.

Table 26 - Precipitation totals 10-18* September 2013 for additional sites in the Upper San Juan Basin (NOAA/NWS 2013m).

**Data sources excluded precipitation on 9 September 2014.*

Location (source)	Precipitation Total (in)
Bloomfield 4.1 SW (CoCoRaHS)	2.34
Farmington 3.4 WSW (CoCoRaHS)	2.33
Farmington 0.6 NNW (CoCoRaHS)	2.18
Farmington Airport (ASOS)	2.02
Farmington 10.1 N (CoCoRaHS)	1.78

CoCoRaHS = Community Collaborative Rain, Hail and Snow Network; ASOS=Automated Surface Observing System; HCN = Historical Climatology Network

Precipitation in the San Juan Basin was more dispersed than in other basins, so that local storms played a major role in the flooding, particularly later in the event when the ground was more saturated. In addition, actively reporting precipitation gauging stations (COOP, CoCoRaHS) are sparse outside of the Farmington area, limiting the amount of information for this large, sparsely-populated basin.

8.4 Event Hydrology in the Upper San Juan Basin

The Animas River at Farmington crested at 8.5 feet (5,620 cfs) at 200am MDT September 13, 2013. This is now the 17th highest crest observed at this location and compares to a previous crest of 9.15 feet on May 21, 2008 and 8.06 feet on May 17, 2001. The record crest is 16.5 feet set back on October 6, 1911. No significant flooding was observed along the Animas River, however several creeks and arroyos leading into this basin experienced flooding. Action stage is 9 feet, minor flood stage 10 feet, moderate flood stage 12 feet, and major flood stage 14 feet (NOAA/NWS 2013m).

The San Juan River at Farmington crested at 6.96 feet (11,300 cfs) at 200am MDT September 13, 2013. This crest is now the 14th highest on record for this location and compares to a previous crest of 7.2 feet on June 19, 1949 and 6.94 feet on June 17, 1993. The record crest is 12.3 feet set back on September 6, 1909. No significant flooding was observed along the San Juan River, however several creeks and arroyos leading into this basin experienced flooding. Action stage is 7 feet , minor flood stage 8.5 feet, moderate stage 10 feet, and major stage 12 feet (NOAA/NWS 2013m).

There is also a gage on the La Plata River near its confluence with the San Juan River. Flows were very flashy, characterized by sharp rises and abrupt fall-offs in flow, including: a large, sustained rise to 413 cfs (gage height 5.91 ft) on 9 September, rising to 654 cfs on 10 September, but falling below <1.0 cfs on 11 September; a sharp rise to 373 cfs (5.68 ft) on the morning of 13 September before dropping well down to 2.8 cfs (2.06 ft) the same day; a sharp rise to 477 cfs (6.26 ft) occurred on the morning of 15 September, and; a more sustained rise over 22-23 September to a peak discharge of 569 cfs (6.83 ft) at 13:30 on 23 September (USGS 2014f)

Provisional stream gage data from the USGS WaterWatch database are shown in Table 27.

Table 27- Summary of flood and high flow conditions 9-18 September at selected gages in the Upper San Juan Basin (USGS provisional WaterWatch data).

			Highest peak from 2013-09-09 to 2013-09-18				Historical Peak	
USGS Station No.	**USGS Station Name**	**Drainage area mi^2**	**Date**	**Stage**	**Stream Flow cfs**	**Rank**	**N of years**	**Max (year) cfs**
09363500	Animas River near Cedar Hill, NM	1090	2013-09-18	8.01	3520	68	78	13100 (1949)
09364010	Animas River below Aztec, NM	--	2013-09-12	10.45	5480	6	9	9130 (2005)
09364500	Animas River at Farmington, NM	1360	2013-09-13	8.5	5560	53	99	25000 (1927)
09365000	San Juan River at Farmington, NM	7240	2013-09-13	6.96	11300	34	89	68000 (1927)
09367000	La Plata River at La Plata, NM	351	2013-09-18	12.1	367	14	19	8000 (1904)
09367500	La Plata River near Farmington, NM	583	2013-09-12	7.5	739	33	59	9700 (1941)
09368000	San Juan River at Shiprock, NM	12900	2013-09-13	13.81	12100	30	85	80000 (1929)

8.5 Flooding in the Upper San Juan Basin

Farmington experienced flooding on 10 September 2013. Inadequate draining within the city caused widespread flooding on 10 September affecting stores, businesses, and other areas. The Farmington area also received rainfall in excess of an inch in the northern foothills on 13 September, although it is not clear that significant flooding resulted. In the southern part of the San Juan Basin, Crownpoint, New Mexico, was hit hard 13-14 September, with intense rainfall on 13 September causing evacuations in the town. This event was followed by a longer duration rainfall that led to widespread areal flooding though 14 September resulting in additional evacuations. Additional communities in the Navajo Nation were also impacted.

8.5.1 Flooding in Crownpoint and Elsewhere on the Navajo Nation

The area around Crownpoint and Lake Valley, New Mexico, experienced significant flooding due to torrential rains on 13 September, which continued as soaking rains through 14 September. Exact precipitation totals for this area are not available due to the lack of observational data. The flooding closed NM Highway 371. In addition, a dam above Crownpoint that blocks tributary flow into the main wash through town was threatened. This dam was mechanically breached by making a cut in the left abutment. Flow through the breach followed an existing channel directing flow to the north. The flood wave from the dam flowed through streets into the Technical College. Some of the buildings in the college were inundated and some homes along the path from the dam may also have been inundated as well.

The community of Lake Valley is located north of Crownpoint along Indian Service Route 7007 (County Road 7730). An irrigation dam upstream of the town filled and threatened to fail, which led to the decision to mechanically breach the dam. The resulting flood damaged downstream irrigation diversion structures, levees and other flood control structures, and flooded some rural residences. Just downstream of Lake Valley, an upstream-migrating headcut washed out County Road 7730 (also known as the Kin Bineola Road) and a section of the dam over which the road traversed.

Although the Arizona portion of the Navajo Nation is outside the Albuquerque District's Area of Responsibility, the Navajo Nation has requested that the District be placed in charge of USACE's response to flooding across the three-state reservation. Flooding occurred in Arizona Navajo Nation communities, including Chinle (22 people evacuated), Many Farms and Rock Point (40 evacuated or rescued), and Tonalea (20 homes damaged), Arizona (Indian Country Today 2013).

On 8 October 2013, District staff visited both Crownpoint and Lake Valley. In a separate trip on 25 October, Albuquerque District staff were invited by the Navajo Nation to visited flood-impacted areas in Window Rock, Red Lake, Gadii'ahi, Chinle, Many Farms, Piute Creek and Dilkon. Among damages observed were:

- Flood damage occurred to the Window Rock Zoo from a wash behind the zoo.

- Flooding occurred due to culvert siltation at a low water crossing in one of the main roads in at Red Lake.

- Multiple instances of culvert sedimentation caused road flooding in the community of Gadii'ahi, and contributing to the flooding of some fields and homes.

- Flood damage occurred throughout the community of Many Farms (Figure 30) due to overbanking flows on Chinle Wash, and the breaching of a stock pond that resulted in flooding of homes downstream, damaged the community well, and silted in culverts.

- Widespread flood damage in Chinle (Figure 31) happened due to overbanking flows in Chinle and Cottonwood washes. The flood impacted businesses, residences, a dialysis hospital and the fire station, and led to the collapse of two active water wells. Vegetation and sediment load in the channels impeded flow, contributing significantly to the flooding.

- Flood damage occurred to the Piute Creek Bridge in southeastern Utah.

- Floodwaters accumulating behind earthen dams near Dilkon, Arizona, caused two of them to breach, sending flows downstream leading to flows that overtopped Navajo Route 60 and damaged culverts.

Figure 32 - Flood damage to a diversion structure in Many Farms, Navajo Nation (courtesy of Rose Whitehair).

Figure 33 - Flood damage to a home in Chinle, Navajo Nation, Arizona (courtesy of Rose Whitehair).

8.5.2 Flooding in Farmington

According to data from the CoCoRaHS network (CoCoRaHS 2014), heavy precipitation occurred on 9 and 10 September, with the La Plata area receiving 1.17 and 0.36 in, respectively, and the area along the Animas River between Farmington and Aztec receiving 1.18 and 1.04 in, respectively[5].

Widespread flooding in Farmington primarily occurred on 10 September. Due to a combination of the rainfall, and flooded and damaged drainage systems along Peace Valley Road, Hubbard Road, East Navajo Street, Main Street, Butler Street, Apache Street, and San Juan Boulevard, flooding occurred in downtown Farmington. Widespread flooding of parking lots, low lying areas, homes and businesses occurred (NOAA/NWS 2013m). Flooding was not reported following similarly heavy rains on 12 September.

8.6 Reservoir Operations and Damages Prevented in the Upper San Juan Basin

USACE has no flood control structures in the San Juan Basin. USACE has Section 7 responsibilities for Reclamation's Navajo Dam. Navajo Dam did not enter flood control operations during the 9-18 September event. Therefore, there were no damages prevented by USACE projects or dam operations in the Upper San Juan Basin during this period.

8.7 USACE Flood Response Efforts in the Upper San Juan Basin

USACE does not function as a first responder to flood events; however, USACE authorities enable the agency to provide vital services before and after a flood event. These activities are coordinated by the Albuquerque District RCO. Flood response efforts in the Upper San Juan Basin conducted that fall within USACE flood risk authorities included:

- Requests for sand bags, which could not be fulfilled by USACE due to the distance involved relative to the speed with which flooding was occurring.

- Requests for post-flooding technical assistance for numerous communities within the Navajo Nation. These requests resulted in two site visits by USACE personnel (Table 28).

[5] CoCoRaHS reports precipitation ending 7 am as the precipitation for a particular day, so precipitation on 10 September at 7am reflects precipitation during the prior 24 hours, most of which likely fell on 9 September.

Table 28 - USACE post-flood site visits in the Upper San Juan Basin.

Date	Locality	Community Representatives Met	USACE Team Members (Disciplines)
8 October 2013	Lake Valley and Crownpoint, NM	Representatives from the Navajo Nation	Christopher Parrish (Regulatory), Donald Gallegos (RCO), Vince Vigil (H&H) and Carlos Aragon (Geotech)
16-18 October 2013	Window Rock, Red Lake, Gadiiahi, Chinle, Dilkon, and Many Farms Lake, Arizona, and Piute Creek Bridge and Dilkon, Utah	Michele Morris, Rose Whitehair, Lee Anna Martinez, NN (Window Rock); Danny Halwood, and Walton Yazzie (Chinle Chapter); Patrick Sandoval, and Malinda O'Dainells (NN Water Resources Department); Kathy Arthur, Danny Francis, and Roland Tso (Many Farms Chapter); Lin Laws and Kelly Pehrson (San Juan County), Henry Begay (BIA-DOT), and Jim Snyder (consultant); David Mikesic (NN Zoo); Emerson Lee (NN Police Department), Floyd Huston (DOT-BIA).	Christopher Parrish (Regulatory), Donald Gallegos (RCO)

RCO= USACE Readiness and Contingency Operations Branch, Albuquerque District; H&H = USACE Hydrology and Hydraulics Section, Albuquerque District; DOT-BIA = Department of Transportation, Bureau of Indian Affairs; NN = Navajo Nation

8.8 FEMA Damages Assessments in the Upper San Juan Basin

Areas in the Upper San Juan Basin in New Mexico that were affected by the 9-18 September Flood Event are covered under FEMA-4152-DR New Mexico – Severe Storms, Flooding, and Mudslides, declared October 29, 2013. Preliminary damages for New Mexico were estimated at $16,598,503. Damages identified were primarily to roads and bridges.

Beginning in November 2013, FEMA initiated field studies to evaluate actual damages, preliminary to the distribution of Federal funds to communities. As of February 2014, there were 146 applications for assistance had been made by communities throughout New Mexico. Damage assessments are anticipated to be completed in summer 2014.

9 - Lower Colorado River Tributary Headwaters

9.1 Lower Colorado River Tributary Headwaters Overview

The division between the Upper and Lower Colorado Basin is made at Lee's Ferry, Arizona. Consequently, both the Little Colorado and Gila River Basins are part of the Lower Colorado Basin.

9.1.1 Little Colorado River Basin Overview

The Little Colorado River and several of its tributaries have headwaters in New Mexico. These tributaries include the Puerco River of the West, with headwaters in the uplands surrounding Gallup, New Mexico and crossing through Navajo Nation land; the Zuni River, which heads in the Zuni Mountains of New Mexico and passes through the Zuni Reservation and partly through the Ramah Navajo Indian Reservation; and Carrizo Wash, which heads in the mountains south of Quemado, New Mexico. Mountain elevations in these headwaters areas range from above 11,000 ft in the headwaters of the Little Colorado River, to between 6900 and 8200 feet among the tributary basins. Tributary water flows southwest or west into the Little Colorado River, which cuts diagonally from New Mexico southwest of Quemado, past Holbrook, Arizona, to its confluence with the Colorado River above the Grand Canyon below Lee's Ferry.

The four subbasins of interest in this report are relatively modest in size. The Little Colorado River Headwaters watershed has an area of 722 mi^2, Carrizo Wash watershed area is 335 mi^2; the Zuni River watershed area measures 735 mi^2; and the upper Puerco River watershed area measures 550 mi^2. Upper area portions of the watershed are in mixed conifer/Ponderosa pine forest, mid-elevation areas are piñon-juniper woodland, and lower elevation areas are vegetated in grasses and shrubs.

9.1.2 Gila River Basin Overview

The Upper Gila Basin refers to the Gila River and its tributaries in southwestern New Mexico and southeastern Arizona above Coolidge Dam (near San Carlos, Arizona). The New Mexico portion of the Upper Gila watershed, including the watershed of its largest tributary, the San Francisco River, comprises about 5,600 mi^2 (14,504 km^2). The Gila River drains westward across southern Arizona, receiving runoff from the Mogollon Rim to the north, and joins the Colorado River near Yuma, Arizona. The major tributaries of the Gila River in the Upper basin, besides the San Francisco River, include (from west to east): Carlyle Canyon, Blue Creek, Mangus Creek, Duck, Creek, Bear Creek, Mogollon Creek, Sapillo Creek, Beaver Creek, and the West and Middle Forks of the Gila River. The town of Mogollon, which experienced a devastating flood in September 2013, is located in Silver Creek Canyon, a small tributary close to Whitewater Baldy.

The headwaters of the Gila and San Francisco Rivers are located primarily in Grant and Catron Counties in New Mexico. For both streams, much of their course through New Mexico passes through narrow, steep-sided canyons between high elevation mountain ranges. These ranges included, from south to north, the Pinos Altos and Diablo Ranges, and the Mogollon, Tularosa, Mangas, Gallo and San Francisco Mountains. The highest peak in the basin is Whitewater Baldy (10,892 ft.), with numerous peaks in the adjoining mountains in excess of 9,000 ft. Valley floor elevations in the headwaters area are at an elevation of approximately 6,670 ft, declining to about 3780 ft near the Arizona-New Mexico border. Mountains and high plateaus form a greater share of the watershed than valley areas. The predominantly narrow valleys are wider near Cliff, Redrock and Virden, where irrigation agriculture has been developed. The major land use types are forested (at the higher elevations) and rangelands.

Two major fires in recent years have impacted watersheds in this basin: the Wallow Fire in 2011 crossed into New Mexico west of Luna, impacting the western headwaters of the San Francisco River. In 2012, the Whitewater Baldy fire burned more than 250,000 acres of the Gila National Forest, affecting the headwaters of the east side tributaries of the San Francisco River (including Mineral, Silver, and Whitewater Creeks), a large part of the Mogollon Creek watershed, and the upper reaches of the West and Middle Forks of the Gila River in an arc running from just east of Reserve to a point north-northeast of Cliff.

9.2 Meteorological Event in the Lower Colorado River Tributary Headwaters

Heavy precipitation in the southwestern part of New Mexico was restricted to two periods during the 9-18 September event. Most of the precipitation fell in mountain areas without precipitation gaging stations, so precipitation is estimated from radar data.

Early in the event, precipitation occurred in the Silver City area, with 1-2 in falling between Silver City and Pinos Altos on 9 September, producing “serious street flooding,” and 3.5 in recorded at Tyrone, south of Silver City, on 10 September (NOAA/NWS 2014e). Precipitation on 10 September also occurred over the high elevation portion of the Gila River basin produced a significant flood along the West Fork of the Gila River. Radar data indicate that less than 2 in of precipitation fell. Precipitation on the Whitewater Baldy and Miller Fire burn scars may have contributed to the volume of the flooding on this day. Flooding along both the West and Middle Forks of the Gila River also occurred on the morning of 14 September.

A significant precipitation event occurred between approximately 23:00 MDT on 14 September and 2:00 on 15 September. Radar data indicate that as much as 6 in of rain may have fallen on portions of the Whitewater Baldy burn scar, producing destructive flooding along Mineral, Silver and Whitewater Creeks, causing extensive flood damage to the town of Mogollon, to residences, businesses and infrastructure in all three watersheds, as well as in the downstream communities of Alma and Glenwood. The USGS stream gaging station Whitewater Creek at the Catwalk recorded 6 in of rain on the evening of 14 September (USGS 2014j).

9.3 Rainfall Data in the Lower Colorado River Tributary Headwaters

Rainfall data were obtained from the National Weather Service and the Western Regional Climate Center. Data come from a variety of sources, including the NWS Cooperative Observer (COOP) stations (Western Regional Climate Center (WRCC) 2014b), remote automated weather station sites (RAWS) (Western Regional Climate Center (WRCC) 2014a), hydrometeorological automated data stations (HADS) and the Climate Reference Network (CRN) (NOAA/NWS 2013a). COOP and RAWS data were available at daily time steps, the others were obtained as sums for the period 10-18 September. For the COOP sites only, the NOAA Atlas 14 provides recurrence intervals (RI) for precipitation(NOAA/NWS 2014c).

Despite the paucity of precipitation gages in this region, the evidence suggests significant precipitation over parts of the Whitewater Baldy Wildfire burn scar during the period 9-15 September (Figure 33). While low elevation sites recorded modest precipitation totals, high elevation sites in the vicinity of the burn scar recorded significant daily and weekly totals. The HADS sites recorded 5-10 in for the 9-day period 10-18 September, most of which likely fell on or before 15 September (precipitation after 15 September is significantly less at COOP and RAWS sites, and therefore probably also at nearby HADS sites). The totals for the Mineral Creek (5.12 in) and Whitewater Creek HADS (10.09 in) likely indicate at least one large precipitation event in the vicinity of the town of Mogollon adjacent to Silver Creek (see below), most likely on the night of 14-15 September when major flooding occurred in all three watersheds. The Mogollon RAWS site, located approximately 15-20 miles southeast along Mogollon Creek recorded 3.52 in on 14 September on top of 3.94 in received in the 5 days leading up to that date.

Table 29 - Rainfall summary 90-18 September 2013, Lower Colorado River tributary headwaters (Western Regional Climate Center (WRCC) 2014a, b).

Location (source)	10-day Precipitation Total (in) (9-18 Sept)	Highest Daily precip (in) (date)	COOP site Av. Recurrence interval (24-hr event)	Highest 7-day precip (in) (dates)	COOP site Av. Recurrence interval (7-day event)
Zuni Buttes (RAWS)	0.81	0.56 (10 Sept)	--	0.81 (9-15 Sept)	--
Quemado (COOP)	2.46	0.89 (17 Sept)	<1 year	1.57 (9-15 Sept)	1 year
Pelona Mountain (RAWS)	4.75	2.84 (14 Sept)	--	4.62 (9-15 Sept)	--
Datil (RAWS)	3.31	1.35 (10 Sept)	--	3.20 (9-15 Sept)	--
Slaughter (RAWS)	2.49	0.85 (13 Sept)	--	2.48 (9-15 Sept)	--
Luna Ranger Station (COOP)	2.46	0.98 (10 Sept)	<1 year	2.35 (10-16 Sept)	1-2 years
Luna (RAWS)	2.16	0.91 (13 Sept)	--	2.12 (9-15 Sept)	--
Reserve (RAWS)	3.95	1.37 (14 Sept)	--	3.86 (9-15 Sept)	--
Mogollon (RAWS)	8.50	3.52 (14 Sept)	--	8.26 (9-15 Sept)	--
Glenwood (COOP)	4.76	1.70 (15 Sept)	No data	4.71 (9-15 Sept)	No data
Beaverhead (RAWS)	4.61	1.85 (14 Sept)	--	4.57 (9-15 Sept)	--

COOP = NWS Cooperative Observer Site; RAWS = Remote Automated Weather Station.

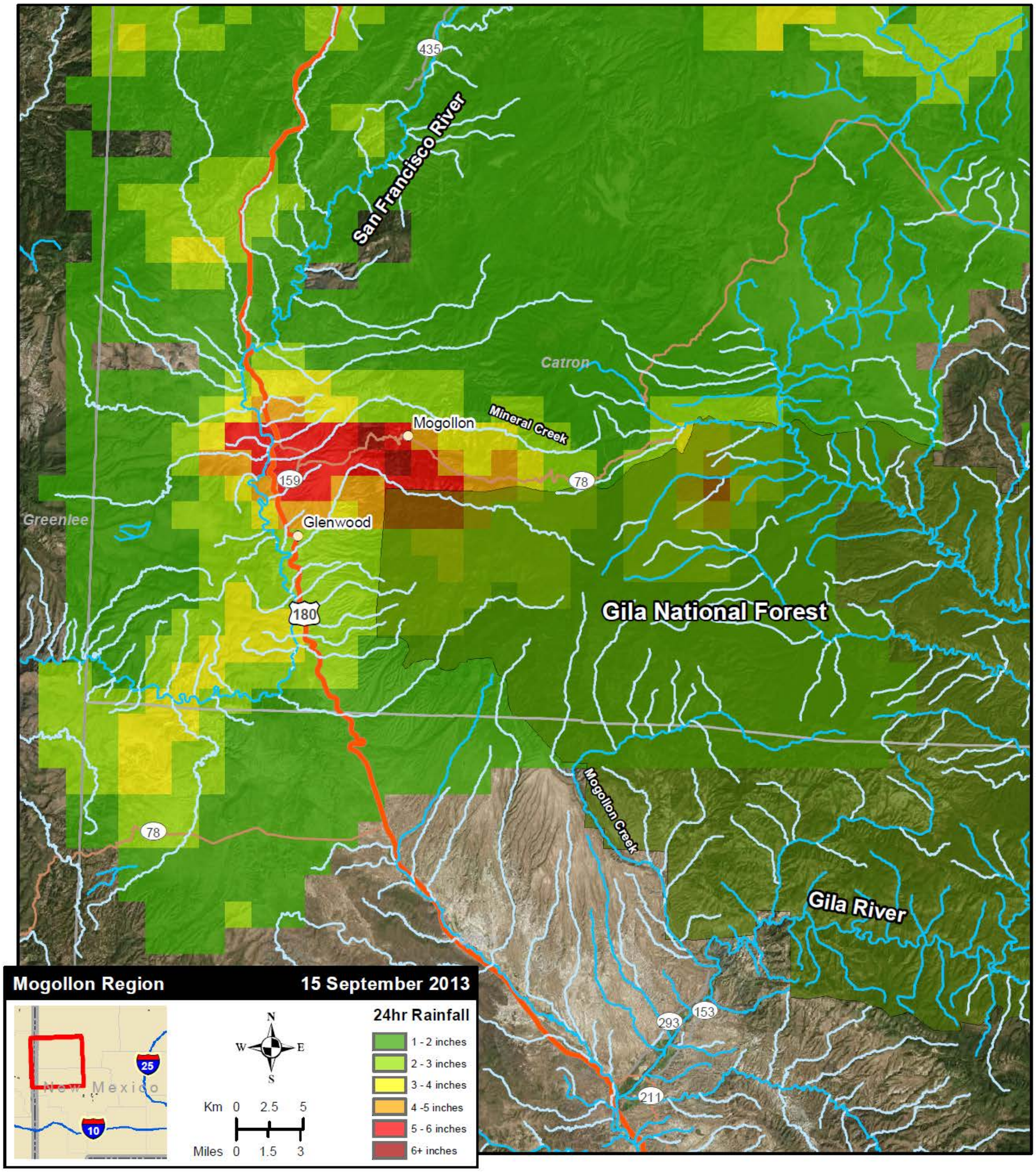


Figure 34 - Doppler radar data showing areas receiving precipitation > 1 inch on 15 September 2013 in the Glenwood area, NM.

Table 30 - Rainfall summary 10-18* September 2013, additional sites in the Lower Colorado tributary headwaters (NOAA/NWS 2013c).

**Data sources excluded precipitation on 9 September 2014.*

Location (source)	Precipitation Total (in)
Mineral Creek (HADS)	5.12
Whitewater Creek (HADS)	10.09
Mogollon Baldy Lookout (HADS)	6.80
Hummingbird Saddle (HADS)	5.87
Sheridan Corral (HADS)	4.92
Gila National Forest (CRN)	3.28

HADS = Hydrometeorological Automated Data Station; CRN=Climate Reference Network

9.4 Event Hydrology in the Lower Colorado River Tributary Headwaters

Stream flows north of Reserve, NM, in the Zuni River and Rio Puerco of the West watersheds, where not exceptional during the 9-18 September event. For instance, the Zuni River above Blackrock Reservoir, for instance, crested at 4.19 ft (495 cfs), the 22nd highest flood in the 42-year gage record. Some flooding did occur, notably along Oak Wash at Zuni Pueblo, but this flooding was due more to channel aggradation than to exceptional precipitation, and was initiated by regular monsoon precipitation on 8 September.

Stream flows were higher in the San Francisco and Gila River watersheds, particularly at gages downstream of tributaries affected by the 2012 Whitewater Baldy wildfire. Above these tributaries, stream flows were more moderate due both to lower precipitation totals and a hydrologic condition more suited to infiltration than flash floods.

Reserve, NM, is located in the upper San Francisco River watershed, upstream from confluences with east-side tributaries originating in watersheds affected by the 2012 Whitewater Baldy fire (a small portion of the uppermost part of the San Francisco River watershed above Luna, NM was burned during the 2011 Wallow Fire). The gage the San Francisco River near Reserve, NM, showed three significant crests during the 9-18 September event (USGS 2014i)

- 10 September: 278 cfs (gage height = 4.88 ft).
- 13 September: 598 cfs (gage height = 6.39 ft).
- 14 September: 960 cfs (gage height = 7.51 ft).

The peak at 960 cfs is the 21st highest discharge recorded at that station since 1959. The record crest is 11,900 cfs (7.47 ft) recorded on 20 October 1971.

Mineral, Silver and Whitewater Creeks are east-side tributaries of the San Francisco with watersheds that were burned by the 2012 Whitewater Baldy fire. Preliminary data from the gage on Mineral Creek shows a discharge of approximately 10 cfs (0.39 ft) until the afternoon of 9

September, when water levels began to slowly rise to about 60 cfs (1.25 ft). On the morning of 13 September, the creek abruptly rose to 282 cfs (2.59 ft) before declining below 100 cfs. Shortly after midnight on 15 September, the creek experienced an abrupt rise from about 77 cfs (1.43 ft) that is estimated to have exceeded 2500 cfs (>4 ft) (USGS 2014k).

Along Whitewater Creek, at the gage Whitewater Creek at Catwalk (USGS 09443800), large peak flows were observed on 9 and 11 September of just under 778 cfs and 931 cfs, respectively, with only modest increases in stage (5.87 ft and 6.18 ft, respectively). Although the gage did not measure discharge after 12 September, on 13 September a stage height of 8.76 ft was recorded, and just after midnight of 15 September, the gage recorded a peak stage of 17.45 ft (USGS 2014j). The estimated peak flow for Whitewater Creek at the Catwalk is 16,100 cfs (19.07 ft) at 23:15 on 14 September, “5 to 6 times higher than any other flow ever observed” (NOAA/NWS 2013c). Although there is no gage on Silver Creek, the coincident timing and magnitude of flooding on Mineral Creek to the north and Whitewater Creek to the south suggests a similar magnitude event in on 15 September.

The San Francisco River gage at Glenwood is located below the confluences with Mineral, Silver, and Whitewater Creeks. The San Francisco River at Glenwood gage crested at 18.87 feet (29,900 cfs) at 200 am MDT 15 September 2013. This is the 2nd highest crest ever observed at this location and compares to a previous crest of 16.61 feet on 20 October 1972. The record crest is 20.8 feet set back on October 2, 1983. Major flooding was observed along many portions of the San Francisco River all the way north to Reserve. Creeks and arroyos leading into this drainage system in the Apache Creek and Cruzville areas also reported flooding. Action stage is 12 feet, minor flood stage 15 feet, moderate flood stage 17 feet, and major flood stage 19 feet (NOAA/NWS 2013c).

South of Glenwood, the San Francisco River turns west-southwest into Arizona. Continuing further south, over a low drainage divide, streams are tributary to the Gila River. Mogollon Creek is a large tributary that drains a portion of the Whitewater Baldy fire scar. The USGS Mogollon Creek gage near Cliff, NM recorded a peak discharge of 27 cfs (0.86 ft) at 10:30 MDT on 9 September, then declined some before the gage ceased recording discharge at 23:45 MDT on 9 September. On Tuesday 10 September, a peak stage height of 4.43 ft was recorded at 12:17 MDT, and shortly thereafter the stage gage also ceased to function (USGS 2014h). NWS reports a peak flow of 8440 cfs (8.49 ft) on 16 September, but the basis for this is not indicated. The 16 September flow would be the 3rd highest flow on record for the gage. The record peak at this gage is 10,800 cfs (13.70 ft) set on August 12, 1967 (USGS 2014a).

The Gila River near Gila, NM, gage is located along the Gila River just upstream of its confluence with Mogollon Creek and below the confluence with Turkey Creek. This gage experienced four peak discharges in two clusters. Two peaks of approximately 13,800 cfs (9.7 ft) in the early afternoon of 10 September and again on the morning of 11 September. Flows subsided over the next several days, to 1260 cfs (3.49 ft) around 22:00 MDT on Friday, 13 September. On 15 September, discharge spiked to 22,300 cfs (11.69 ft) at 23:00 MDT on 14 September and 28,800 cfs (12.90 ft) at 19:30MDT on 15 September. The peak at 28,800 cfs is the third highest flow at this gage’s 85-year record (USGS 2014g).

The flood flows attenuated downstream, with peak flows at the gages on the Gila River at Redrock and near Virden being 12,000 cfs (15.55 ft, 18th rank) and 11,200 cfs (17.68 ft, 15th rank), respectively.

Provisional stream gage data from the USGS WaterWatch database are shown in the table, below.

Table 31 - Summary of flood and high flow conditions 9-18 September at selected gages in the Lower Colorado River tributary headwaters (U.S. Geological Survey (USGS) 2014l).

			Highest peak from 2013-09-09 to 2013-09-18				Historical Peak	
USGS Station No.	**USGS Station Name**	**Drainage area mi^2**	**Date**	**Stage**	**Stream Flow cfs**	**Rank**	**N of years**	**Max (year) cfs**
Little Colorado Tributary Headwaters								
09386900	Rio Nutria near Ramah, NM	71.4	2013-09-13	10.21	377	16	42	1840 (1995)
09386950	Zuni River above Black Rock Reservoir, NM	848	2013-09-16	4.19	495	22	42	7000 (2006)
San Francisco and Gila Rivers								
09442680	San Francisco River near Reserve, NM	350	2013-09-14	7.51	960	21	53	11900 (1971)
09444000	San Francisco River near Glenwood, NM	1653	2013-09-15	18.87	29900	3	85	37100 (1983)
09430600	Mogollon Creek near Cliff, NM	69	2013-09-16	--	5000	--	46	10800 (1967)
09430500	Gila River near Gila, NM	1864	2013-09-15	12.9	28800	3	85	35200 (1984)
09431500	Gila River near Redrock, NM	2829	2013-09-16	15.55	12000	18	79	48800 (1978)
09432000	Gila River below Blue Creek, near Virden, NM	3203	2013-09-16	17.68	11200	15	87	58700 (1978)

9.5 Flooding in the Lower Colorado River Tributary Headwaters

Flooding in the Lower Colorado River Tributary Headwaters area occurred primarily due to heavy rains on the Whitewater Baldy burn scar. Some areas received as much as 8 to 10 in of precipitation over the period 9-18 September. Precipitation events that caused significant flooding occurred on 9-10 September and again on the night of 14-15 September. Flooding was also reported in Pietown, and Reserve between 12 and 15 September (NOAA/NWS 2013c).

Figure 35 - High water mark on the general store, Mogollon, NM.

Figure 36 - Cars buried in sediment following a September 2013 flood in Mogollon, NM.

9.5.1 Flooding Near Glenwood: Mogollon and the Catwalk

Major flooding occurred in the vicinity of Glenwood, NM, the night of 14-15 September. As much as 3.5 inches of precipitation fell on the mountains east of town, following on more than an inch of precipitation in preceding days.

The biggest damage occurred in the town of Mogollon (population 13-18 individuals). The town sits astride Silver Creek, a small tributary sandwiched between Mineral and Whitewater Creeks. The only road through town runs along the former creek bed (the creek has been confined to one small part of its former channel). Major flooding began late Saturday when the creek left its banks, destroying almost every bridge along the creek, including the New Mexico Highway 159 bridge just below mile marker 9 (Steele 2013c). Individuals reported a 15-foot wall of water surging through town (Figure 34), carrying a large quantity of rocks and woody debris (Steele 2013b). Several buildings tumbled into the creek, structural damage occurred to the theater (which lost its front porch and projection booth), and water entered most buildings, leaving mud and water damage behind (Steele 2013b) (Figure 35). At least 5 feet of water was still coursing through town the following day. Residents were trapped in their houses by the high water, and the community was left without power or telephone. Food and drinking water were brought to residents by crews from the Glenwood Ranger Station of the Gila National Forest (Mikkelson 2013a). New Mexico Department of Transportation created a temporary road to replace the damaged portions of Highway 159 (Grant County Beat 2013).

A single death occurred in Mogollon. An 83-year-old man, Howard Bassett, attempted to drive out of Mogollon near midnight on 14 September 2013, about the time that stream gages in the region peaked. His vehicle was found partially buried in mud and rocks in a drainage ditch near a destroyed section of Highway 159. His body was recovered on 21 September near Mogollon (Mikkelson 2013b).

Damage also occurred along downstream reaches of Mineral Creek (Figure 37), stranding 22 upstream residents without a road out (Mikkelson 2013a). One home was directly affected by the flood waters, multiple homes received minor flood damage, an RV park and mobile home park were damaged, and several others close to the new channel were threatened. Power and phone lines were damaged (Grant County Beat 2013). In addition three homes and one business along Whitewater Creek were directly impacted by floodwaters (Mikkelson 2013a).

Flooding along Whitewater Creek destroyed the Catwalk (Glenwood Gazette News 2013), a popular tourist attraction that includes a pathway that runs on a metal structure affixed to the wall of Whitewater Canyon (Figure 36). Damage included: portions of the stone stairs and metal grillwork, established by the Civilian Conservation Corps, were damaged; a 30-foot section of the cement bridge across Whitewater Creek was washed away; landslides closed both the “universal” trail and the “old” trail; and the picnic area, parking area and access road were covered in woody debris, boulders, rocks and sediment (Glenwood Gazette News 2013). New Mexico Highway 174 to the Catwalk was damaged by a landslide and by high flows along Whitewater Creek (Glenwood Gazette News 2013).

Downstream areas also flooded. Near Alma, water ran over the Mineral Creek and Whitewater Creek Bridges, and water and debris also flowed over Highway 180 in Glenwood (Steele 2013c).

Figure 37 - Flood damage to the Catwalk, a popular tourist destination near Glenwood, NM.

Figure 38 – Channel work along Whitewater Creek, near Glenwood, NM, following a September 2013 flood event.

Low-lying areas in Glenwood were flooded (Grant County Beat 2013). Water came over a dyke and through an irrigation ditch below Mineral Creek bridge. There were reports of voluntary evacuations in Glenwood and Alma (Mikkelson 2013a). One business, three homes and several outbuildings in Glenwood were directly impacted by floodwaters (Grant County Beat 2013).

Roads were closed throughout the region. NM DOT closed Highway 159 from mile marker 10 to mile marker 25; New Mexico Highway 174 from mile marker 1 to mile marker 4; new Mexico Highway 211 from mile marker 3 at Gila to mile marker 4; and New Mexico Highway 15 from mile marker 40 to 41 (Steele 2013c).

9.5.2 Flooding in the Vicinity of Gila Cliff Dwellings National Monument

Gila Cliff Dwellings National Monument is located along the West Fork of the Gila River at its confluence with the Middle Fork, both tributaries whose upper reaches were burned during the Whitewater Baldy fire. The West Fork also was burned during the 2011 Miller Fire, which crossed onto the monument.

Flooding in this area occurred both on Tuesday, 10 September and then during the morning on Saturday, 14 September. On Tuesday, two couples and a group of students from Aldo Leopold High School became trapped when the river rose 8 ft overnight, the 12th biggest vertical rise since 1928 (Steele 2013d). Then, around 11 AM on Saturday, a “giant surge of water and debris” came down the Middle Fork, sweeping over the Highway 15 bridge south of the Visitor Center (Steele 2013d), the only road leading out of the monument. Search and Rescue was able to rescue the stranded individuals later in the day on Saturday.

Search and Rescue volunteer Dave Berry noted “there were log jams that were acres and acres across coming down from the Middle Fork and the West Fork…there was the giant raft of huge trees. You could hear them slamming against each other and you could see these huge trees being uprooted…the debris was forming dams and then it would burst out and scour the area. We are talking hundreds of thousands of tons of wood floating down…Portions of the Middle Fork are not going to be the same after this” (Steele 2013d). Damage occurred also to park camp grounds and facilities. Five locals elected to raft the river during the flood and could not be dissuaded by emergency personnel (Steele 2013c).

A log jam and debris also caused problems downstream on the West Fork, leading to flooding in the vicinity of Gila Hot Springs that damaged roads and buildings (NOAA/NWS 2014e).

9.5.3 Flooding at Zuni Pueblo

Localized flooding occurred along Oak Wash in the vicinity of Zuni Pueblo beginning 8 September 2013 due to monsoon precipitation in the mountains upstream of the village. Flooding occurred because sediment in the channel had reduced its flood conveyance capacity, enabling flows to overtop the banks and flood parts of the community. The initial flooding was exacerbated by overnight rains at the village on the night of 8-9 September, which fell on flood-saturated ground. Flooding subsided by 10 September [USACE trip reports]. Rivers in the northern portion of the Lower Colorado River headwaters did not experience significant flooding during the period 9-18 September.

9.6 Reservoir Operations and Damages Prevented in the Lower Colorado River Tributary Headwaters

USACE has no flood control structures in the Lower Colorado Tributary Basins. Therefore, there were no damages prevented by USACE projects or dam operations in the Lower Colorado Tributary Basins during 9-18 September event.

9.7 USACE Flood Response Efforts in the Lower Colorado River Tributary Headwaters

USACE does not function as a first responder to flood events; however, USACE authorities enable the agency to provide vital services before and after a flood event. These activities are coordinated by the Albuquerque District RCO. Flood response efforts in the Lower Colorado River Tributary Headwaters that fall within USACE flood risk authorities included:

- Requests for post-flooding technical assistance from communities within the region. These requests resulted in three site visits by USACE personnel (table, below).

Table 32 - USACE post-flood site visits in the Upper San Juan Basin.

Date	Locality	Community Representatives Met	USACE Team Members (Disciplines)
24-25 September 2013	Catron County, NM	Kenny Rogers (Congressman Pearce's office), Bucky Allred (Catron County), Leonard Rice (Glenwood Fish Hatchery)	Theresa Rogers (RCO); Donald Gallegos (RCO); Stephen Scissons (H&H); Steve Boberg (H&H), Rick Gatewood (Regulatory)
10 October 2013	Village of Zuni, NM		Donald Gallegos (RCO); Christopher Parrish (Regulatory); Vince Vigil (H&H); Carlos Aragon (Geotechnical Engineering)
3-4 February 2014	Mineral and Whitewater Creeks, Catron County, NM	Kenny Rogers (Congressman Pearce's office), Bucky Allred (Catron County), Jim Scully (U.S. Forest Service), Mark Huntzinger (Sierra County); Barry Ragsdale (Sierra County)	Donald Gallegos (RCO); Theresa Rogers (RCO); Michael Fies (Project Manager)

RCO= USACE Readiness and Contingency Operations Branch, Albuquerque District; H&H = USACE Hydrology and Hydraulics Section, Albuquerque District

9.8 FEMA Damages Assessments in the Lower Colorado River Tributary Headwaters

Areas in the Lower Colorado River Headwaters in New Mexico that were affected by the 9-18 September Flood Event are covered under FEMA-4152-DR New Mexico – Severe Storms, Flooding, and Mudslides, declared October 29, 2013. Preliminary damages for New Mexico were estimated at $16,598,503. Damages identified were primarily to roads and bridges.

Beginning in November 2013, FEMA initiated field studies to evaluate actual damages, preliminary to the distribution of Federal funds to communities. As of February 2014, there were 146 applications for assistance had been made by communities throughout New Mexico. Damage assessments are anticipated to be completed in summer 2014.

10 - Recommendations

Flooding in September, while catastrophic for affected individuals and communities, occurs regularly in New Mexico, Far West Texas and Southeast Colorado in the early fall. Such events are anticipated to occur in the future. This report serves to document the significant events associated with the 9-19 September 2013 flooding.

10.1 General Recommendations

Compilation of this report suggested several areas where data collection could be improved during future flood responses:

- Data on high water marks in areas without USGS gages needs to be collected immediately and more systematically than was done in this flood event. Too much time and too few crew members hampered collection of this information before cleanup efforts obliterated flood evidence at key locations.

- Better and more systematic collection of photos of active flooding should be taken, and a more systematic archive of such photos created. Photos collected in response to the 2013 events showed post-flooding damage sometimes many months after the event being documented, and in some cases after subsequent flood events had occurred.

- Better real-time organization of information is needed, particularly to ensure completeness of the flood record.

- More systematic and more extensive gathering of news and other media documentation of the flood event needs to occur close in time to the event as online information is quickly archived by organizations.

- A more systematic and complete archive of past flood information for the district is needed not only to support flood documentation per se, but to support flood risk management projects district-wide.

10.2 Floodplain Management Recommendations

- Educating flood risk to communities can be achieved through the use of sound floodplain maps. During the September 2013 flood events in Colorado and New Mexico, new generations of community members saw “first-hand”, what previous generations have experienced. This visual acquisition of floodplain knowledge, not presented on a paper map, will have lasting impressions on those who witnessed it.

- The September 2013 precipitation event has shown communities in both states, those areas in which there exists a high probability of flooding. Given this latest round of large scale flooding, current floodplain maps should be reviewed and revised if needed to bring the most up to date information to the public. Also, careful review of development within the floodplains that experienced a flood event should be undertaken by local, state, and federal governments whose responsibility involves managing development in those floodplains.

Appendix 1 - National Weather Service Information

National Weather Service Albuquerque Online Feature

Available online at: http://www.srh.noaa.gov/abq/?n=2013SeptemberFlooding, accessed 16 September 2014

Historic Rainfall Event September 10-18, 2013

Meteorological Summary for Northern and Central New Mexico: From Drought to Deluge!

A deep upper level low pressure system that became relatively stationary over the Great Basin beginning on September 10th provided a steady stream of near record monsoon moisture over New Mexico. Multiple upper level disturbances pushed north and northeast across the region within the monsoon moisture plume through the 18th producing widespread historic rainfall amounts. This unprecedented heavy rain event resulted in saturated ground over much of New Mexico and directly contributed to additional flooding due to strong to severe thunderstorms from September 18, 2013 through September 22, 2013. Details for each county in northern and central New Mexico, including photos, are available via the map at the bottom of this page.

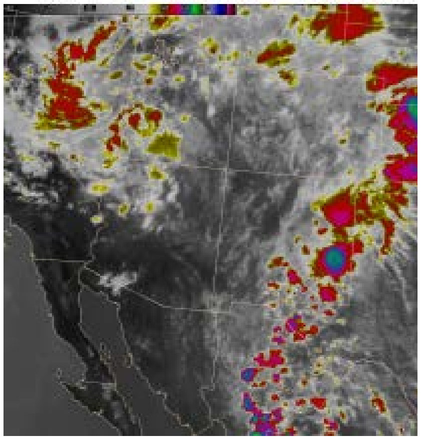
The focus for widespread, long duration heavy rainfall waivered across the state during the 9-day period, ensuring that most areas would receive a healthy dose of much needed precipitation. The focus for heavy rain from the 10th to the 12th was primarily over southern and eastern New Mexico. After much of eastern New Mexico experienced a record to near record deluge of rainfall and flooding, the focus shifted into central and western New Mexico from the 13th to the 15th. Widespread heavy rains became more convective from the 16th to the 18th, focusing torrential rainfall over much smaller areas of the state. These convective rains on top of the saturated soil conditions left over from multiple days of widespread heavy rainfall exacerbated flooding concerns. Record to near record river flooding and areal flooding was observed in several areas of northern and central New Mexico by the end of the period, while numerous locations reported disastrous impacts from flash flooding as well.

Total rainfall amounts over the 9-day period averaged 3 to 6 inches and in some areas just over 10 inches. Several river gauges reported record to near record crests and in a couple cases gauges were completely destroyed. Emergency management reported disastrous impacts to residential, commercial, and transportation infrastructure across northern and central New Mexico. Significant coverage of this event was broadcast by local and national media outlets. Social media coverage of the event was extraordinary as residents and visitors to the region shared valuable feedback with the National Weather Service. A total of 12 New Mexico counties, 4 cities and towns, and 4 pueblos, including the Navajo Nation, were included in a statewide disaster declaration. The New Mexico State Emergency Operations Center was in command at Level 2 operations for several days.

The NWS Office of Hydrologic Development constructed statistics and a graphic for annual exceedance probabilities for the 7-day period from September 9 to September 16, 2013.

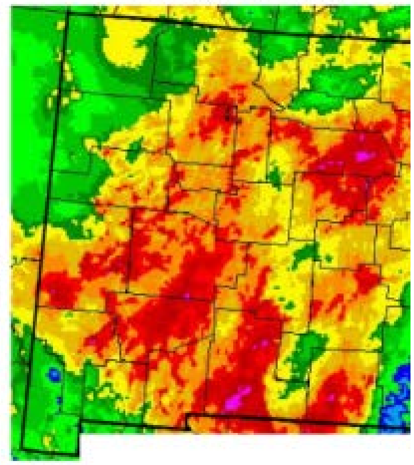
Several impressive moisture surges were captured very well by satellite imagery. In the image on the left below, the stationary upper level low pressure can be seen over the Great Basin while a deep plume of monsoon moisture surges northward over New Mexico and Colorado. For a satellite loop of the entire event period visit the Albuquerque National Weather Service YouTube link available below the imagery. The center graphic is a composite radar reflectivity image valid on September 12, 2013. Note the widespread coverage of heavy rainfall over central and eastern New Mexico . A radar loop of the 7-day period from September 10 to September 16 is also available on YouTube beneath the imagery. The illustration on the right is a precipitation estimation for the 21-day period ending September 21, 2013 from the Advanced Hydrologic Prediction Service (AHPS). Note the most of the precipitation fell during the period from September 10-18. Precipitation estimates based on radar and gages from AHPS were astounding over New Mexico. Storm total precipitation amounts for this prolonged event were enough to wipe out yearly deficits over nearly all of the region, and in some cases modest surpluses were obtained, thereby improving the drought status across much of New Mexico. The precipitation estimates from AHPS will underestimate the rainfall in radar beam blocked areas, such as east of the Sandia Mountains, over much of the Four Corners and from the Guadalupe Mountains north to southwest Chaves County.

Satellite Imagery 9/11/210



Radar Imagery 9/12/2103

Observed Precipitation
1-21 September 2013



9-Day Storm Total Precipitation by County for Northern & Central New Mexico September 10-18, 2013

Bernalillo County	Precipitation Total
Tijeras 5 E (CoCoRaHS)	5.49
Albuquerque 8.1 ESE (CoCoRaHS)	5.37
Albuquerque 8.2 ENE (CoCoRaHS)	5.23
Albuquerque 5.9 WNW (CoCoRaHS)	5.00
Albuquerque 6.8 WNW (CoCoRaHS)	4.86
Paradise Hills 1.4 SSE (CoCoRaHS)	4.76
Sandia Park 3.7 ESE (CoCoRaHS)	4.74
Tijeras 9.1 SE (CoCoRaHS)	4.64
Albuquerque 7.7 ENE (CoCoRaHS)	4.64
Tijeras 4.2 NE (CoCoRaHS)	4.42
Albuquerque 9 ENE (CoCoRaHS)	4.38
Albuquerque 8 NNW (CoCoRaHS)	4.38
Albuquerque 8.1 ENE (CoCoRaHS)	4.38
Albuquerque 2.4 E (CoCoRaHS)	4.34
Albuquerque 8 NNW (CoCoRaHS)	4.31
Albuquerque 7.8 ENE (CoCoRaHS)	4.22
Albuquerque 4.4 WNW (CoCoRaHS)	4.20
Albuquerque 1.7 SSE (CoCoRaHS)	4.12
ABQ Foothills (COOP)	4.10
Albuquerque International Sunport (ASOS)	3.14
ABQ Valley (COOP)	3.00
Catron County	Precipitation Total
Whitewater Creek (HADS)	10.09
Mogollon Baldy Lookout (RAWS)	6.80
Mogollon (RAWS)	6.78

Hummingbird Saddle (HADS)	5.87
Mineral Creek (HADS)	5.12
Sheridan Corral (HADS)	4.92
Glenwood (COOP)	4.63
Pelona Mountain (RAWS)	4.45
Beaverhead (RAWS)	3.86
Gila National Forest (CRN)	3.28
Datil (RAWS)	3.18
Reserve (RAWS)	3.10
Bear Wallow Lookout (RAWS)	2.77
Luna Ranger Station (COOP)	2.39
Slaughter (RAWS)	2.08
Quemado (COOP)	1.90
Luna (RAWS)	1.50
Chaves County	Precipitation Total
Bitterlakes (COOP)	6.47
Dunken (RAWS)	5.48
North Roswell (COOP)	4.98
Roswell 17.4 N (CoCoRaHS)	4.56
Roswell Airport (ASOS)	3.98
Roswell (COOP)	3.95
Eight Mile Draw (RAWS)	3.65
Hagerman (HCN)	3.06
Elida (CRN)	1.94
Cibola County	Precipitation Total
Brushy Mountain (RAWS)	4.05
Cubero (COOP)	3.17
El Malpais Natl Monument (COOP)	2.86
Bluewater Ridge (RAWS)	2.15
Grants (RAWS)	2.00
El Morro Natl Monument (HCN)	1.83
Ramah (RAWS)	1.71
Grants/Milan Airport (AWOS)	1.58
Grants 2 S (HCN)	1.34
Laguna 1 N (RAWS)	1.33
Colfax County	Precipitation Total
Angel Fire 10.2 SSE (CoCoRaHS)	7.40
Cimarron (RAWS)	4.07
Taos Portable (RAWS#2)	3.68
Maxwell 3 NW (COOP)	3.43
Cimarron 4 SW (COOP)	3.10
Springer (COOP)	3.10
Raton Airport (ASOS)	3.09
Angel Fire 1 S (COOP)	3.05
Eagle Nest (COOP)	2.41
Angel Fire Airport (AWOS)	1.99
Curry County	Precipitation Total
Melrose (COOP)	4.03
Clovis AFB (ASOS)	3.86

Clovis 6.5 WNW (CoCoRaHS)	2.71
Clovis 13 N (COOP)	2.63
Ned Houk (HCN)	2.44
Clovis Airport (AWOS)	2.31
De Baca County	Precipitation Total
Sumner Dam (COOP)	8.33
Fort Sumner 5 S (COOP)	4.91
Guadalupe County	Precipitation Total
Vaughn (HCN)	2.55
Harding County	Precipitation Total
Rosebud 7 NW (COOP)	3.90
Mills 6 WSW (HCN)	3.55
Mills Canyon (RAWS)	3.42
Lincoln County	Precipitation Total
Skyview (HADS)	8.34
Buck Mountain (HADS)	8.21
Picacho (COOP)	7.06
Lincoln 4.6 SSE (CoCoRaHS)	6.54
Bluefront Crest Trail (HADS)	6.23
Ruidoso 1.7 WNW (CoCoRaHS)	5.53
Runnels Stables (HADS)	5.46
Nogal Peak Crest (HADS)	5.36
Capitan (COOP)	4.85
Bonito Lake (HADS)	4.66
Lincoln 1.4 ESE (CoCoRaHS)	4.41
Roswell Portable (RAWS#1)	4.37
Roswell Portable (RAWS#2)	4.31
Sierra Blanca Regional Airport (AWOS)	4.24
Corona 10 SW (COOP)	4.15
Ruidoso (COOP)	3.69
Carrizozo (HCN)	3.45
Circle Fork Ranch (HADS)	2.10
Los Alamos County	Precipitation Total
Bandelier Natl Monument (HCN)	7.93
Los Alamos 2.6 W (CoCoRaHS)	7.67
LANL (Mesonet)	7.56
Los Alamos 6.1 SE (CoCoRaHS)	7.27
White Rock 1.5 NNE (CoCoRaHS)	6.71
Los Alamos 0.9 SW (CoCoRaHS)	6.68
Los Alamos Airport (AWOS)	7.05
Los Alamos (COOP)	5.34
McKinley County	Precipitation Total
Mesa Chivato (RAWS)	3.73
Gallup 8.1 NNW (CoCoRaHS)	1.79
Gallup 0.6 NW (CoCoRaHS)	1.51
Gallup Airport (ASOS)	1.09
Gallup Sand & Gravel (COOP)	0.64
Zuni Buttes (RAWS)	0.62

Mora County	Precipitation Total
No Reports	N/A
Quay County	Precipitation Total
House 0.1 S (CoCoRaHS)	5.74
Tucumcari 4.0 NW (CoCoRaHS)	5.05
McAlister 3.7 WNW (CoCoRaHS)	4.34
Ragland 3 SSW (COOP)	4.05
Tucumcari (COOP)	3.90
Tucumcari 2.7 NE (CoCoRaHS)	3.90
Tucumcari 3.4 ENE (CoCoRaHS)	3.60
Tucumcari 4.7 NNW (CoCoRaHS)	3.32
Tucumcari Airport (ASOS)	3.09
Logan 1.5 W (CoCoRaHS)	2.54
Tucumcari 9.7 ESE (CoCoRaHS)	2.54
Logan 5.2 SSW (CoCoRaHS)	2.23
Tucumcari 10.6 E (CoCoRaHS)	2.21
Rio Arriba County	Precipitation Total
Abiquiu 7.5 WNW (CoCoRaHS)	4.38
Espanola 1.1 SE (CoCoRaHS)	3.86
El Rito 2.3 NW (CoCoRaHS)	3.65
Truchas (RAWS)	3.62
Jarita Mesa (RAWS)	3.59
Espanola 5.4 WNW (CoCoRaHS)	3.52
Abiquiu Dam (COOP)	2.97
Coyote (RAWS)	2.91
Tres Piedras (HCN)	2.57
Deadman Peak (RAWS)	2.03
Chama (COOP)	1.97
Dulce (RAWS#2)	1.84
Heron Dam (COOP)	1.84
Stone Lake (RAWS)	1.60
Jicarilla Ranger Station (HCN)	1.47
El Vado Dam (COOP)	1.31
Roosevelt County	Precipitation Total
Melrose Range (RAWS)	5.33
Portales 5.1 SSW (CoCoRaHS)	3.82
Portales (COOP)	3.49
Sandoval County	Precipitation Total
Bandelier National Monument (HCN)	7.93
Los Posos (DRI)	7.33
Redondo (DRI)	7.26
Cochiti Dam (COOP)	6.83
Valles Caldera (CRN)	6.67
Valles Headquarters (DRI)	6.57
Tower (RAWS)	6.48
Valle Toledo (DRI)	5.18
San Antonio (DRI)	4.59
Rio Rancho 3.3 ENE (CoCoRaHS)	4.52
Rio Rancho 2.2 SSE (CoCoRaHS)	4.52

Rio Rancho 2.1 ENE (CoCoRaHS)	4.42
Rio Rancho 2.5 S (CoCoRaHS)	4.41
Rio Rancho 5.6 NE (CoCoRaHS)	4.19
Rio Rancho 5.8 NNW (CoCoRaHS)	4.11
Rio Rancho (COOP#1)	3.93
Placitas 2.1 SE (CoCoRaHS)	3.91
Rio Rancho (COOP#2)	3.89
Jemez Dam (COOP)	3.85
Sandia Lakes (RAWS)	3.33
Jemez Springs (DRI)	3.21
Corrales (COOP)	2.67
Cuba (RAWS)	1.76
San Juan County	Precipitation Total
Aztec Ruins (COOP)	2.68
Bloomfield 4.1 SW (CoCoRaHS)	2.34
Farmington 3.4 WSW (CoCoRaHS)	2.33
Farmington (COOP)	2.26
Farmington 0.6 NNW (CoCoRaHS)	2.18
Farmington Airport (ASOS)	2.02
Farmington 10.1 N (CoCoRaHS)	1.78
Albino Canyon (RAWS)	1.71
Bloomfield 3 SE (COOP)	1.18
Narbona Pass (RAWS)	1.10
Chaco Culture Center (HCN)	1.04
San Miguel County	Precipitation Total
Las Vegas 8.4 NW (CoCoRaHS)	9.78
Las Vegas 12.1 W (CoCoRaHS)	9.74
Las Vegas 10.3 N (CoCoRaHS)	9.27
Las Vegas 4.6 SSW (CoCoRaHS)	8.10
Las Vegas 2.6 SE (CoCoRaHS)	7.49
Rociada 5.6 E (CoCoRaHS)	7.04
Pecos (RAWS)	6.45
Sapello 5.1 WNW (CoCoRaHS)	6.45
Las Vegas Airport (ASOS)	6.24
Mosquero 15 SSE (CoCoRaHS)	4.32
Santa Fe County	Precipitation Total
Edgewood 3.4 NW (CoCoRaHS)	5.23
Edgewood 6.4 N (CoCoRaHS)	4.69
Golden (COOP)	4.84
Pojoaque 1 E (CoCoRaHS)	4.31
Santa Fe 7.7 WNW (CoCoRaHS)	4.20
Stanley 4.9 SSE (CoCoRaHS)	4.15
Edgewood 2.1 WNW (CoCoRaHS)	4.12
Lamy 1.3 WNW (CoCoRaHS)	3.88
Cerrillos 4.5 WSW (CoCoRaHS)	3.80
Santa Fe Airport (ASOS)	3.72
Santa Fe 1.1 ENE (CoCoRaHS)	2.98
Tesuque 0.7 SSW (CoCoRaHS)	2.47
Socorro County	Precipitation Total

Socorro 9.9 SSE (CoCoRaHS)	5.72
Bosque (RAWS)	4.62
Magdalena (RAWS)	4.42
Socorro Airport (AWOS)	4.17
Gran Quivira (COOP)	3.86
Lemitar 0.7 NNE (CoCoRaHS)	3.50
Sevilleta (RAWS)	3.49
Chupadera (RAWS)	3.41
Polvadera 0.5 S (CoCoRaHS)	3.09
Bernardo (COOP)	2.83
Taos County	Precipitation Total
Valdez 1.5 NNW	3.75
Taos 11.2 E	3.60
Taos 1.6 SSE	3.15
Ranchos de Taos 2.4 W	3.15
Taos Pueblo 2.8 NW	3.00
Taos 1.5 ENE	2.93
Taos 0.4 SSW	2.90
Taos 4.3 NNW	2.85
Questa 2.2 NNE	2.62
Red River	2.44
Wild Rivers	2.21
Taos Airport	2.10
Torrance County	Precipitation Total
McIntosh 4.1 SW	6.72
Mountainair 6 NW	5.45
Moriarty 4.3 E	4.47
Moriarty 1 NE	4.40
Mountainair 1 S	3.68
Clines Corners	2.60
Union County	Precipitation Total
Pasamonte (COOP)	5.37
Clayton 3 ENE (HCN)	3.99
Clayton (ASOS)	3.81
Capulin (COOP)	3.15
Capulin Volcano (HCN)	2.83
Valencia County	Precipitation Total
Belen 9.3 SE (CoCoRaHS)	2.59
Bosque Farms 1 N (CoCoRaHS)	2.48
Los Lunas 3.5 E (CoCoRaHS)	2.45
Belen 5.1 SSE (CoCoRaHS)	2.36
Belen 1 NE (CoCoRaHS)	2.01
Los Lunas 3 SSW (COOP)	1.94
Belen Airport (AWOS)	1.56

National Weather Service Santa Teresa-El Paso

Text from Southwest Weather Bulletin, Fall-Winter 2013-2014 Edition

Available online at: http://www.srh.noaa.gov/images/epz/swww/swwb2013b.pdf, accessed 16 September 2014

September 9-12: A large trough of low pressure to the west generated deep southerly winds across New Mexico and western Texas with the transport of very moist unstable air. As a result, showers and thunderstorms with torrential rainfalls deluged much of the region producing devastating flooding over some locations. The governor of New Mexico would declare a State of Emergency as the high water levels brought widespread damage and disruptions to the region.

September 9: Serious street flooding was reported from downtown Silver City to Pinos Altos as 1 to 2 inches of rain fell across the area.

September 10: Widespread thunderstorms with heavy rains moved across southern New Mexico and west Texas. Grant County was hardest hit as 3.5 inches of rain fell near Tyrone with around 1 to 2 inches falling elsewhere. Almost 2 inches of rain also fell at Santa Teresa in Dona Ana County.

September 11: Showers and thunderstorms continued with heaviest rains falling over Hudspeth, El Paso and Dona Ana counties. Up to 7 inches of rain fell around Dell City flooding the Salt Flats. Almost 4 inches of rain also fell at Fort Hancock with 3.3 inches at Horizon City and 2.3 inches at Socorro. Heavy rains flooded Vado forcing some people to evacuate a trailer park. Flash flooding was reported around the East Mesa portion of Las Cruces where 1 to 2 inches of rain fell.

September 12-13: An extremely active period as heavy rains caused severe and widespread flooding from the morning of the 12th to the morning of the 13th. Over 4 inches of rain fell across portions of El Paso flooding roads and homes over portions of the city and causing a car to overturn. The flooding and heavy rains caused rock slides which closed Trans Mountain Road and floodwaters forced the closure of Interstate 10. The rains also caused an electrical explosion and fire in downtown El Paso.

Meanwhile almost 4 inches of rain fell at Horizon City TX causing flooding here and at Loma Linda while over Tornillo water levels were up to the hoods of cars. Homes and neighborhoods flooded in Socorro TX with at least 15 families having to be evacuated. In San Elizario TX serious flooding damaged the historic Old County Jail and La Portales Museum along with some homes.

In southern New Mexico, 2 day rain totals of around 3 to 4 inches caused widespread home flooding and evacuations in southern Dona Ana County with many roads washed out and utility outages occurring. La Union suffered severe damage after an earthen dam was breached causing massive flooding in the community as the high waters inundated homes and streets.

Further north 3 to 4 inches of rain fell across Sierra County including the Truth or Consequences vicinity. The heavy rains caused Palomas and Animas Creeks to overflow and as a result about

200 households had to be evacuated as homes and roads flooded. In addition the floods washed out bridges including those across Highway 187. A dike broke near King Canyon further exacerbating the flooding and water damage.

Tragically a motorist drowned when floodwaters swept his vehicle off highway 54 in Ash Canyon.

September 14: Heavy rains to the north combined with a log jam and debris to cause the west fork of the Gila River to overflow and flood Gila Hot Springs. Water rescues were necessary as a few dwellings and roads were washed out.

September 15: Over 5 inches of rain fell around the Cloudcroft vicinity resulting in severe flooding of area roads. Highway 144 at Silver Lake was closed as the water levels reached depths of 5 to 6 feet. Highways 82 and 130 were also closed from the flooding. The floodwaters pushed over utility poles and trees and damaged several buildings.

September 16: Thunderstorms with heavy rains caused street flooding around Alamogordo and Boles Acres. Highway 82 also flooded.

September 17: Two inches of rain fell in an hour near Sixteen Springs in Otero County. As a result flooding occurred around Sixteen Springs and Walker Canyon with evacuations

Appendix 2 - USGS Report and Data

Peak streamflow for floods of September, 2013, New Mexico and Southeastern Colorado Administrative Report prepared by the U.S. Geological Survey for the U.S. Army Corps of Engineers

By Anne Marie Matherne
19 September 2014

1.0 Introduction

Rainfall associated with a persistent, relatively stationary low pressure system during September 10–18, 2013, followed by severe thunderstorms on September 18–22, brought record and near-record precipitation to Colorado and New Mexico in what was termed a "historic rainfall event" (National Weather Service, 2013). Fort Stanton, Colorado, recorded 12 inches of rain in 24 hours on September 12–13, a historic record for Colorado (William Payne, USGS Colorado Water Science Center, 2014, oral communication.). Rainfall in New Mexico, focused primarily in the central and south-central portions of the state during September 9–16, had an annual exceedance probability for the worst case 7-day rainfall of 0.1–0.2 percent in some locations (National Weather Service, 2013). In Colorado, the Federal disaster declaration included 18 counties and an estimated $245 million in Federal disaster aid (Federal Emergency Management Agency, 2013a). In New Mexico, the Federal disaster declaration included 22 counties, four cities and towns, and four tribal lands (Federal Emergency Management Agency, 2013b). Reservoirs downstream of some of the affected areas in Colorado and New Mexico served to capture and retain a portion of the floodwaters generated by the September 2013 rains, limiting the extent of flood damage and conserving floodwaters for subsequent beneficial use.

Record or near-record high flows occurred at streamgage locations in parts of New Mexico and southeastern Colorado in conjunction with the persistent monsoonal rains and thunderstorms in September 2013. Documenting and determining the magnitude and frequency of peak flows along affected river reaches are needed to provide a synoptic picture of the streamflow response to this historic rainfall event. Data provided in this report will support a U.S. Army Corps of Engineers (USACE) report documenting the capacity of reservoirs to effectively accommodate upstream floodwaters.

2.0 Objectives and Scope

This report presents peak flows and the exceedance probability of those flows for selected U.S. Geological Survey (USGS) streamgages in New Mexico and southeastern Colorado, areas included in the USACE Albuquerque District Area of Operations, for the September 2013 floods. Data are grouped by major river basin and include mainstem and contributing basins where a flood response was identified.

3.0 Methods

Streamgages were selected from the USGS streamgaging network to represent flood response to the September, 2013 storms from each major river basin in New Mexico and including three streamgages near Colorado Springs, Colorado. Date and time of peak flow, peak flood stage, and peak discharge are reported for each streamgage, and, where possible, the annual exceedance probability (AEP) for the peak discharge. Data for a total of 58 streamgages are reported, with AEPs determined for 46.

3.1 Determination of Stage and Discharge for Flood Peaks

Peak stage and discharge for the September, 2013 floods was determined either directly or indirectly, depending on conditions at the streamgage. For many streamgages, peak stage and discharge could be determined directly based on established stage-discharge relations at that location. In this case, data was collected, analyzed, and approved following standard USGS methods for surface water records (Rantz and others, 1982). Records are archived in the USGS National Water Information System (NWIS) data base and are publically available at http://waterdata.usgs.gov/nwis.

At locations where it was necessary to determine peak stage and discharge by indirect methods, high-water marks were flagged as soon as possible following the floods in September 2013. These sites were surveyed by teams of hydrographers from the USGS Colorado, New Mexico, and Arizona Water Science Centers (WSCs) and the survey data used to establish peak discharge by indirect hydraulic methods (Benson and Dalrymple, 1967). Peak-flood discharge was estimated using the Slope-Area Method (Dalrymple and Benson, 1967; Fulford, 1994; Bradley, 2012). All discharge estimations were reviewed and verified by the New Mexico WSC Surface Water Specialist or other approving official, and archived in the National Water Information Center (NWIS) data base (http://nwis.waterdata.usgs.gov/nwis), as part of the systematic record for that streamgage. Analyses and reports associated with the indirect discharge determinations are archived in the New Mexico WSC Data Archive.

3.2 Determination of Exceedance Probability for Flood Peaks

The annual exceedance probability (AEP) for a particular streamflow is the probability of that streamflow being equaled or exceeded in any given year. AEPs were estimated using the USGS program PeakFQ (http://water.usgs.gov/software/PeakFQ/) (Flynn and others, 2006). The program PeakFQ performs statistical flood-frequency analyses of annual-maximum peak flows following procedures recommended in Bulletin 17B of the Interagency Advisory Committee on Water Data (1982). The Bulletin 17B procedures treat the occurrence of flooding at a site as a sequence of annual random events or trials. The magnitudes of the annual events are assumed to be independent random variables following a log-Pearson Type III probability distribution. This distribution defines the probability that any single annual peak will exceed a specified streamflow. The program PeakFQ estimates the parameters of the log-Pearson Type III frequency distribution from the logarithmic sample moments (mean, standard deviation, and coefficient of skewness) of the record of annual flows, with adjustments for low outliers, high outliers, historic peaks, and generalized peak skew. The generalized peak skew coefficient for New Mexico (Waltemeyer, 1996) and southeastern Colorado (Vaill, 1999) has been established as zero. The parameter values are used to calculate the percentage points (or quantiles) of the log-Pearson Type III distribution for selected exceedance probabilities. No estimate of exceedance probability was made at locations with less than 10 years of peak flow data.

Flooding also occurred in some localities in New Mexico in July 2013 and, in some cases, the flood peak associated with the September floods was not the annual maximum. In this case, an exceedance probability would be estimated for the September peak using a partial-duration flood series and not the annual-maximum series (Dunne and Leopold, 1978). The exceedance probability estimated from the partial-duration series is the probability of occurrence of a flood of a given magnitude irrespective of its relation to the year, whereas an estimate from the annual-maximum series is the probability of occurrence of a flood of a given magnitude as an annual maximum. The differences between the partial-duration and the annual-maximum series are negligible for probabilities greater than 10 percent (Dunne and Leopold, 1978), and exceedance probabilities for these higher-magnitude September flood peaks were interpolated using the annual-maximum distribution derived from peakFQ, following methods in Office of Surface Water Technical Memorandum 2013.01(SW 2013.01) (Mason, 2012). Upper and lower confidence limits for all exceedance probabilities were calculated based on the 66.7 percent confidence level, following guidance in SW 2013.01. Results of the peakFQ analyses used to establish exceedance probabilities for the September floods are archived in the New Mexico WSC Project files.

Large-scale wildfires in parts of New Mexico in recent years, such as the Whitewater-Baldy Complex in the Gila National Forest, 2012, have altered affected watersheds in ways that increase erosion and runoff potential (Tillery and others, 2012). Because of the change in watershed conditions following the wildfire, the streamflow record prior to the wildfire is not appropriate for estimating an exceedance probability for the 2013 flood peaks. The postwildfire period of record is of insufficient duration to support a flood frequency estimate, so no exceedance probability was estimated for wildfire affected flood peaks. In addition, no exceedance probability could be estimated at streamgages with generally regulated flow because there were insufficient data for floods under unregulated, "run-of-the-river" conditions to support a flood frequency estimate.

4.0 Flood Peaks at Selected USGS Streamgages for September 2013 Floods in Southeastern Colorado and New Mexico

Table 2-1 summarizes the date and time of flood peaks associated with the September 2013 floods for 58 streamgages in seven major river basins in New Mexico and southeastern Colorado. Peak discharge is reported, in cubic feet per second, and the exceedance probability of the peak flood, in percent, is estimated where possible given the peak discharge record for each streamgage. For eight of the flood peaks for which exceedances are estimated, the September 2013 peak represents the maximum peak for the period of record for that streamgage. Figures 1–6 show flooding or the effects of flooding in the vicinity of four streamgages for which peak flows are reported.

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Figure 1: Pecos River below Cañon del Uta (08382600) staff gage, September, 2013. (Photograph by M. Carlson.)

Figure 2: Pecos River upstream from the streamgage at Cañon del Uta. *A,* September 2013. *B,* October, 2013. (Photographs by M. Carlson.)

Figure 3: Pecos River above Santa Rosa Lake (08382650) showing affects of overbank flooding on riparian vegetation, September, 2013. (Photograph by M. Carlson.)

Figure 4: Pecos River near Puerto de Luna (08383500), September, 2013. Survey rod marks location of high-water mark. Pecos River is to the left in the photograph. (Photograph by M. Carlson.)

Figure 5. Rio Puerco near Bernardo (08353000), September 16, 2013. Flood peak occurred near midnight. Submerged gage house is seen in center of photograph. (Photograph by J. Cederberg).

Figure 6: Rio Felix at Old Highway Bridge near Hagerman, NM (08394500), September 12, 2013. (Photograph by A. McGlone.)

Figure 7. Rio Puerco near Pecos (08378500), September 13, 2013. (Photograph by J. Cederberg).

Table 1. Discharge, in cubic feet per second, and exceedance probability, in percent, of flood peaks at selected USGS streamgages for the September 2013 floods in southeastern Colorado and New Mexico.

[USGS, U.S. Geological Survey; N, north; W, west; CO, Colorado; °, degree; ', minutes; ", seconds; NM, New Mexico; CL, confidence limits are upper and lower nonparametric annual exceedance probability confidence limits for the 66.7-percent level; Comment codes - D - discharge affected by regulation or diversion, E - estimate based on records at contiguous streamgages, F - discharge affected by fire, I - indirect discharge measurement, N - record of insufficient length for exceedance calculation, P - gage height not maximum for year; where more than one flood peak of the same magnitude was recorded or the peak magnitude continued over a period of time, multiple peak times or an interval of time are listed.]

USGS Station Id. Number	Station Name	Latitude (N)	Longitude (W)	Drainage Basin, in square miles	Date	Time	Discharge (cfs)	Period of Un-affected record (years)	Exceedance Probability (%)	Lower CL (%)	Upper CL (%)	Comments
Arkansas Basin (Fountain Creek)												
07105490	Cheyenne Creek At Evans Ave. at Colorado Springs, CO	38°47'26"	104°51'49"	22	9/12/2013	23:30	1,470	22	4.4	0.8	7.8	M
07105940	Little Fountain Creek near Fountain, CO	38°38'33.54"	104°44'54.18"	27	9/12/2013	21:15	2,810	12	7.7	1.5	14	M
07105945	Rock Creek above Fort Carson Reservation, CO	38°42'27 "	104°50'46"	7	9/12/2013	20:10	805	35	2.8	0.5	5.0	M
Canadian River Basin												
07203000	Vermejo River near Dawson, NM	36°40'51.7"	104°47'11.02"	301	9/1/2013	17:15	137	84	94	3.6	30	
07208500	Rayado Creek near Cimarron, NM	36°22'20.44"	104°58'09.44"	65	9/13/2013	14:45	83	91	73	0.6	6	
07211500	Canadian River near Taylor Springs, NM	36°17'51.25"	104°29'43.70"	2,850	9/2/2013 9/13/2013	1:00- 1:15 4:15	1,310	72	92	3.0	26	P
07215500	Mora River at La Cueva, NM	35°56'42.42"	105°15'20.64"	174	9/13/2013	23:45	240	80	79	1.1	10	
07216500	Mora River near Golondrinas, NM	35°53'27.14"	105°09'49.03"	267	9/15/2013	5:45	333	87	83	1.2	11	

USGS Station Id. Number	Station Name	Latitude (N)	Longitude (W)	Drainage Basin, in square miles	Date	Time	Discharge (cfs)	Period of Un-affected record (years)	Exceedance Probability (%)	Lower CL (%)	Upper CL (%)	Comments
07218000	Coyote Creek near Golondrinas, NM	35°54'59.48"	105°09'50.70"	215	9/13/2013	20:15	1,720	85	16	0.3	2.5	
07221500	Canadian River near Sanchez, NM	35°39'17.4"	104°22'43"	6,015	9/16/2013	3:15	10,000	79	33	0.7	6.6	E
Rio Grande Basin												
08252500	Costilla Creek above Costilla Dam, NM	36°53'54.1"	105°15'16.8"	25	9/3/2013	15:20	33	75	78	1.1	10	
08253000	Casias Creek near Costilla, NM	36°53'48.68"	105°15'37.65"	17	9/22/2013	23:15-23:45	26	77	90	2.3	20	
08253500	Santistevan Creek near Costilla, NM	36°53'03"	105°16'52"	2	9/2/2013	16:15	9	75	46	0.4	4.3	
08266820	Red River below Fish Hatchery, near Questa, NM	36°40'58.22"	105°39'14.84"	185	9/14/2013	14:00	140	35	86	3.6	30	
08267500	Rio Hondo near Valdez, NM	36°32'30.47"	105°33'23.48"	36	9/23/2013	0:00	65	77	89	1.6	15	P
08269000	Rio Pueblo De Taos near Taos, NM	36°26'22"	105°30'13"	67	9/13/2013	19:00-2045	37	79	91	1.4	23	
08271000	Rio Lucero near Arroyo Seco, NM	36°30'29.84"	105°31'51.47"	17	9/15/2013	4:45-6:15	53	85	85	1.4	13	E
08275500	Rio Grande Del Rancho near Talpa, NM	36°18'11.17"	105°34'51.61"	83	9/22/2013	20:15, 22:15-23:00	27	57	92	3.6	30	P
08277470	Rio Pueblo near Penasco, NM	36°10'06.48"	105°36'10.04"	101	9/16/2013	2:00, 2:45-3:00	173	22	78	3.6	30	E
08279000	Embudo Creek at Dixon, NM	36°12'39.08"	105°54'49.07"	305	9/22/2013	20:15	479	75	80	2.6	23	
08284100	Rio Chama near La Puente, NM	36°39'45.57"	106°38'00.12"	480	9/18/2013	13:00	539	58	98	8.7	59	P
08291000	Santa Cruz River near Cundiyo, NM	35°57'53"	105°54'17"	86	9/15/2013	7:00	648	83	20	0.3	2.6	

USGS Station Id. Number	Station Name	Latitude (N)	Longitude (W)	Drainage Basin, in square miles	Date	Time	Discharge (cfs)	Period of Un-affected record (years)	Exceedance Probability (%)	Lower CL (%)	Upper CL (%)	Comments
08324000	Jemez River near Jemez, NM	35°39'43.14"	106°44'36.38"	470	9/13/2013	7:30-7:45	1,010	68	58	0.8	7.2	
08353000	Rio Puerco near Bernardo, NM	34°24'37"	106°51'16"	7,350	9/15/2013	22:30	9,020	74	9.3	0.3	2.6	
Pecos River Basin												
08377900	Rio Mora near Terrero, NM	35°46'37.61"	105°39'28.90"	53	9/13/2013	9:45	713	50	10	3.6	30	
08378500	Pecos River near Pecos, NM	35°42'30.06"	105°40'57.73"	189	9/13/2013	11:15-11:30	2,290	89	3.3	0.2	2.0	F
08379500	Pecos River near Anton Chico, NM	35°10'43.21"	105°06'31.69"	1,050	9/17/2013	--	9,000	93	28	0.3	2.6	E
08380500	Gallinas Creek near Montezuma, NM	35°39'07.18"	105°19'07.79"	84	9/12/2013	--	3,610	97	8.2	0.2	2.0	I
08382000	Gallinas River near Lourdes, NM	35°28'08.05"	105°09'41.19"	313	9/14/2013	21:50	8,860	19	5.0	1.0	9.0	M
08382500	Gallinas River near Colonias, NM	35°10'55.06"	104°54'00.96"	610	9/17/2013	5:45	22,000	62	1.6	0.3	2.8	I, M
08382600	Pecos River above Canon Del Uta near Colonias, NM	35°05'29"	104°48'02"	2,330	9/17/2013	9:45	30,800	38	2.6	0.5	4.6	M
08382650	Pecos River above Santa Rosa Lake, NM	35°03'34"	104°45'40"	2,340	9/17/2013	--	28,000	37	2.6	0.5	4.7	E, M
08383500	Pecos River near Puerto de Luna, NM	34°43'48.3"	104°31'29.68"	3,970	9/11/2013	18:40	21,000	42				D, I
08386505	Rio Ruidoso at Ruidoso, NM	33°20'11.51"	105°43'34.71"	18	9/13/2013	16:45	192	13				F
08387000	Rio Ruidoso at Hollywood, NM	33°19'36.09"	105°37'31.20"	120	9/13/2013	21:00	191	59	52	0.6	6.0	

USGS Station Id. Number	Station Name	Latitude (N)	Longitude (W)	Drainage Basin, in square miles	Date	Time	Discharge (cfs)	Period of Un-affected record (years)	Exceedance Probability (%)	Lower CL (%)	Upper CL (%)	Comments
08390020	Rio Hondo above Chavez Canyon near Hondo, NM	33°22'16.5"	105°15'26.6"	588	9/14/2013	1:30	595	2				N, F
08390500	Rio Hondo at Diamond A Ranch near Roswell, NM	33°20'57"	104°51'06"	947	9/11/2013	9:30	29,500	69				D
08390800	Rio Hondo below Diamond A Dam near Roswell, NM	33°17'59.53"	104°43'18.03"	963	9/20/2013	12:45	275	0				D
08393610	Rio Hondo near Roswell, NM	33°24'31.59"	104°28'18.18"	2,900	9/12/2013	12:15	1,920	0				N, D
08394500	Rio Felix at Old Highway Bridge near Hagerman, NM	33°07'30"	104°20'40"	932	9/12/2013	--	14,300	57	21	0.4	3.8	I
08397620	Rio Penasco near Hope, NM	32°50'12.38	105°04'09.92"	675	9/15/2013	21:30	7,010	8				N
08398500	Rio Penasco at Dayton, NM	32°44'36.41"	104°24'50.87"	1,060	9/14/2013	--	1,340	58	42	0.5	5.1	
08401200	South Seven Rivers near Lakewood, NM	32°35'19"	104°25'17"	220	9/11/2013	--	22,600	45	4.4	0.4	3.9	I
08401900	Rocky Arroyo at Highway Bridge nr Carlsbad, NM	32°30'21.89"	104°22'29.96"	285	9/11/2013	--	29,700	46	4.3	0.4	3.9	I
08405500	Black River above Malaga, NM	32°13'44.72"	104°09'06.67"	343	9/12/2013	22:00	2,800	66	37	0.4	4.2	
08406000	Black River at Malaga, NM	32°14'27.12"	104°03'52.87"	350	9/13/2013	0:15	2,120	10	9.1	1.8	16	M
08408500	Delaware River near Red Bluff, NM	32°01'23.31"	104°03'16.04"	689	9/12/2013	--	23,000	74	9.3	0.3	2.6	I

USGS Station Id. Number	Station Name	Latitude (N)	Longitude (W)	Drainage Basin, in square miles	Date	Time	Discharge (cfs)	Period of Un-affected record (years)	Exceedance Probability (%)	Lower CL (%)	Upper CL (%)	Comments
Tularosa Basin												
08481500	Tularosa Creek near Bent, NM	33°08'41.6"	105°53'52.45"	120	9/2/2013	14:45	106	61	93	3.6	30	P
San Juan River Basin												
09363500	Animas River near Cedar Hill, NM	37°02'11.65"	107°52'31.2"	1,090	9/22/2013	18:30	3,520	79	85	1.5	14	
09364010	Animas River below Aztec, NM	36°49'04.3"	108°01'28.0"	1,301	9/12/2013	23:00	5,480	10	55	3.6	30	
09364500	Animas River at Farmington, NM	36°43'21.00"	108°12'06.30"	1,360	9/13/2013	2:00	5,560	99	53	0.4	3.7	
09386950	Zuni River above Black Rock Reservoir, NM	35°06'01"	108°45'06"	848	9/16/2013	18:45	495	6	70	0.5	5.1	P
Gila River Basin												
09430500	Gila River near Gila, NM	33°03'41.41"	108°32'14.59"	1,864	9/15/2013	19:30	28,800	85				F
09430600	Mogollon Creek near Cliff, NM	33°10'00"	108°38'59"	69	9/16/2013	--	5,000	42				F
09431500	Gila River near Red Rock, NM	32°43'37"	108°40'32"	2,829	9/16/2013	6:15	12,000	77				F
09432000	Gila River below Blue Creek near Virden, NM	32°38'53"	108°50'43"	3,203	9/16/2013	11:30	11,200	87	18	0.3	2.5	
09442680	San Francisco River near Reserve, NM	33°44'12.19"	108°46'16.23"	350	9/14/2013	7:30	960	53				F
09444000	San Francisco River near Glenwood, NM	33°14'49.8"	108°52'48.0"	1,653	9/15/2013	2:00	29,900	84				F

Appendix 3 - Federal Disaster Declarations and FEMA Damages

Complete FEMA damages estimates were not available at the time of report publication. However, the following table represents Public Assistance funds obligated by FEMA as of 11 August 2014 totaling $437,320.07 for FEMA-4151-DR Santa Clara Pueblo (Table A3-1) and totaling $29,084,452.68 for FEMA-4152-DR New Mexico (Table A3-2). These are detailed in the table, below, retrieved from http://www.fema.gov/media-library/assets/documents/28331, accessed 16 September 2014.

Table A3-1 - FEMA Damages Awarded Under FEMA-4151-DR Santa Clara Pueblo as of 11 August 2014.

Project Title	Damage Category	Project Amount	Federal Share Obligated
SCP020A Debris Removal - Large Tree	A - Debris Removal	$12,580.00	$9,435.00
SCP001A Debris Removal- Irrigation Diversion System	A - Debris Removal	$17,750.01	$13,312.51
SCP003B EPM Ditch Clearing	B - Protective Measures	$18,705.00	$14,028.75
SCP002D Canyon Irrigation Diversion System	D - Water Control Facilities	$107,535.00	$80,651.25
SCP001B EPM Jersey Barriers Upstream of Kee St Bridge	B - Protective Measures	$17,746.61	$13,309.96
SCP003D Ditch Repair	D - Water Control Facilities	$2,831.88	$2,123.91
SCP021A Debris Removal - Skate Park	A - Debris Removal	$2,080.00	$1,560.00
SCP001G Skate Park Walking Trail and Embankment Scourin	G - Recreational or Other	$9,768.30	$7,326.23
SCP004B EPM Ditch Clearing Old San I	B - Protective Measures	$9,902.75	$7,427.06
SCP004D Ditch Repair (Dasheno, Rio Grande, Culverts)	D - Water Control Facilities	$86,663.49	$64,997.62
SCP002F Electrical Utility Equipment	F - Public Utilities	$29,714.77	$22,286.08
SCP003C Canyon Culverts	C - Roads & Bridges	$69,800.00	$52,350.00
SCP002C Village Road Repairs	C - Roads & Bridges	$5,390.55	$4,042.91
324 Management Cost	Z - State Management	$13,047.00	$13,047.00
SCP005B EPM Reservation Wide	B - Protective Measures	$26,594.21	$19,945.66
SCP006B Emergency Temporary Canyon Road	B - Protective Measures	$148,634.84	$111,476.13

Table A3-2 – FEMA Damages Awarded Under FEMA-4152-DR New Mexico as of 11 August 2014.

Project Title	Damage Category	Project Amount	Federal Share Obligated
GRC002C Grants George Hanosh Blvd Bridge	C - Roads & Bridges	$6,915.61	$5,186.71
VOM001F Milan Water Well Repairs	F - Public Utilities	$9,763.98	$7,322.99
CIC003B Bluewater Village & countywide sandbagging	B - Protective Measures	$10,977.71	$8,233.28
SDP001A - Debris Removal (Irrigation Ditch)	A - Debris Removal	$256,227.86	$192,170.90
MKC002B McKinley County Haystack Rd Emergency Repairs	B - Protective Measures	$5,664.54	$4,248.41
MKC001A McKinley County Sand/Silt Debris	A - Debris Removal	$1,355.12	$1,016.34

Project Title	Damage Category	Project Amount	Federal Share Obligated
Removal Count			
VOM 005A Sandbags and Berm cleanup	A - Debris Removal	$4,072.42	$3,054.32
LAC001C Pueblo Canyon low crossing and road	C - Roads & Bridges	$15,530.06	$11,647.55
LUW001F La Union Water Distribution Line	F - Public Utilities	$12,313.73	$9,235.30
CHC001C - MULTIPLE SITES	C - Roads & Bridges	$233,809.10	$175,356.83
BDW006F Bluewater Acres Domestic Water Users utility	F - Public Utilities	$7,472.28	$5,604.21
BDW007C Bluewater Acres gravel roads & culvert damages	C - Roads & Bridges	$16,888.05	$12,666.04
MKC003C McKinley County Lori Gravel and Road Embankment	C - Roads & Bridges	$3,653.15	$2,739.86
MKC004C McKinley County - Charlotte Drive Ditch Repair	C - Roads & Bridges	$4,405.60	$3,304.20
MKC005C McKinley County Jerry Drive Culvert-Ditch Repair	C - Roads & Bridges	$2,110.93	$1,583.20
MKC006C McKinley County Haystack Drive Repair	C - Roads & Bridges	$14,070.62	$10,552.97
MKC007C McKinley County Ronnie Drive Repair	C - Roads & Bridges	$2,846.28	$2,134.71
MKC008C McKinley County Woodview Drive Repair	C - Roads & Bridges	$7,316.36	$5,487.27
MKC009C McKinley County Rd27 1 Culvert Repair	C - Roads & Bridges	$8,062.79	$6,047.09
RAC002B sand bags	B - Protective Measures	$3,480.00	$2,610.00
RGW001E Lower Rio Grande WA Burnio Building Damage	E - Public Buildings	$9,034.59	$6,775.94
COR001C - Road Surface & Sewer Line	C - Roads & Bridges	$81,727.48	$61,295.61
EBC001C Low water crossing washed out	C - Roads & Bridges	$4,555.35	$3,416.51
LNC001C Lincoln County Road Repair	C - Roads & Bridges	$126,212.97	$94,659.73
SIC001C Caballo Rd. Shoulder & Arroyo crossing eroded	C - Roads & Bridges	$5,157.09	$3,867.82
SIC002C Los Palomas Shoulder & Arroyo crossing eroded	C - Roads & Bridges	$5,606.07	$4,204.55
DAC001D- DAM B FAILURE AND ACCESS ROAD	D - Water Control Facilities	$844,162.74	$633,122.06
MKC011C McKinley County Rd27 - Ditch Washout Site 9	C - Roads & Bridges	$17,813.20	$13,359.90
CHC002C - Shoshonie Road	C - Roads & Bridges	$15,963.54	$11,972.66
CIC008C- Road Damages	C - Roads & Bridges	$89,474.89	$67,106.17
CIC004C Cibola County Roads	C - Roads & Bridges	$124,139.52	$93,104.64
LNC001B Lincoln County Cat B	B - Protective Measures	$3,236.17	$2,427.13
MKC014C McKinley County Rd15 - Backfill / Clean Culvert	C - Roads & Bridges	$6,920.21	$5,190.16
AFD001B Emergency Protective Measures	B - Protective Measures	$2,705.63	$2,029.22
AFD002B Emergency Protective Measures	B - Protective Measures	$3,090.00	$676.41
CHC003C- Country Club Road	C - Roads & Bridges	$40,165.38	$30,124.04
TRC001C - Road/Culvert Washouts - 8 sites - PAAP Fixed	C - Roads & Bridges	$98,180.66	$73,635.50
MKC030C McKinley County Rd 37 - Shape &	C - Roads & Bridges	$1,167.06	$875.30

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
grade			
MKC031C McKinley County Rd 140 - Shape & grade	C - Roads & Bridges	$1,824.74	$1,368.56
CHC005B - EPM Equipment Only	B - Protective Measures	$2,659.61	$1,994.71
MKC020C McKinley Brid County Rd27	C - Roads & Bridges	$16,896.54	$12,672.41
DMA001B Emergency Protective Measures	B - Protective Measures	$199,833.58	$149,875.19
HRC001C - Mosquero Canyon Road	C - Roads & Bridges	$3,589.10	$2,691.83
HRC002C Campbell Rd- Road and Shoulder Washout	C - Roads & Bridges	$17,017.76	$12,763.32
CHC004C - Bojax Road	C - Roads & Bridges	$62,646.10	$46,984.58
CCD001D CHILI DITCH LOC 1	D - Water Control Facilities	$8,191.76	$6,143.82
LSD001A LOS SALAZARDITCH	A - Debris Removal	$3,565.00	$2,673.75
RAC003B RIO ARRIBA EOC	B - Protective Measures	$3,774.87	$2,831.15
OTC001C Twin Forks Ranch Estates Subdivison Roads	C - Roads & Bridges	$38,853.25	$29,139.94
MKC032C McKinley County Rd 37 - Shape & Grade Ditch	C - Roads & Bridges	$8,115.95	$6,086.96
MKC028C McKinley Chico Rd - Culvert - backfill	C - Roads & Bridges	$8,130.42	$6,097.82
MKC027C McKinley County Woodview Rd - Replaced Milling	C - Roads & Bridges	$18,788.29	$14,091.22
CHC006B - Donated Resources - Labor only	B - Protective Measures	$521.00	$390.75
TRC002C Bluegrass, Spangler, and Peacock Roads	C - Roads & Bridges	$10,310.72	$7,733.04
LJA001D-Water Control Facilities	D - Water Control Facilities	$25,695.00	$19,271.25
OTC004C Hollywood Blvd & Meadow View Glen	C - Roads & Bridges	$19,252.29	$14,439.22
OTC002C Twin Forks Ranch Units 1-2-3-6 (NE) Subdivison	C - Roads & Bridges	$30,175.66	$22,631.75
OTC003C Twin Forks Ranch Units 1-2-3-6 (NW) Subdivison	C - Roads & Bridges	$29,359.78	$22,019.84
DAC002D Vado Arroyo	D - Water Control Facilities	$131,002.42	$98,251.82
OTC005C Twin Forks Units 7 & 9	C - Roads & Bridges	$67,508.96	$50,631.72
OTC006C James Canyon Estates	C - Roads & Bridges	$16,692.02	$12,519.02
COR002G - 2 Sites - Parks and Recreation Dept. Office	G - Recreational or Other	$43,639.17	$32,729.38
CCD002A CHILI DITCH loc 2	A - Debris Removal	$1,100.50	$825.38
ADV001D DE LOS VIGILES	D - Water Control Facilities	$12,979.90	$9,734.93
HRC003C - Gap Road	C - Roads & Bridges	$22,543.14	$16,907.36
HRC004C Trigg Road Washout	C - Roads & Bridges	$11,223.95	$8,417.96
HRC006C - Dehaven and Lovato Roads	C - Roads & Bridges	$16,032.45	$12,024.34
HRC007C-Rosebud,Emplazado,Laumbach,Lacinta Roads	C - Roads & Bridges	$16,841.70	$12,631.28
ECD001D - El Cerrito Ditch Assoc. Acequia Berm Repair	D - Water Control Facilities	$30,396.40	$22,797.30
FAR001A Debris removal Hood Arroyo FARMINGTON-4152	A - Debris Removal	$243,495.61	$182,621.71

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
FAR010F Farmington Storm Sewer	F - Public Utilities	$830,407.85	$622,805.89
MKC026C McKinley County Old WindMilk - Replaced Milling	C - Roads & Bridges	$15,749.11	$11,811.83
AZC009A Aztec - Museum Debris Removal	A - Debris Removal	$2,184.74	$1,638.56
AZC006F Aztec - Fire Hydrant	F - Public Utilities	$4,521.19	$3,390.89
AZC001D Aztec - Detention Ponds	D - Water Control Facilities	$6,088.21	$4,566.16
ADP002D - Water Facility	D - Water Control Facilities	$4,378.00	$3,283.50
SMC008C - Camp Blue, Jolly Jeep Roads	C - Roads & Bridges	$41,772.10	$31,329.08
AZC010C Aztec - Retaining Walls / Storm Drain	C - Roads & Bridges	$27,956.42	$20,967.32
TRC003C - Road and Culvert Washouts	C - Roads & Bridges	$61,364.34	$46,023.26
AMD001F WATER DISTRICT	F - Public Utilities	$13,492.70	$10,119.53
RRC061G Bank Repair and Stabilization	G - Recreational or Other	$17,483.46	$13,112.60
NO2401B Donated Resources (EMP) - NTU	B - Protective Measures	$10,760.00	$8,070.00
NE0905B EPM Crownpoint VFD Pumping water at dam	B - Protective Measures	$4,378.50	$3,283.88
ADP001A - Debris Removal	A - Debris Removal	$13,646.00	$10,234.50
RRC063F - Public Utilities	F - Public Utilities	$100,790.00	$75,592.50
ATY001C Anthony Sidewalk Repair	C - Roads & Bridges	$4,230.90	$3,173.18
FAR004B Emer Prot Meas	B - Protective Measures	$1,578.95	$1,184.21
FAR001C Arroyo-Culvert Clean Out	C - Roads & Bridges	$372,827.50	$279,620.63
FAR002C Arroyo-Culvert Clean Out - 2	C - Roads & Bridges	$201,433.53	$151,075.15
SIF001D Trujillo Canyon Restore levee	D - Water Control Facilities	$352,664.00	$264,498.00
AZC004C Aztec - Culvert Ash St.	C - Roads & Bridges	$16,218.76	$12,164.07
FAR003E Veh Maint Bldg	E - Public Buildings	$18,755.55	$14,066.66
SIC003C Bridge rail Low water crossing	C - Roads & Bridges	$21,663.32	$16,247.49
SIC004C Berrenda Rd Roadway & Arroyo crossing eroded	C - Roads & Bridges	$39,923.97	$29,942.98
AZC018F Aztec - Sewer Line , Hampton Arroyo	F - Public Utilities	$81,044.75	$60,783.56
CLG001D Holding Tanks Dmge	D - Water Control Facilities	$19,143.74	$14,357.81
FAR002F Storm Drain Lines and Manholes 1	F - Public Utilities	$26,408.95	$19,806.71
MKC018C McKinley Thompson Bridge - Site 11	C - Roads & Bridges	$43,294.87	$32,471.15
MKC015C McKinley County Rd15 - Site 15	C - Roads & Bridges	$28,593.52	$21,445.14
MKC017C McKinley Owl Canyon Rd - Site 10B	C - Roads & Bridges	$26,347.80	$19,760.85
AAN001A ANCON ACEQUIA	A - Debris Removal	$9,660.00	$7,245.00
OTC001B Otero County Emergency Protective Measures	B - Protective Measures	$3,419.37	$2,564.53
AZC003C Aztec - Blanco Ditch Shape & Grade	C - Roads & Bridges	$33,031.89	$24,773.92
AZC002C Aztec - Culvert Crossing #7, N Rio Grande.	C - Roads & Bridges	$16,081.60	$12,061.20
PDC012F - Early Warning System (Flood)	F - Public Utilities	$22,185.50	$16,639.13
PDC013D - Santa Fe River Berm	D - Water Control	$50,363.60	$37,772.70

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
	Facilities		
PDC016C - Road Washout	C - Roads & Bridges	$7,999.62	$5,999.72
PDC006D-Levee (Adjacent to Old Village)	D - Water Control Facilities	$50,194.62	$37,645.97
PDC004D - Diversion Berm #2	D - Water Control Facilities	$74,646.62	$55,984.97
EDC003A - Eddy County - Debris	A - Debris Removal	$4,002.65	$3,001.99
SDP002A - Debris Removal (Sediment from Levee)	A - Debris Removal	$429,490.93	$322,118.20
SDP003D - Water Diversion Berm Repair	D - Water Control Facilities	$28,695.54	$21,521.66
SDP004A - Debris Removal	A - Debris Removal	$256,572.38	$192,429.29
SDP005D - Levee Repairs	D - Water Control Facilities	$48,067.95	$36,050.96
SAP016A - Debris Removal (S. Santa Fe Trail, Bern. Cty)	A - Debris Removal	$10,608.70	$7,956.53
DAC001C- La Union Roads	C - Roads & Bridges	$205,775.46	$154,331.60
FAR003C Pallas, Katherine, and Auburn	C - Roads & Bridges	$152,029.77	$114,022.33
FAR003F Storm Drain Lines and Manholes 2	F - Public Utilities	$3,011.76	$2,258.82
COE001C-Road Washout and Fencing	C - Roads & Bridges	$1,574.04	$1,180.53
OOP001C Ohkay Owingeh - Roads	C - Roads & Bridges	$39,004.95	$29,253.71
CRC001C Catron County Roads District 1	C - Roads & Bridges	$70,660.84	$52,995.63
SPK001A Sunland Park Debris Removal	A - Debris Removal	$20,060.57	$15,045.43
OTC014C ¿ Chippaway Subdivision	C - Roads & Bridges	$18,601.82	$13,951.37
OTC015C ¿ Waterfall East & West Subdivisions	C - Roads & Bridges	$12,212.32	$9,159.24
DAC001B- Emergency Protective Measures	B - Protective Measures	$17,682.07	$13,261.55
OTC001A - Debris Removal (Alternate Procedures)	A - Debris Removal	$7,146.16	$5,359.62
DAC002C- Southern Dona Ana County Road Repairs	C - Roads & Bridges	$18,641.91	$13,981.43
SIC006C El Aquila Shoulder & Arroyo crossing eroded	C - Roads & Bridges	$12,059.02	$9,044.27
OOP002B Ohkay Owingeh - Protective Measures	B - Protective Measures	$9,743.48	$7,307.61
OTC008C ¿ Riata Road	C - Roads & Bridges	$12,641.36	$9,481.02
OTC017C ¿ County Road E001	C - Roads & Bridges	$40,209.99	$30,157.49
OTC012C ¿ Bobwhite Street- Timberon & Virden Road	C - Roads & Bridges	$4,924.10	$3,693.08
SPK001C Sunland Park Road Repair	C - Roads & Bridges	$144,018.68	$108,014.01
ATY001A Anthony Debris Removal	A - Debris Removal	$4,917.68	$3,688.26
NS1901A - Upper Fruitland Chapter - debris removal	A - Debris Removal	$1,490.00	$1,117.50
NO2404B EPM- Sheltering- NTU	B - Protective Measures	$55,477.02	$41,607.77
SPK001G-Sunland Park Sports Complex Repair	G - Recreational or Other	$77,384.87	$58,038.65
LUP002C Seama/New York Road Repairs	C - Roads & Bridges	$2,714.16	$2,035.62
DEP001B - Emergency Protective Measures Brantley Lake	B - Protective Measures	$4,303.87	$3,227.90
DEP002B - Emergency Protective Measures	B - Protective Measures	$1,027.03	$770.27

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
Sumner Lake			
DAC001F- La Union Sewer Line Repair	F - Public Utilities	$3,983.39	$2,987.54
OTC010C Walker Canyon Area Roads	C - Roads & Bridges	$165,564.32	$124,173.24
OTC011C ¿ Pine Mt, Iron Gate & Robin Hood Subdivision	C - Roads & Bridges	$11,600.06	$8,700.05
SPK001B Sunland Park Emergency Protective Measures	B - Protective Measures	$5,129.85	$3,847.39
SJC001C Road Damage	C - Roads & Bridges	$26,921.69	$20,191.27
SIC008B Donated Labor	B - Protective Measures	$5,472.50	$4,104.38
SJC002C Road Damage	C - Roads & Bridges	$23,114.47	$17,335.85
SJC003C Road Damage	C - Roads & Bridges	$104,347.94	$78,260.96
SJC004C Road Damage	C - Roads & Bridges	$226,100.78	$169,575.59
SJC005C Road Damage	C - Roads & Bridges	$138,667.13	$104,000.35
SJC006C Road Damage	C - Roads & Bridges	$24,648.69	$18,486.52
SJC007C Road Damage	C - Roads & Bridges	$56,274.31	$42,205.73
SJC008C Road Damage	C - Roads & Bridges	$53,235.43	$39,926.57
SJC009C Road Damage	C - Roads & Bridges	$6,049.63	$4,537.22
SJC010C Road Damage	C - Roads & Bridges	$2,625.25	$1,968.94
SJC011C Road Damage	C - Roads & Bridges	$61,152.83	$45,864.62
SJC012C Road Damage	C - Roads & Bridges	$7,689.43	$5,767.07
SJC014C Road Damage	C - Roads & Bridges	$16,527.85	$12,395.89
AZC008G Aztec - Hartman Park Fence	G - Recreational or Other	$6,931.88	$5,198.91
AZC011F Aztec - Sabena Waterline	F - Public Utilities	$18,982.40	$14,236.80
AZC013D Aztec - Tiger Reservoir Slope Repair	D - Water Control Facilities	$24,774.06	$18,580.55
AZC005F Aztec - Water Line Repair, Willians Arroyo	F - Public Utilities	$8,150.35	$6,112.76
NE2601B Canoncito Health Clinic	B - Protective Measures	$5,552.25	$4,164.19
RRC024B Emergency Protective Measures	B - Protective Measures	$8,739.46	$6,554.60
RAC008D RETENTION POND	D - Water Control Facilities	$12,759.90	$9,569.93
NE1101C - Iyanbito - Roads & Culvert	C - Roads & Bridges	$2,118.80	$1,589.10
NE1301C - MANUELITO - GRADING ROADS	C - Roads & Bridges	$2,509.50	$1,882.13
NE3001C - Rocksprings Chapter	C - Roads & Bridges	$15,415.66	$11,561.75
OTC016C Russia Canyon & Upper Penasco Areas	C - Roads & Bridges	$104,170.78	$78,128.09
CRC002C Catron County Roads District 2	C - Roads & Bridges	$546,242.63	$409,681.97
CCD003A CHILI DITCH LOC 3	A - Debris Removal	$2,279.70	$1,709.78
OTC007C Chapparral Lp, Star Thistle & Hurshel White	C - Roads & Bridges	$34,546.69	$25,910.02
OTC018C Cornucopia Area Roads	C - Roads & Bridges	$46,449.00	$34,836.75
MRD001A Debris Removal - PAAP Alternative Procedures	A - Debris Removal	$12,103.23	$9,077.42
MRD003D-Siphon and Access Road	D - Water Control Facilities	$83,157.36	$62,368.02

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
NN0701C - NN Dept of Ag - Road and culvert damage	C - Roads & Bridges	$12,877.39	$9,658.04
MAT001C- Road and Gravel Washout	C - Roads & Bridges	$46,257.35	$34,693.01
FAR007C Arroyo-Culvert Clean Out - 5	C - Roads & Bridges	$326,965.84	$245,224.38
FAR004C Hubbard Pond	C - Roads & Bridges	$85,262.61	$63,946.96
NE1001C Huerfano Chapter	C - Roads & Bridges	$3,558.12	$2,668.59
SAC001C - Road and Shoulder Damage	C - Roads & Bridges	$10,573.66	$7,930.25
MAT001B- Emergency Protective Measures	B - Protective Measures	$7,180.18	$5,385.14
SDA001A Storm Ditch Association Debris Removal	A - Debris Removal	$1,457.21	$1,092.91
OOP004D Ohkay Owingeh - Water Control Facilities	D - Water Control Facilities	$16,886.01	$12,664.51
SIF002D Seco creek Restore levee	D - Water Control Facilities	$709,353.00	$532,014.75
SIF003D Cuchillo Creek, Restore levee	D - Water Control Facilities	$970,865.00	$728,148.75
SIF005D Animas Creek	D - Water Control Facilities	$596,939.00	$447,704.25
SIF006D Los Palomas Creek Site 3	D - Water Control Facilities	$1,331,767.00	$998,825.25
SIF007D Alamosa Creek site 1	D - Water Control Facilities	$754,660.00	$565,995.00
SIF004D Cuchillo Creek Site 1	D - Water Control Facilities	$311,475.00	$233,606.25
OTC013C Round Mountain Road	C - Roads & Bridges	$50,420.26	$37,815.20
LMD002A DEBRIS LOS MARTINEZ	A - Debris Removal	$12,263.24	$9,197.43
RRC064F - Utilities	F - Public Utilities	$57,664.08	$43,248.06
LCD001A Acequia De la Conception	A - Debris Removal	$10,502.50	$7,876.88
CRC003C Catron County Roads District 3	C - Roads & Bridges	$214,344.50	$160,758.38
LCDOO2D ACEQUIA DE LA CONCEPTION	D - Water Control Facilities	$47,993.75	$35,995.31
SMC001C - Campus Drive and Sebastian Canyon	C - Roads & Bridges	$29,781.97	$22,336.48
SMC003C - Cinder Rd. Trail-La Liendre-Tecolotito Rd.	C - Roads & Bridges	$42,638.33	$31,978.75
SMC006C - County Road A-20 (Ojitos Frios Rd)	C - Roads & Bridges	$18,156.58	$13,617.44
MOC001C - Roads	C - Roads & Bridges	$21,817.18	$16,362.89
MOC006B -- Emergency Services	B - Protective Measures	$11,795.00	$8,846.25
LTDOO1A Las Tusas	A - Debris Removal	$3,099.63	$2,324.72
LTDOO2D Las Tusas Community Ditch	D - Water Control Facilities	$2,789.58	$2,092.19
SWU001D - Storrie Project Water User's Canal Breach	D - Water Control Facilities	$289,538.55	$217,153.91
LVS001C - West LV High School Access Road Washout	C - Roads & Bridges	$20,840.80	$15,630.60
ALV001D - Damaged Acequia	D - Water Control Facilities	$7,253.43	$5,440.07
ALV002A Acequia Madre	A - Debris Removal	$12,408.34	$9,306.26
RHD001A Debris Removal	A - Debris Removal	$2,019.13	$1,514.35

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
RHD002D Acequia Repair	D - Water Control Facilities	$4,432.60	$3,324.45
CRU001F Camino Real Utility Lift Station #4	F - Public Utilities	$103,274.48	$77,455.86
FAR008C Site 10 - Retaining Wall	C - Roads & Bridges	$24,607.20	$18,455.40
DEP003G Permanant Repair Sumner Lake	G - Recreational or Other	$2,267.66	$1,700.75
DEP004G Santa Rosa Lake State Park - Other	G - Recreational or Other	$2,128.15	$1,596.11
DEP008G Park Damages	G - Recreational or Other	$8,143.95	$6,107.96
DEP007A Elephent Butte Debris	A - Debris Removal	$1,342.69	$1,007.02
OTC009C ¿ 16 Spring Canyon Road	C - Roads & Bridges	$372,737.42	$279,553.07
GCA001A Debris Removal	A - Debris Removal	$2,000.00	$1,500.00
RRC023E Rented Equipment Repairs and Supplies	C - Roads & Bridges	$141,421.21	$106,065.91
ADT009D - Water Facility	D - Water Control Facilities	$8,123.44	$6,092.58
ADT003A - Debris removal	A - Debris Removal	$6,552.90	$4,914.68
SCD005A - Debris Removal	A - Debris Removal	$16,475.00	$12,356.25
SCD006A - Donated Resources	A - Debris Removal	$760.80	$570.60
SCC003B EPM	B - Protective Measures	$7,549.00	$5,661.75
AZC016C Aztec - Crossing #6- Blanco Ditch	C - Roads & Bridges	$6,701.88	$5,026.41
AZC007F Aztec - Electric Pole, Sabena St.	F - Public Utilities	$1,896.45	$1,422.34
AZC012C Aztec - Aztec Crossing #5, Culvert Hampton Arro	C - Roads & Bridges	$3,345.19	$2,508.89
AZC014C Aztec - Martinez Lane	C - Roads & Bridges	$14,419.18	$10,814.39
AZC015G Aztec - Hartman Park Gabion	G - Recreational or Other	$8,667.13	$6,500.35
OOP003A Ohkay Owingeh - Debris	A - Debris Removal	$9,959.16	$7,469.37
CVA001A ditch, debris	A - Debris Removal	$2,554.00	$1,915.50
SIC005B Countywide	B - Protective Measures	$20,487.18	$15,365.39
SIC007C Apache Gap	C - Roads & Bridges	$7,964.73	$5,973.55
SMC007C - County Roads CRA - A20; A19; A18	C - Roads & Bridges	$29,469.19	$22,101.89
ADA001D 4 Irrigation dtiches	D - Water Control Facilities	$6,198.53	$4,648.90
DEP006B Elephant Emergency Measures	B - Protective Measures	$10,964.81	$8,223.61
SCD008D - Water Facilities	D - Water Control Facilities	$1,277.50	$958.13
CRC004B Donated Labor	B - Protective Measures	$12,351.92	$2,852.28
NE0502C - Casamero Lake Chapter Roads	C - Roads & Bridges	$11,296.64	$8,472.48
NE1901B - Pinedale Chapter	B - Protective Measures	$1,545.12	$1,158.84
NE0501C - Casamero Lake Chapter Roads	C - Roads & Bridges	$6,675.92	$5,006.94
NS1803C Toadlena/Two Grey Hills Chapter	C - Roads & Bridges	$8,501.72	$6,376.29
NN8001B - EPM; DNR Complex Septic System Pumping	B - Protective Measures	$1,566.18	$1,174.64
NF2302C - Tohatchi Road Grading	C - Roads & Bridges	$1,559.16	$1,169.37
NF2301C - Tohatchi - Culvert	C - Roads & Bridges	$5,042.26	$3,781.70

Project Title	Damage Category	Project Amount	Federal Share Obligated
PSA001C Power Line Road	C - Roads & Bridges	$1,142.30	$856.73
PSA002A - Debris Removal (Sediment)	A - Debris Removal	$1,495.72	$1,121.79
PSA006C - Water Tank Access Road	C - Roads & Bridges	$22,494.99	$16,871.24
PSA009C - Culverts	C - Roads & Bridges	$9,142.66	$6,857.00
PSA011G - Well # 3	G - Recreational or Other	$6,051.38	$4,538.54
NO1004F - NTUA, Shiprock, DoE and NAPI fused cutouts	F - Public Utilities	$1,923.61	$1,442.71
NE1303C - Manuelito - Road Washout	C - Roads & Bridges	$1,375.00	$1,031.25
NE1902C - Pinedale Chapter	C - Roads & Bridges	$16,938.00	$12,703.50
NF1402C - Mexican Springs Chapter - Roads	C - Roads & Bridges	$22,207.97	$16,655.98
NF1403C - Mexican Springs Roads	C - Roads & Bridges	$15,002.06	$11,251.55
NF1401D - Mexican Springs Chapter - Earthen Dam	D - Water Control Facilities	$4,944.91	$3,708.68
NE1104C - Iyanbito Road Grading	C - Roads & Bridges	$1,411.80	$1,058.85
NE2201C Redrock Chapter	C - Roads & Bridges	$7,427.00	$5,570.25
LPD001A debris removal	A - Debris Removal	$3,246.49	$2,434.87
LPD002D Irrigation ditches	D - Water Control Facilities	$3,841.28	$2,880.96
NN1106C Road 5012,5005,N34,0096	C - Roads & Bridges	$6,805.98	$5,104.49
NN0704C - NN Dept of Ag - Road and culvert damage	C - Roads & Bridges	$2,910.40	$2,182.80
EBC002C San Andras, San Mateo Espina	C - Roads & Bridges	$47,459.07	$35,594.30
NE2001C - Pintado/Beclabito Road Damage	C - Roads & Bridges	$6,971.85	$5,228.89
NN1102C Road 7039 slope and Road 57 culvert	C - Roads & Bridges	$42,909.59	$32,182.19
NE0504C - Casamero Lake Chapter Roads	C - Roads & Bridges	$17,090.77	$12,818.08
FAR005C Arroyo-Culvert Clean Out - 3	C - Roads & Bridges	$177,595.66	$133,196.75
ZIA005C - Culvert	C - Roads & Bridges	$1,299.00	$974.25
ZIA007G - Corral	G - Recreational or Other	$66,256.11	$49,692.08
RRC002C DIRT ROADS	C - Roads & Bridges	$23,614.39	$17,710.79
SSA015A - Debris Angel Road - Black Dam	A - Debris Removal	$1,398.38	$1,048.79
SSA017A - Debris	A - Debris Removal	$147,466.34	$110,599.76
SSA016D - Debris Enchanted Hills	D - Water Control Facilities	$53,771.56	$40,328.67
NMP002D WATER CONTROL FACILITY - BERM BREACH NEAR POND	D - Water Control Facilities	$27,011.12	$20,258.34
PSF010C - Cam De San Francisco Road	C - Roads & Bridges	$3,304.14	$2,478.11
POP002D - Towa Retention Pond	D - Water Control Facilities	$19,737.75	$14,803.31
SAP015C - South Santa Fe Trail	C - Roads & Bridges	$69,235.17	$51,926.38
ZIA006C - Camel Hump Rd and Red Rock Rd	C - Roads & Bridges	$8,159.25	$6,119.44
ZIA004G - Fencing	G - Recreational or Other	$4,440.00	$3,330.00
ZIA010C - Tribal Roads	C - Roads & Bridges	$8,306.45	$6,229.84
ZIA009D - Retention Dam	D - Water Control	$24,232.00	$18,174.00

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
	Facilities		
LUP003B Emergency Protective Measures	B - Protective Measures	$6,137.70	$4,603.28
LUP032C Sedillo Range Roads	C - Roads & Bridges	$30,730.80	$23,048.10
LUP032D Sedillo Range WCFs	D - Water Control Facilities	$333,278.68	$249,959.01
LUP031C Destroyed Grady Day Bridge	C - Roads & Bridges	$27,518.90	$20,639.18
LUP004A Debris at Seama Irrigation Flume	A - Debris Removal	$16,189.40	$12,142.05
Road Repair - POI001C	C - Roads & Bridges	$10,594.49	$7,945.87
Road Repair - POI002C	C - Roads & Bridges	$5,544.34	$4,158.26
Temporary Road Access - POI003B	B - Protective Measures	$2,378.06	$1,783.55
NE0201C Eight (8) Sites Roads	C - Roads & Bridges	$7,391.72	$5,543.79
MKC021C McKinley Manuelito Canyon Rd - Site 18A	C - Roads & Bridges	$377,195.54	$282,896.66
AGAOO1A ANCON DEL GATO ACEQUIA	A - Debris Removal	$2,183.50	$1,637.63
MKC022C McKinley Manuelito Canyon Rd - Site 18B	C - Roads & Bridges	$113,959.46	$85,469.60
AGAOO2D Ancon Del Gato Acequia	D - Water Control Facilities	$31,772.50	$23,829.38
MKC025C McKinley Manuelito Canyon Rd - Site 18E	C - Roads & Bridges	$71,189.40	$53,392.05
DEP009C Road Washout	C - Roads & Bridges	$1,577.25	$1,182.94
MKC016C McKinley Owl Canyon Rd - Site 10A	C - Roads & Bridges	$48,545.22	$36,408.92
NE0201B Emergency Protective Measures (Temp Berm)	B - Protective Measures	$1,645.00	$1,233.75
NMP007G - PICNIC STRUCTURE	G - Recreational or Other	$25,863.68	$19,397.76
NMP004F SEWAGE LAGOON EMBANKMENT-	F - Public Utilities	$31,922.93	$23,942.20
OOP005G Ohkay Owingeh -Parks, Recreational & Other	G - Recreational or Other	$21,116.18	$15,837.14
NE3102C Tsayatoh Roads	C - Roads & Bridges	$6,030.40	$4,522.80
RRC021C-Dirt Roads/Streets	C - Roads & Bridges	$19,989.42	$14,992.07
RRC022C-Dirt Roads/Streets 5 Locations	C - Roads & Bridges	$23,509.02	$17,631.77
RRC020C-Dirt Roads/Streets	C - Roads & Bridges	$9,864.56	$7,398.42
SSA014A - Debris Lomitis Negras	A - Debris Removal	$27,275.47	$20,456.60
NC1903D Upper Fruitland Chapter - Water Pond / Dirt Dam	D - Water Control Facilities	$54,005.17	$40,503.88
NC1904C Upper Fruitland Chapter - Road Wash out	C - Roads & Bridges	$22,733.02	$17,049.77
NC1905D Upper Fruitland Chapter - Water Pond / Dirt Dam	D - Water Control Facilities	$58,928.41	$44,196.31
NO1002F - NTUA - TGH, Nageezi, Cudei, Crownpoint Rpr	F - Public Utilities	$5,347.07	$4,010.30
NO1008F - NTUA, Shiprock; Arrestors, Fuses, and Txfmr	F - Public Utilities	$1,413.03	$1,059.77
NO1006F - NTUA, Shiprock, Dist-wide Electrical Repair	F - Public Utilities	$1,554.08	$1,165.56
EDC009C - Low Water Crossings	C - Roads & Bridges	$25,205.53	$18,904.15

Project Title	Damage Category	Project Amount	Federal Share Obligated
EDC002B Eddy County Protective Measures	B - Protective Measures	$9,915.90	$7,436.93
EDC010C - Crossbuck	C - Roads & Bridges	$39,586.55	$29,689.91
SSA019D RCP Repair	D - Water Control Facilities	$10,130.25	$7,597.69
SSA018A - Debris	A - Debris Removal	$4,668.34	$3,501.26
MOC002C - Mora County Roads	C - Roads & Bridges	$29,942.39	$22,456.79
LVC008C Road Damage	C - Roads & Bridges	$2,879.84	$2,159.88
LVC009C Side Walk Damage	C - Roads & Bridges	$2,631.15	$1,973.36
RRC018C-Dirt Roads/Streets 4 Locations	C - Roads & Bridges	$10,967.76	$8,225.82
RRC019C-Dirt Roads/Streets 5 Locations	C - Roads & Bridges	$31,472.22	$23,604.17
RRC003C DIRT ROADS	C - Roads & Bridges	$14,856.13	$11,142.10
LUP005C Mesita Area Road Repairs	C - Roads & Bridges	$3,088.94	$2,316.71
LUP007C Harrington Area Road Repairs	C - Roads & Bridges	$9,059.36	$6,794.52
MDA001A Debris Removal	A - Debris Removal	$13,491.52	$10,118.64
MDA002D Irrigation Channels	D - Water Control Facilities	$49,422.80	$37,067.10
NN0702C - NN Dept of Ag - Road and culvert damage	C - Roads & Bridges	$4,286.70	$3,215.03
AHD001D - Conchas Canal	D - Water Control Facilities	$122,477.78	$91,858.34
SADOO3D San Augustin CMP	D - Water Control Facilities	$2,690.00	$2,017.50
SADOO2D San Augustin Gabion	D - Water Control Facilities	$48,340.00	$36,255.00
SADOO1A San Augustin Community Ditch	A - Debris Removal	$17,148.75	$12,861.56
POT002D Water Control Facilities	D - Water Control Facilities	$9,114.78	$6,836.09
POT001C Taos Roads and Bridges	C - Roads & Bridges	$9,792.95	$7,344.71
CRC006A Debris Removal	A - Debris Removal	$2,932.01	$2,199.01
CRC005B EPM	B - Protective Measures	$8,477.12	$6,357.84
SCC002A Granular sediment removal	A - Debris Removal	$11,835.00	$8,876.25
SCC004C Multiple Roads	C - Roads & Bridges	$272,716.16	$204,537.12
SCC001C MULTIPLE ROADS	C - Roads & Bridges	$274,311.49	$205,733.62
RRC004C DIRT ROADS	C - Roads & Bridges	$28,030.28	$21,022.71
LAB001D 40 FT x 15 IN Irrigation Pipe	D - Water Control Facilities	$12,529.66	$9,397.25
NE1102C - Iyanbito Chapter - CULVERTS	C - Roads & Bridges	$7,205.80	$5,404.35
LMD001D DAM	D - Water Control Facilities	$8,508.50	$6,381.38
ZIA008C - Un-named Tribal Road	C - Roads & Bridges	$29,431.80	$22,073.85
SSA022D Pond and fence repair	D - Water Control Facilities	$5,949.45	$4,462.09
SSA021A - Debris	A - Debris Removal	$17,821.60	$13,366.20
SSA023A - Debris Northern Meadow	A - Debris Removal	$2,938.53	$2,203.90
SSA020D Sediment pond repair	D - Water Control Facilities	$13,655.51	$10,241.63

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
SSA026A - Debris Tract 17	A - Debris Removal	$1,417.42	$1,063.07
RAC004C CR 367 LOC 3 & 4	C - Roads & Bridges	$11,626.14	$8,719.61
POP006B - Temporary Retention Pond	B - Protective Measures	$1,472.09	$1,104.07
NMP001C - CHILDREN'S PARK & RECREATION ROAD	C - Roads & Bridges	$148,648.32	$111,486.24
SSA024D Sediment pond repair	D - Water Control Facilities	$7,941.70	$5,956.28
CBC001C Callaway Dr.	C - Roads & Bridges	$205,852.07	$154,389.05
SMC002A - Debris Removal Countywide	A - Debris Removal	$9,889.06	$7,416.80
SMC004C - La Tewa Road Causeway	C - Roads & Bridges	$15,414.42	$11,560.82
SWU002D - Storrie Canal Breach	D - Water Control Facilities	$22,732.02	$17,049.02
POP001C - Embankment Failure	C - Roads & Bridges	$5,520.96	$4,140.72
POP003G - Fencing along Arroyo	G - Recreational or Other	$5,555.53	$4,166.65
NN0901B Emergency Management Department - Navajo Nation	B - Protective Measures	$10,684.02	$8,013.02
SSA031D Pond 116	D - Water Control Facilities	$1,160.51	$870.38
SSA030D Northern Meadows Pond #3	D - Water Control Facilities	$5,373.20	$4,029.90
SSA028G Hydroseeding	G - Recreational or Other	$29,339.46	$22,004.60
SSA025A - Debris	A - Debris Removal	$6,601.07	$4,950.80
SSA027D Sediment pond repair	D - Water Control Facilities	$63,098.12	$47,323.59
NN1107C- Road N36 Culvert Blockage Sand Removal	C - Roads & Bridges	$6,367.92	$4,775.94
RRC016C-Dirt Streets/Roads 5 Sites	C - Roads & Bridges	$79,237.38	$59,428.04
RRC014C-Dirt Streets/Roads 5 Sites	C - Roads & Bridges	$17,559.45	$13,169.59
RRC017C-Washouts at Arroyos 2 Sites	C - Roads & Bridges	$31,554.86	$23,666.15
SSA034A - Debris Sportplex	A - Debris Removal	$1,341,255.35	$1,005,941.51
SSA035A - Debris	A - Debris Removal	$11,831.36	$8,873.52
SSA040G Rail Fence	G - Recreational or Other	$5,791.17	$4,343.38
SSA037B Patchouge Road Culvert Crossing	B - Protective Measures	$1,341.47	$1,006.10
SSA032A - Debris	A - Debris Removal	$2,507.37	$1,880.53
RRC005C DIRT ROADS	C - Roads & Bridges	$10,304.97	$7,728.73
NO0401G Northern Edge Navajo Casino - Dirt Wash out	G - Recreational or Other	$3,027.57	$2,270.68
NE0301C - Roads/Culverts	C - Roads & Bridges	$30,038.24	$22,528.68
AOS001D DE OJO SARCO	D - Water Control Facilities	$8,767.42	$6,575.57
PSA003C - Tribal Road Repair	C - Roads & Bridges	$11,742.22	$8,806.67
PSA010G - Fence Damages	G - Recreational or Other	$2,948.36	$2,211.27
PSA008D - Dams	D - Water Control Facilities	$297,374.74	$223,031.06

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
PSA007A - Ditches	A - Debris Removal	$31,921.42	$23,941.07
RRC006C DIRT ROADS	C - Roads & Bridges	$11,932.96	$8,949.72
POP005A - Debris Removal (Sediment)	A - Debris Removal	$3,824.38	$2,868.29
NO1010F - NTUA, Shiprock Electric	F - Public Utilities	$5,588.16	$4,191.12
NO1007F - NTUA, Shiprock, Dist-wide Electrical Repair	F - Public Utilities	$1,857.45	$1,393.09
SRC002B-Emergency Protective Measures	B - Protective Measures	$2,736.95	$2,052.71
PSA005A - Debris Removal (Sediment)	A - Debris Removal	$108,629.66	$81,472.25
POP004F - Damaged Utilities	F - Public Utilities	$18,555.98	$13,916.99
NMP003A DEBRIS REMOVAL - HEADGATE IRRIGATION DIVERSION	A - Debris Removal	$12,148.19	$9,111.14
NMP005A - DEBRIS REMOVAL- CULVERTS AT NP101 RIO NAMBE	A - Debris Removal	$49,368.49	$37,026.37
SFC004C - Roads	C - Roads & Bridges	$249,016.75	$186,762.56
NMP006C-ACCESS ROAD EMBANKMENT TO THE PINE PICNIC AREA;	C - Roads & Bridges	$15,638.65	$11,728.99
SFC007C - Roads	C - Roads & Bridges	$109,477.27	$82,107.95
SDP012A - Debris Removal (Galesteo Road)	A - Debris Removal	$265,031.34	$198,773.51
SAP001B Emergency Protective Measures	B - Protective Measures	$2,193.48	$1,645.11
PDC003C - Route 92 Embankment Repairs	C - Roads & Bridges	$119,666.35	$89,749.76
PDC010C - Kiva Road	C - Roads & Bridges	$4,546.85	$3,410.14
POJ006C Check Dams Holy Ghost Road	C - Roads & Bridges	$7,277.88	$5,458.41
POJ009D Irrigation System - Siphons	D - Water Control Facilities	$54,868.32	$41,151.24
SDP006A - Debris (Sile Channel)	A - Debris Removal	$979,854.58	$734,890.94
SDP008A - Debris Removal - Eastside Retention Pond #2	A - Debris Removal	$970,939.72	$728,204.79
VOP002 - Pinon Lane Repairs - Pecos Village	C - Roads & Bridges	$1,818.04	$1,363.53
NS1801B Protective Measures/Two Grey Hills	B - Protective Measures	$10,818.30	$8,113.73
NE1305C - Manuelito - Culverts	C - Roads & Bridges	$46,460.00	$34,845.00
CBC003A Debris removal	A - Debris Removal	$5,929.26	$4,446.95
EDC006C - Lakewood Road	C - Roads & Bridges	$12,463.63	$9,347.72
EDC008B N. County Rd. Dept. Protective measures	B - Protective Measures	$2,164.79	$1,623.59
LAC012A - Debris Removal	A - Debris Removal	$3,448.15	$2,586.11
LAC026A - Debris Removal	A - Debris Removal	$3,641.00	$2,730.75
LAC019C- Roads	C - Roads & Bridges	$10,025.99	$7,519.49
LAC011A - Debris Removal	A - Debris Removal	$10,117.97	$7,588.48
LAC013A - Debris Removal	A - Debris Removal	$1,526.50	$1,144.88
LUP006C Potoche Area Road Repairs	C - Roads & Bridges	$9,936.01	$7,452.01
LUP010C Montano Range Roads	C - Roads & Bridges	$54,457.77	$40,843.33
LUP011D Montano/Bar PL WCFs	D - Water Control Facilities	$220,901.00	$165,675.75
LUP014C - Bell Rock Range Roads	C - Roads & Bridges	$69,203.92	$51,902.94
LUP015D- Bell Rock Range WCFs	D - Water Control	$4,860.24	$3,645.18

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
	Facilities		
MOC004C - Roads	C - Roads & Bridges	$33,587.48	$25,190.61
MOC005C - Damaged Roads	C - Roads & Bridges	$36,377.28	$27,282.96
MOC007C - Rio La Casa Road	C - Roads & Bridges	$13,888.51	$10,416.38
LAC017A - Debirs removal	A - Debris Removal	$74,394.30	$55,795.73
LAC016A - Debris Removal	A - Debris Removal	$29,644.56	$22,233.42
LAC027A - Debris Removal	A - Debris Removal	$1,507.50	$1,130.63
POJ002D Red Rock Dam	D - Water Control Facilities	$55,932.18	$41,949.14
HAG001D-Felix & Dexter Siphons	D - Water Control Facilities	$17,640.89	$13,230.67
NO2402B -NTU - Emergency Protective Measures	B - Protective Measures	$27,823.51	$20,867.63
NN0905B Old PHS Dam	B - Protective Measures	$8,940.40	$6,705.30
NEE291C Roads/Bridge	C - Roads & Bridges	$25,781.49	$19,336.12
NS1802C Toadlena/Two Grey Hills Roads	C - Roads & Bridges	$2,125.65	$1,594.24
SDP013C - Multiple Tribal Roads	C - Roads & Bridges	$67,355.27	$50,516.45
NO0402G Northern Edge Navajo Casino - Site 6 & 9	G - Recreational or Other	$42,706.19	$32,029.64
PVI003D-Sediment Trap Repair	D - Water Control Facilities	$11,969.76	$8,977.32
NO0404G Northern Edge Navajo Casino - Concrete Spillway	G - Recreational or Other	$78,399.13	$58,799.35
RRC001C Dirt Roads	C - Roads & Bridges	$75,020.24	$56,265.18
NE1402C Little Water Chapter Roads 2	C - Roads & Bridges	$13,524.90	$10,143.68
CBC004B Emergency Protective Measures	B - Protective Measures	$8,929.70	$6,697.28
LUP020C- Diamond 'L' Range Roads	C - Roads & Bridges	$11,970.90	$8,978.18
CBC008E Rescue boat	E - Public Buildings	$500.00	$375.00
PVI002A-Debris Removal Sediment Trap	A - Debris Removal	$333,592.97	$250,194.73
MOC003C - Sierra Loop Road	C - Roads & Bridges	$17,318.43	$12,988.82
SRC004F - Repair WWTP Pump	F - Public Utilities	$2,999.76	$2,249.82
GUC005C - Mesa de Leon Bridge	C - Roads & Bridges	$14,914.99	$11,186.24
NE3101C Tsayatoh Roads	C - Roads & Bridges	$1,230.00	$922.50
NS1501C Shiprock Roads	C - Roads & Bridges	$57,217.39	$42,913.04
NE0503C - Casamero Lake Chapter Roads	C - Roads & Bridges	$12,312.80	$9,234.60
NE1403C Little Water Chapter Roads 3	C - Roads & Bridges	$11,030.20	$8,272.65
NF0502C - Ft Defiance Chapter - Sandy Hill Rd	C - Roads & Bridges	$92,397.61	$69,298.21
NF1601C - Naschitti - Road & Culvert	C - Roads & Bridges	$8,434.11	$6,325.58
SRC010F - Lift Station Site - First St. and Corona Ave.	F - Public Utilities	$6,626.48	$4,969.86
RAC005C DEBRIS/SILT CR 379 LOC 1	B - Protective Measures	$2,625.22	$1,968.92
CBC006G beach and docks, buoys	G - Recreational or Other	$12,381.13	$9,285.85
CBC005C Hildalgo	C - Roads & Bridges	$19,672.28	$14,754.21
SRC007A - Debris Removal	A - Debris Removal	$14,430.14	$10,822.61

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
SDP014C - Middle East Drainage Road	C - Roads & Bridges	$29,425.75	$22,069.31
LUP018D Seama Irrigation Flume	D - Water Control Facilities	$6,868.12	$5,151.09
SSA033D pond repair	D - Water Control Facilities	$13,943.21	$10,457.41
SDP016A - Middle West Drainage Debris Removal	A - Debris Removal	$2,359,164.60	$1,769,373.45
PSF006D - San Francisco Arroyo	D - Water Control Facilities	$8,112.00	$6,084.00
EDC004C Dark Canyon Road	C - Roads & Bridges	$2,614.74	$1,961.06
FSI002A - Debris at Dam	A - Debris Removal	$1,840.89	$1,380.67
SSA041C Patchouge Road Culvert Crossing	C - Roads & Bridges	$206,346.47	$154,759.85
PDC008C - Pueblo Route 85, Road and Culverts	C - Roads & Bridges	$30,047.14	$22,535.36
LAC009C Los Alamos Guaje Canyon Permanent Road repair	C - Roads & Bridges	$115,979.91	$86,984.93
LAC003C Los Alamos Guaje Canyon Road & Waterline Repair	C - Roads & Bridges	$1,205,352.80	$904,014.60
PSF005C - Indian Ditch Road	C - Roads & Bridges	$1,940.20	$1,455.15
PSF009G - Speedway Parking Lot	G - Recreational or Other	$2,200.00	$1,650.00
PSF007F - Waste Water Treatment Plant	F - Public Utilities	$18,000.00	$13,500.00
SRC013G - culvert	G - Recreational or Other	$1,834.59	$1,375.94
RRC015C-Dirt Streets/Roads 5 Sites	C - Roads & Bridges	$17,556.32	$13,167.24
LAC029A - Debris Removal	A - Debris Removal	$1,062.50	$796.88
LAC015A - Debris Removal	A - Debris Removal	$339,504.93	$254,628.70
LAC014A - Debris Removal	A - Debris Removal	$2,489.91	$1,867.43
LAC036A - Debirs Removal	A - Debris Removal	$273,043.24	$204,782.43
LAC033B - Los Alamos Reservoir Road Repair EPM	B - Protective Measures	$81,028.99	$60,771.74
PDC009C - Cochiti Canyon Road	C - Roads & Bridges	$648,845.00	$486,633.75
HAG002B - Temporary Berm at Diversion Dam	B - Protective Measures	$48,759.69	$36,569.77
LAC020B - Emergency Protective Measures	B - Protective Measures	$1,680.00	$1,260.00
LAC018A - Debirs removal	A - Debris Removal	$48,166.17	$36,124.63
NO1009F - NTUA, Shiprock-Transformers; security lights	F - Public Utilities	$2,300.12	$1,725.09
NO1003F - NTUA - Water Line Repair - Ft. Defiance	F - Public Utilities	$1,497.78	$1,123.34
NN1108C- Road 57 Washout	C - Roads & Bridges	$64,738.60	$48,553.95
NE1502D Mariano Lake Chapter Stock Reservoir	D - Water Control Facilities	$2,040.00	$1,530.00
POJ003D Head Start Arroyo	D - Water Control Facilities	$20,911.74	$15,683.81
SRC005G - pump building, chainlink fence, earthen berm	G - Recreational or Other	$3,917.79	$2,938.34
SRC006C - City roads	C - Roads & Bridges	$12,151.79	$9,113.84
ADO031A - Debris Removal	A - Debris Removal	$1,000.00	$750.00
EDC007C - Lake Rd road damaged	C - Roads & Bridges	$18,919.18	$14,189.39

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
GUC001C Rio,Ola,Armstrong,Moise & Agua Negra Road	C - Roads & Bridges	$15,627.91	$11,720.93
GUC002C- Latigo, Brahma Roads	C - Roads & Bridges	$13,373.74	$10,030.31
POJ005A Owl Bridge Sediment Removal	A - Debris Removal	$8,454.98	$6,341.24
POJ008D East Ditch	D - Water Control Facilities	$33,066.28	$24,799.71
SDP010C - Borrego Canyon Road Repair	C - Roads & Bridges	$167,987.50	$125,990.63
PDC017A - Bland Canyon Levee Sediment Removal	A - Debris Removal	$139,847.88	$104,885.91
FSS001E - Fort Sumner School Track	E - Public Buildings	$792.63	$594.47
SRC009D- Tres Lagunas Dam Emergency Spillway	D - Water Control Facilities	$8,118.24	$6,088.68
SRC011G City Parks	G - Recreational or Other	$26,357.86	$19,768.40
GUC007B - Emergency Protective Measures	B - Protective Measures	$7,963.42	$5,972.57
GUC003C Bar Y, Cowden and Singlecow Road	C - Roads & Bridges	$13,869.42	$10,402.07
SDP009A - Debris (Eastside Retention Pond #3)	A - Debris Removal	$113,971.08	$85,478.31
SDP015A - Debris Removal (SE Drainage Sediment)	A - Debris Removal	$1,077,422.62	$808,066.97
PVI004D-Bathymetric Survey	D - Water Control Facilities	$13,356.00	$10,017.00
HCD002C EMBANKMENT/ROAD	C - Roads & Bridges	$70,727.78	$53,045.84
ADR025A - Debris Removal	A - Debris Removal	$3,871.50	$2,903.63
ADR034D Water Facility	D - Water Control Facilities	$5,875.00	$4,406.25
WAA001D Diversion Dam	D - Water Control Facilities	$1,112,950.00	$834,712.50
SRC001F PDL Water Line	F - Public Utilities	$48,743.56	$36,557.67
SRC003E - Public Buildings	E - Public Buildings	$6,020.54	$4,515.41
LUP021D- Diamond 'L' WCFs	D - Water Control Facilities	$32,859.15	$24,644.36
LUP025D- Turquoise Springs Range WCFs	D - Water Control Facilities	$58,530.50	$43,897.88
RAC006C CR 367 LOC 1 & 2	C - Roads & Bridges	$107,046.64	$80,284.98
LUP029D-Jackward Range WCFs	D - Water Control Facilities	$24,044.80	$18,033.60
LUP040D- Dough Mtn Range WCFs	D - Water Control Facilities	$44,007.00	$33,005.25
GUC008C Yucca, Mesa de Leon, Manuelito and Ola Road	C - Roads & Bridges	$17,511.06	$13,133.30
GUC004C Corriente,Questa,Puerto Crk, Aguaje Blanco Road	C - Roads & Bridges	$11,334.85	$8,501.14
FSI001D-Damaged Canal & Ditch System	D - Water Control Facilities	$180,675.30	$135,506.48
RAC001C CR 379 LOC 2	C - Roads & Bridges	$171,817.33	$128,863.00
GUC009C - Milagro Road	C - Roads & Bridges	$23,318.29	$17,488.72
GUC012C - Los Novios Road	C - Roads & Bridges	$53,707.52	$40,280.64
POJ017F WWT Lagoon	F - Public Utilities	$364,723.51	$273,542.63

Project Title	**Damage Category**	**Project Amount**	**Federal Share Obligated**
POJ015C Holy Ghost Road	C - Roads & Bridges	$208,702.73	$156,527.05
POJ016C Culvert/Road Washout	C - Roads & Bridges	$351,679.00	$263,759.25
LAC035B - Emergency Protective Measures	B - Protective Measures	$26,858.61	$20,143.96
PSI001A - Sediment Removal	A - Debris Removal	$4,982.56	$3,736.92
PSI002B - Emergency Protective Measures	B - Protective Measures	$23,643.47	$17,732.60
PSI004C - 2 - Access Roads	C - Roads & Bridges	$6,328.18	$4,746.14
LAC023B - Emergency Protective Measures	B - Protective Measures	$14,106.48	$10,579.86
SSA029A - Debris HJC	A - Debris Removal	$1,552,499.85	$1,164,374.89
HCD003D HEADGATE REPAIR	D - Water Control Facilities	$2,330.00	$1,747.50
HCD001A DEBRIS/SILT SAN JOSE DE HERNANDEZ	A - Debris Removal	$6,546.02	$4,909.52
LVC002B Emergency Protective Measures	B - Protective Measures	$15,530.63	$11,647.97

Appendix 4 - Rio Grande Basin

Reports of Site and Project Visits by USACE Personnel:

- Memorandum for Record, 2 October 2013: RCO Trip Report with Findings and Recommendations for Santa Clara Pueblo, Post-Las Conchas Fire.

- Memorandum for Record, 3 October 2013: Hydrology and Hydraulics Section Trip Report with Findings and Recommendations for the Santa Clara Pueblo, Post-Las Conchas Fire, Sandoval and Rio Arriba Counties, NM.

- Memorandum for Record, 23 October 2013: Hydrology and Hydraulics Section Trip Report with Observations and Conclusions for the Field Inspection on 11 October 2013 to Assess Damages due to Flooding at the Ohkay Owingeh Pueblo, New Mexico.

- Memorandum for Record, 1 November 2013: Hydrology and Hydraulics Section Trip Report with Findings and Recommendations for Isleta Pueblo, Pottery Mound, Valencia County, NM.

- Memorandum for Record, 12 November 2013: Hydrology and Hydraulics Section Trip Report with Observations and Conclusions for Santa Clara, Grant County, New Mexico as Part of the Field Inspection 7 November 2013 to Assess the Effects of Flooding.

- Memorandum for Record, 3 December 2013: Hydrology and Hydraulics Section Trip Report With Findings and Recommendations for Areas Within and Adjacent to Del Norte, South Fork and Creede, in Response to the West Fork Complex Fire, Hinsdale, Mineral, and Rio Grande Counties, CO.

- Memorandum for Record, 3-4 February 2014: Trip Report with Observations for Mineral Creek and Whitewater Creek, Catron County, and Las Palomas and Las Animas Arroyos, Sierra County, NM.

- Memorandum for Commander, South Pacific Division, 31 January 2014: Annual Flood Damage Report for State of New Mexico.

- FOUO - Memorandum for Record, 19 September 2013: Record Pool and Inspection, 16 Sep 2013, Galisteo Dam, Rio Galisteo, Santa Fe County, New Mexico, Rio Grande Basin.

- FOUO - Memorandum for Record, 19 September 2013: High Pool and Inspection, 16 Sep 2013, Jemez Canyon Dam, Jemez River, Sandoval County, New Mexico, Rio Grande Basin.

- Memorandum for Record, 8 November 2013: Hydrology and Hydraulics Section trip report with observations and conclusions for Santa Clara, Grant County, New Mexico as part of the field inspection 6 November 2013 to assess the effects of flooding (Cameron Creek).

- Memorandum For Record, 8 November 2013: Hydrology and Hydraulics Section trip report with observations and conclusions for Santa Clara, Grant County, New Mexico as part of the field inspection 6 November 2013 to assess the effects of flooding (Twin Sisters Creek).

- Trips for which trip logs or memoranda of record were not compiled: San Felipe, NM (18 October); Madrid, NM (no date); Española, NM (24 October).

Appendix 5 - Pecos Basin

Reports of Site and Project Visits by USACE Personnel:

- Memorandum for Record, 18 September 2013: Record Pool and Inspection, 13 Sep 2013, Two Rivers Project, Rocky Arroyo and Rio Hondo, Chaves County, New Mexico, Pecos River Basin.

- Memorandum for Record, 18 September 2013: Pool Increase and Inspection, 13 Sep 2013, Santa Rosa Dam, Pecos River, Guadalupe County, New Mexico, Pecos River Basin.

- Memorandum for Record, 19 September 2013: Continued Pool Increase and Inspection, 19 Sep 2013, Santa Rosa Dam, Pecos River, Guadalupe County, New Mexico, Pecos River Basin.

- Memorandum for Record, 4 October 2013: Hydrology and Hydraulics Section Trip Report with Observations and Conclusions for West Puerto de Luna Acequia Diversion Dam, Guadalupe County, New Mexico as Part of the Field Inspection 3 October 2013 to Assess the Effects of Flooding.

- Memorandum for Record, 3 October 2013: West Puerto de Luna (Giddings Baca) Diversion Dam: Inspection of Damage Due to Recent Flood Events. [Tracy Baker, P.E.]

- Memorandum for Commander, South Pacific Division, 31 January 2014: Annual Flood Damage Report for State of New Mexico.

- Notes from Silver Jackets Meeting, 1 November 2013, held at Tererro in San Miguel County, NM.

Appendix 6 - Canadian Basin

No visits by USACE personnel were made to the Canadian Basin in conjunction with this flood event.

Appendix 7 - Arkansas Basin

- USACE Project Information Report, 5 March 2014: Rehabilitation of Damaged Flood Control Works, Fountain Creek, Pueblo, Colorado Project.

- Memorandum for Record, 14 March 2014: Rainbow Falls Section 14 Findings of Site Visit and Determination of Eligibility under Section 14 Authority.

- Field Trip Report, 2-3 April 2014: Colorado Springs.

Appendix 8 - Upper San Juan Basin

Reports of Site and Project Visits by USACE Personnel:

- Memorandum for Record, 9 October 2013: Trip Report for Navajo Nation Flood Response Site Visit.

- Memorandum for Record, 25 October 2013: RCO (Readiness and Contingency Operations) Trip Report with Findings and Recommendations for Navajo Nation Flooding Assessment.

- Memorandum for Record, 21 October 2013: Hydrology and Hydraulics Section Trip Report with Observations and Conclusions for the Field Inspection on 8 October 2013 to Assess Damages due to Flooding on the Navajo Nation in New Mexico at the Areas of Lake Valley and Crownpoint.

Appendix 9 - Lower Colorado River Tributary Headwaters

Reports of Site Visits by USACE Personnel:

- Memorandum for Record, 3-4 February 2014: Trip Report with Observations for Mineral Creek and Whitewater Creek, Catron County, and Las Palomas and Las Animas Arroyos, Sierra County, New Mexico.

- Additional trips, for with memoranda of record are not available, include trips to Catron County on 24-25 September 2013, and the Village of Zuni, New Mexico, on 10 October 2013.

Appendix 10 - Other RCO Data (including letters requesting USACE assistance)

- Pueblo of San Felipe, Letter Requesting USACE Assistance, dated 23 September 2013.
- Letter, 11 October 2013: Request for Assistance from Earl Wilkinson, City of Pueblo, Department of Public Works.
- Letter, 23 October 2013: New Mexico Department of Homeland Security and Emergency Management regarding the levee system between Reserve and Glenwood, Catron County, New Mexico.

Appendix 11 - Print Media Articles Concerning Flooding, 9-18 September 2013

Article Title	Article Date	Source	URL	Date Accessed
'Desert Rain' Parts of County Face an Influx of Rainwater Challenges	9/17/2013	Cibola Beacon	http://www.cibolabeacon.com/news/desert-rain/article_932d73c0-1f43-11e3-b31f-001a4bcf887a.html	2/28/2013
70 Juárez families evacuated after reservoir flood	9/13/2013	El Paso Times	http://www.elpasotimes.com/newupdated/ci_24078886/70-ju-rez-families-evacuated-after-reservoir-floods	2/28/2013
Airlift canceled for town isolated by flooding (Mogollon)	9/17/2013	Alamogordo Daily News	http://www.alamogordonews.com/ci_24118666/airlift-canceled-town-isolated-by-flooding	2/28/2013
Airlift planned for New Mexico town isolated by flooding	9/17/2013	Chicago Sun-Times	https://www.suntimes.com/photos/galleries/22624130-417/airlift-planned-for-new-mexico-town-isolated-by-flooding.html	2/27/2013
Airlift to supply Mogollon after floods wash out roads	9/15/2013	Las Cruces Sun-News	http://www.lcsun-news.com/ci_24108693/airlift-supply-mogollon-after-floods-wash-out-roads	2/28/2013
Albuquerque rainfall breaks record from 1929	9/17/2013	Albuquerque Journal	http://www.abqjournal.com/264020/news/rain-keeps-pouring-on-new-mexico.html	2/27/2013
Aldo students and teachers rescued after Gila rises eight feet in one day	9/12/2013	Silver City Sun-News	http://www.scsun-news.com/ci_24082398	2/27/2013
An apology to the fish that saved Albuquerque	9/30/2013	Las Cruces Sun-News	http://www.lcsun-news.com/las_cruces-opinion/ci_24191152/an-apology-fish-that-saved-albuquerque	2/28/2013
Are New Mexico's tribes being flooded — then left high and dry?	11/11/2013	New Mexico In Depth	http://nmindepth.com/2013/11/11/are-new-mexicos-tribes-being-flooded-then-left-high-and-dry/	2/27/2013
Berino residents seek answers from the county about recent flooding	9/21/2013	Las Cruces Sun-News	http://www.lcsun-news.com/ci_24148553/residents-seek-answers-from-county-about-recent-flooding	2/28/2013
Big flood flow headed Albuquerque's way	9/13/2013	Albuquerque Journal	http://www.abqjournal.com/262635/abqnewsseeker/big-flood-flow-headed-albuquerques-way.html	2/27/2013
Big flood unlikely but possible	9/13/2013	El Defensor Chieftain	http://www.dchieftain.com/2013/09/19/big-flood-unlikely-but-possible	2/27/2013
Body found in Catron County ID'd as missing Arizona man	9/25/2103	Silver City Sun-News	http://www.scsun-news.com/silver_city-news/ci_24175626	2/27/2013
Boyd Acknowledges Community Effort	9/27/2013	Cibola Beacon	http://www.cibolabeacon.com/news/boyd-acknowledges-community-effort/article_e0dfabbe-2714-11e3-adfe-001a4bcf887a.html	2/28/2013
Breaking: Major flooding forcing evacuations	9/13/2013	Las Vegas Optic	http://www.lasvegasoptic.com/content/breaking-major-flooding-forcing-evacuations	2/28/2013

Article Title	**Article Date**	**Source**	**URL**	**Date Accessed**
Carlsbad area floods, evacuations by boat, helicopter underway	9/12/2013	El Paso Times	http://www.elpasotimes.com/newupdated/ci_24080759/carlsbad-area-floods-evacuations-by-boat-helicopter-underway	2/28/2013
Carlsbad Current-Argus: Residents of RV park flown by helicopter to evacuation center	9/12/2013	El Paso Times	http://www.elpasotimes.com/ci_24082325/carlsbad-current-argus-residents-rv-park-flown-by	2/28/2013
Catron County deputies find body in sand bar after recent flooding	9/22/2013	Albuquerque Journal	http://www.abqjournal.com/267435/abqnewsseeker/catron-county-deputies-find-body-in-sand-bar-after-recent-flooding.html	2/27/2013
Catron County flood response	9/18/2013	Grant County Beat	http://www.grantcountybeat.com/index.php/news/news-articles/12309-catron-county-flood-response	4/9/2013
Catron County flood response	9/17/2013	Grant County Beat	http://www.grantcountybeat.com/index.php/news/news-articles/12297-catron-county-flood-response-sept-17	4/9/2013
Catron County forest roads washed out, eroded or extremely muddy	9/24/2013	Silver City Sun-News	http://www.scsun-news.com/silver_city-news/ci_24166679	2/27/2013
Catron County officials assess flood damage, begin repairs	9/17/2013	Silver City Sun-News	http://www.scsun-news.com/ci_24116909	2/27/2013
Catwalk receives major flood damage	9/19/2013	Grant County Beat	http://www.grantcountybeat.com/index.php/news/news-articles/12343-catwalk-receives-major-flood-damage	4/9/2013
Catwalk receives major flood damage	9/19/2013	Glenwood Gazette News	http://gazetteonline.blogspot.com/2013/09/catwalk-receives-major-flood-damage.html	9/19/2013
Chama River floods homes	9/19/2013	Albuquerque Journal	http://www.abqjournal.com/265523/news/chama-river-floods-homes.html	2/27/2013
City pegs its flood damage at $2.2M	9/24/2013	Las Vegas Optic	http://www.lasvegasoptic.com/content/city-pegs-its-flood-damage-22m	2/28/2013
City's worst flood was in 1904	9/19/2013	Las Vegas Optic	http://www.lasvegasoptic.com/content/city%E2%80%99s-worst-flood-was-1904	2/28/2013
Colo. flood death toll rises	9/14/2013	Albuquerque Journal	http://www.abqjournal.com/262379/news/boulder-area-calls-for-thousands-more-evacuations.html	2/27/2013
Colorado flood: water closes all roads into Manitou Springs	9/12/2013	Denver Post	http://www.denverpost.com/breakingnews/ci_24080334/colorado-flood-water-closes-all-roads-into-manitou-springs#	4/29/2013
Colorado Springs wants to be part of flood disaster zone	9/18/2013	Denver Post	http://www.denverpost.com/breakingnews/ci_24122137/colorado-springs-wants-be-part-flood-disaster-zone	4/29/2013
Colorado Springs, El Paso County assess flood damage: Roads, parks, creeks need work	9/17/2013	The Gazette	http://gazette.com/colorado-springs-el-paso-county-assess-flood-damage-roads-parks-creeks-need-work/article/1506324	4/29/2013
Congressman Pearce to tour flood-damaged Catron County	9/20/2013	Silver City Sun-News	http://www.scsun-news.com/ci_24142895	2/27/2013

Article Title	**Article Date**	**Source**	**URL**	**Date Accessed**
Congressman Pears tours flood damage in Glenwood	9/21/2013	Silver City Sun-News	http://www.scsun-news.com/ci_24148863	2/27/2013
County may get disaster funds	9/19/2013	El Defensor Chieftain	http://www.dchieftain.com/2013/09/19/county-may-get-disaster-funds	2/27/2013
County plans to declare state of emergency Friday	9/19/2013	Alamogordo Daily News	http://www.alamogordonews.com/ci_24137055/county-plans-declare-state-emergency-friday	2/28/2013
Damages to Colorado Springs utilities systems will cost millions to repair	9/19/2013	The Gazette	http://gazette.com/damages-to-colorado-springs-utilities-systems-will-cost-millions-to-repair/article/1506436	4/29/2013
Danger hides in standing or flood waters	9/19/2013	El Defensor Chieftain	http://www.dchieftain.com/2013/09/19/danger-hides-in-standing-or-flood-waters	2/27/2013
Dona Ana County commission declares state of disaster (updated)	9/16/2013	Las Cruces Sun-News	http://www.lcsun-news.com/ci_24106959/do-ana-county-commission-declares-state-disaster	2/28/2013
Donation account set up for Santa Clara flood victims	10/16/2013	Silver City Sun-News	http://www.scsun-news.com/silver_city-news/ci_24324665?IADID=Search-www.scsun-news.com-www.scsun-news.com	2/27/2013
Donations needed for La Union, Berino flood victims	9/24/2103	Las Cruces Sun-News	http://www.lcsun-news.com/las_cruces-news/ci_24166102/donations-needed-la-union-berino-flood-victims	2/28/2013
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Appendix 12 - CD Containing NEXRAD Rainfall Data

A CD containing NEXRAD rainfall data for September 2013 is included with this report.

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