APPENDIX C

Additional Information: Flooding and Stormwater Management

Attachment 1:	Fountain Creek Flood Summary (table)
Attachments 2a and 2b:	Flooding along Fountain Creek (narrative)
Attachments 2c – 2s:	Flooding along Fountain Creek (photos)
Attachment 3:	Trends in Precipitation and Streamflow in the Fountain Creek Watershed, Southeastern Colorado, 1977–99 (US Geological Survey)
Attachment 4:	Trends in Impervious Surface Area
Attachment 5:	Fountain Creek Watershed Study Initial Recommendations

(Attachment 1)

Fountain Creek
Flood Summary

Watershed Area^1 = 925 mi^2 Date: 8/10/2005

Annual Percent Chance Flood Event	Return Period	Peak Discharge (cfs)						
		URS HEC-HMS Model^2		USGS Regression	CWCB Regression	FEMA FIS^5	DBPS^6	
		Existing	Future	Analysis, Plains Region^3	Analysis, ARK - 5^4		Existing	Future
50%	2-year	4,700	5,800	1,078	---	---	---	---
20%	5-year	10,000	12,000	2,987	---	---	---	---
10%	10-year	16,000	17,000	5,601	---	18,500	---	---
4%	25-year	24,000	29,000	10,768	---	---	---	---
2%	50-year	33,000	38,000	16,232	---	45,000	---	---
1%	100-year	45,000	51,000	23,211	---	64,000	---	---
0.2%	500-year	74,000	83,000	47,357	---	99,000	---	---

Notes: 1) Drainage Area was taken from the URS HEC-HMS model for the watershed.
2) Existing and Future Peak Discharges from the URS HEC-HMS models prepared as part of the Fountain Creek Watershed Study for USACE.
3) USGS Regression Analysis equations are from "Analysis of the Magnitude and Frequency of Floods in Colorado" Water-Resources Investigations Report 99-4190. The Plains Region covers the portion of Fountain Creek below an elevation of about 9,000 feet. Drainage areas for the study ranged from 5 to 1,000 mi^2.
4) CWCB Regression Analysis equations are not applicable to Fountain Creek mainstem.
5) FEMA FIS flows were taken from "Flood Insurance Study - City of Pueblo, Colorado", September 1986
6) No local Drainage Basin Planning Study (DBPS) flows are available.

(Attachment 2a)

Flooding along Fountain Creek

May 7, 2007 – In Pueblo, a newer roadway to a Wal-Mart Supercenter commercial district and a nearby, small residential neighborhood were swamped with water when an aged Fountain Creek levee broke after rainstorm runoff from the Colorado Springs area caused a shift in the creek's path through the area.

June 21, 2005 — In Colorado Springs, a flash flood hit the city, killing two boys. The flood also broke sewage pipes, sending around 318,000 gallons of untreated wastewater down Fountain Creek. The sewage spill triggered a lawsuit against Colorado Springs by Pueblo District Attorney Bill Thiebaut and also set in motion a push in Colorado Springs to create a stormwater utility to fund improvements. Source: Colorado Springs Independent.

April 29-30, 1999 — (18,900 cfs, Pueblo) On April 29, heavy rains swelled Fountain Creek and the Arkansas River, prompting flooding in the region, particularly downriver in La Junta. In Pueblo, city crews worked to keep the Fountain from washing away the riverbank behind the Target Store at the Pueblo Mall. The water tore out a sewer line along the river. The Pinon Bridge was washed away. Pueblo County was declared a disaster area with at least $3 million in property and public road bridges reported. In Colorado Springs, up to 10 inches of rain fell along the foothills. Heavy rain and runoff in Fountain Creek results in the river running 6 feet above normal, and doing much damage along the river banks south of Colorado Springs and in Pueblo. Many people are homeless due to the flooding, and many more without power due to the storms. When the storm was over, it had done more than $4 million in damage to the region.

May 17, 1995 and June 1997 — Large rainstorms cause heavy channel erosion on Fountain Creek, including washing out Pinon Road and areas around Pinon Bridge and (1997) causing one pier to settle by 9 inches. Pueblo County public works officials propose study of possible construction of dam on creek.
June 7, 1997 — Thunderstorms with heavy rain and hail cause four mud and rock slides, closing U.S. 24 in Ute Pass, and much flooding in Manitou Springs.

May 18, 1995 — Three inches of rain in Colorado Springs floods the city, while 18 inches of snow fall in nearby Woodland Park. The heavy rainfall causes a landslide closing U.S. 24 on Ute Pass.

June 17, 1965 — (47,000 cfs, Pueblo) Fifteen days of steady rain result in the flooding of the Arkansas and South Platte rivers and Fountain Creek. President Lyndon B. Johnson declares Colorado a major disaster area. In Pueblo, 1,000 residents are evacuated from their homes as the raging Fountain washes out the Pinon Bridge north of the city. Rainfall estimated put at 14 inches. Five people drown in the Lamar area as a result of the Arkansas River flood waters. Flook prompts eventual construction of Fountain Creek levee in Pueblo.
July 10, 1945 — (17,850 cfs, Pueblo) — No details readily available.

(Attachment 2b)

May 30, 1935 — (35,000 cfs, Pueblo) Memorial Day flood on Fountain and Monument creeks kills 18 people and washes away bridges and buildings in downtown Colorado Springs. Among victims is Pueblo couple stranded in car on South Nevada Avenue. In north Pueblo, downstream flooding swamped businesses along Fountain Creek and parts of Downtown. Rail traffic halted. Estimated peak flow in Pueblo: 35,000 cfs.
June 3, 1921 — (34,000 cfs, Pueblo) Pueblo's most devastating flood, primarily due to overflows on the Arkansas River, also included flooding along Fountain Creek. USGS estimates Fountain Creek's peak flow reached 34,000 cfs on June 4. The main Arkansas River flooding left more than 100 people dead and hundreds homeless. Bridges and buildings on both waterways are washed out with property damage and loss estimated at $25 million. A high water mark of the Arkansas River still can be seen on the Union Depot.

Aug. 7, 1904 — A flash flood on Porter Draw (near Eden, north of Pueblo) washes a train from the tracks, killing 89 passengers. Flood waters weaken a bridge, which gives way under the weight of the train.

Attachment 2c - 2007

Water from the Fountain Creek spills into low−lying areas near Highway 47 and Dillion Drive where an embankment gave way Monday, flooding homes and businesses. Photo by Mike Sweeney 5.7.07

Attachment 2d - 2007

Flood waters spill over Dillion Drive Monday after a levee along the Fountain Creek broke, flooding nearby homes and businesses. Photo by Mike Sweeney 5.7.07

Attachment 2e - 2007

Crews work on replacing an old river levee which broke on the Fountain Creek Monday morning causing major flooding on Pueblo's northside. Chieftain photo John Jaques 5.8 07

Attachment 2f - 1999

Mary McNamara, of Colorado Springs, and Suzanne Green, of Manitou Springs, watch the floodwaters flow through Soda Springs Park and into Fountain Creek, Saturday May 1, 1999 in Colorado Springs, Colo., near the historic and troubled Manitou Spa building. In Larimer County, some 60 people were evacuated from a flooded trailer park, and around Colorado Springs, homes were evacuated and two towns declared local disasters. (AP Photo/The Gazette, Bob Jackson)

Attachment 2g - 1999

COLORADO FLOOD

Utilities workers from Colorado Springs and Fountain, Colo. work on damaged power lines near Fountain on Saturday May 1, 1999. The lines were damaged Friday by debris washing down Fountain Creek causing a major power outage. (AP Photo/The Gazette, Jay Janner)

Attachment 2h - 1999

DON MALDONADO

Don Maldonado, a worker with the Pueblo County Department of Public Works, surveys the damage done to the Pinon bridge which crosses the Fountain River near Pueblo, Colo., Monday May 3, 1999. A section of the bridge was washed away during Friday's storm which turned the usually tame Fountain into a raging torrant. (AP Photo)(The Pueblo Chieftain, Bryan Kelsen)

Attachment 2i - 1999

Hundreds of trees fill the Fountain River riverbed just north of the Highway 47 bridge Monday. The trees are part of the debris left when the waters of the flooding river receeded. Chieftain Photo by Bryan Kelsen

Attachment 2j - 1999

Recent rains that have caused flooding along Fountain Creek have also causedextensive damage to the river trail south of the east fourth Street bridge −− photo byc hris mclean 8−2−99

Attachment 2k - 2001

The Union Pacific Railroad is shoring up the cliff adjacent to their railroad tracks along the Fountain River just north of Pueblo near the Eden exit of Interstate 25. During the 1999 flood ,the river cut a new channel that eroded the cliff and brought it closer to the tracks that run alongside to the left. They are installing mesh fabric to secure large rocks and riprap along about a 1−mile stretch. The work began last week and should continue for about 6 weeks−−photo by chris mclean 4−26−01

Attachment 2l - 1965

floodwaters innundate an east side home during the 1965 flood in pueblo −− chieftain file photo

Attachment 2m - 1965

METRO
AND THE REGION

INSIDE

Debris from a building (left photo) that washed up against the Eighth Street bridge was left behind when floodwaters receded in 1965. Lower Fountain Creek (right photo) briefly turned into a lake below the old Walter's Brewery during the flood of 1965.

Water, water everywhere

'65 flooding sparked idea of dam on Fountain Creek

Muddy, destructive wave of water came out of blue for Puebloans.

By CHRIS WOODKA
THE PUEBLO CHIEFTAIN

Pueblo's weather forecast for June 17, 1965, called for mostly cloudy skies with scattered showers and the chance of a thunderstorm, possibly heavy in the evening.

The front page of *The Pueblo Chieftain* that morning boasted "Freak Weather Misses Pueblo; Only Rain, High Wind Recorded." Up north, there was widespread devastation as Palmer Lake was battered by tornadoes and the South Platte River crested at 20 feet.

By the next day, Pueblo learned it had not escaped Mother Nature's wrath. Fountain Creek had cut a path of destruction through the city. The headlines read: "Flood Deals Pueblo Heavy Blow" and "River Stomps Pueblo."

As reporter Jerry Skelton summed it up at the time: "The Fontaine qui Bouille (fountain that boils) lived up to its French name Thursday night as it boiled through Pueblo, ripping houses from their foundations, tossing automobiles and house trailers about like toys, straining bridges to the breaking point and spreading a coat of slimy mud over everything in its path."

The photos that day and over the next few weeks showed the dramatic destruction of floods in Pueblo and the surrounding area. A lumber yard shed lodged itself in the center of the Fourth Street Bridge. The Pinon Bridge was photographed as it was literally swept away. A train made a nosedive into the Purgatoire River.

The flooding on Fountain Creek was just a part of a week of storms and flooding that caused $500 million in damage in the South Platte Basin, largely in the Denver metro area, and $37 million in the Arkansas Basin, much of it to cities and farms east of Pueblo. While Pueblo's East Side was hammered, the flood was less devastating to the city than the June 3, 1921, flood.

Considered a 100-year flood (a storm that has a chance of occurring once in a century) on Fountain Creek, the 1965 storm dumped 4.7 inches in six hours, centered on the Jimmy Camp Creek area, or what is now the Banning-Lewis Ranch development in eastern Colorado Springs. That particular storm did not cause much damage to Colorado Springs, because Jimmy Camp Creek joins the Fountain south of the city.

The peak flow at Jimmy Camp Creek was 124,000 cubic feet per second.

Flows through Pueblo crested at 80,000 cfs, and further downstream at the Catlin Canal headgate, the Arkansas River topped out at 43,200 cfs. Flows decreased as the floods moved downward because the channels became wider.

While John Martin Dam captured the entire flow of the river — with levels going from almost nothing to more than 230,000 acre-feet overnight. It was fed by torrential flows on the Purgatoire River and other tributaries below Fountain Creek as well, with a peak flow of 104,000 cfs. Below John Martin, there were even worse storms — at Holly 11 inches of rain fell in just six hours.

Arkansas not a problem

Puebloans flocked to the creek to watch as a 20-foot wall of water moved down the creek. Police had to keep the curious away from parts of the channel that would soon be flooded.

Nearly lost in all the accounts was the fact that most of Pueblo was protected by measures put in place after the 1921 flood. While storms were not as severe on the mainstem of the Arkansas River, a levee and a dam built by the U.S. Army Corps of Engineers prevented more rain from compounding the damage to Pueblo. But the project only rated a mention in 1965 news accounts.

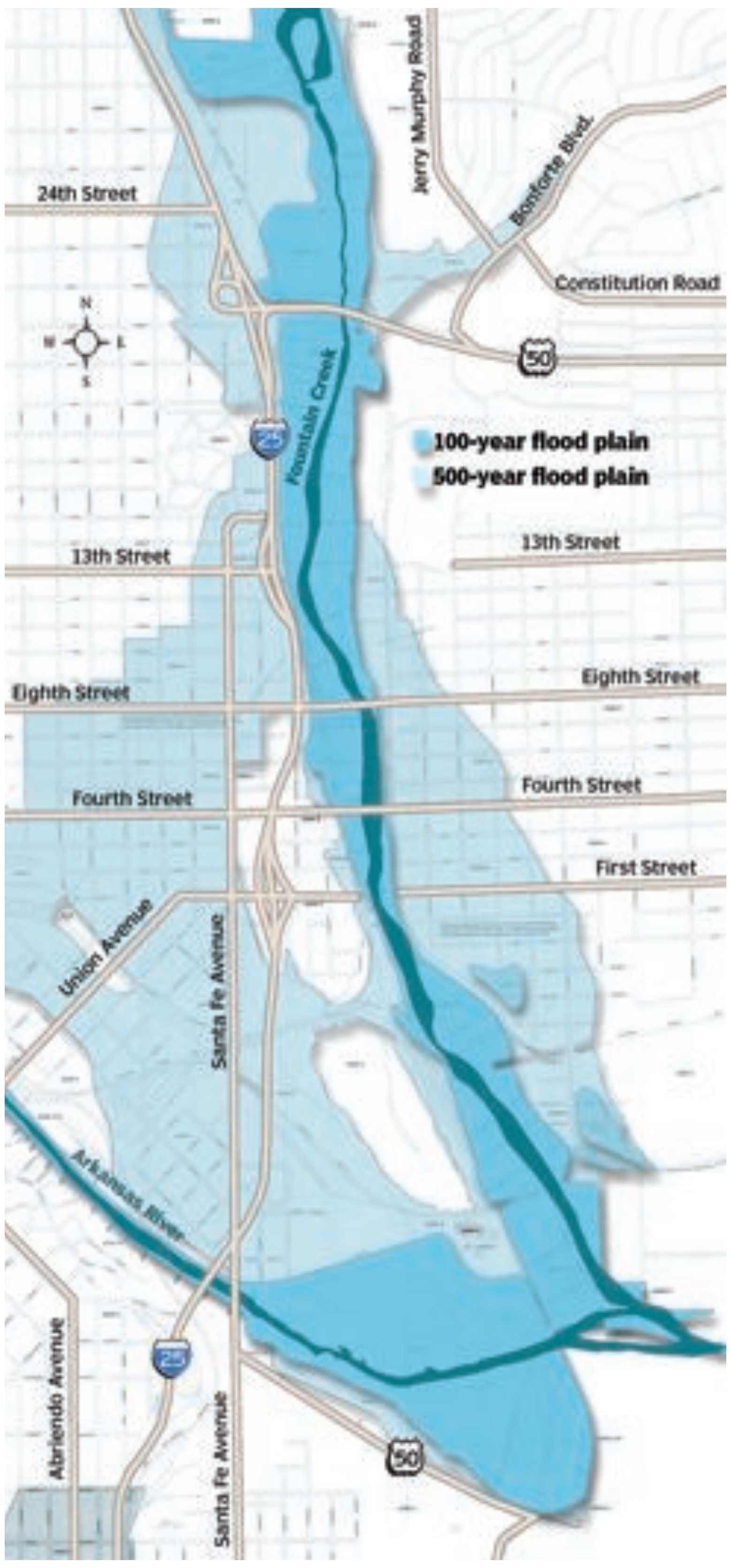
The levee is still there, covered with painted murals that serve as urban scenery along a kayak course.

PLEASE SEE FLOOD, XB

COURTESY PHOTOS/PUEBLO LIBRARY DISTRICT

East Side residents survey a muddy yard while cleaning up after the 1965 flood on Fountain Creek. The dark area on the walls of the house shows the high-water mark from flooding.

A railroad tanker rests on its side after floodwaters receded from the June 17, 1965, flood on Fountain Creek.



Where would the water go?

Downtown, East Side largely protected by levees, unless something has changed.

If a flood like the one on June 17, 1965, were to occur again on Fountain Creek, where would the water go?

Hopefully, down the channel and into the Arkansas River, as the U.S. Army Corps of Engineers intended when it built a system of levees along the normally sluggish creek in the 1980s.

The current Federal Emergency Management Agency map, drawn in 1986 as the levees were being constructed, shows there is little development in the 100-year flood plain. But a wider area likely to flood in a more severe storm event is drawn to include many areas of the East Side and much of the Downtown area.

However, more silt and trees are filling the channel every year, as flows continue to eat away at the reaches of Fountain Creek above Pueblo, said Dennis Maroney, Pueblo stormwater utility director.

The Army Corps of Engineers rated the city's plan to clean out the channel on a regular basis as one of the highest priorities in a preliminary assessment of alternatives recently.

"It would be a continual job, almost an annual thing," Maroney said.

The tamarisks and other trees growing in the area south of Eighth Street were cleared in 2005, but already have returned and the city has not attempted any dredging. A large sandbar accumulating at the confluence of Fountain Creek and the Arkansas River was scoured out by heavy rains in 2006, however.

PLEASE SEE LEVEES, XB

Attachment 2n - 1935

photo shows the ackup water close to the Walter's Brewing Company−−from page 7 of June 1, 1935 Pueblo Chieftain

Attachment 2o - 1935

Marked for Death Seeking protection from the swirling water, Orville C. O'Neill and his sweetheart, Helen Carver, both of Pueblo, are pictured here as they climbed to the top of their automobile in Colorado Springs Memorial day where they were swept to their deaths after resisting the flood tide for two hours. The flooded Nevada avenue bridge is shown in the background. Organized search for the bodies continued fruitlessly Monday along the Fountain river. (Associated Press Photo).

Attachment 2p - 1935

The Pueblo Chieftain

SIXTY-SEVENTH YEAR

PUEBLO, COLORADO, SATURDAY, JUNE 1, 1935

FULL ASSOCIATED PRESS SERVICE

22 DEAD, MANY MISSING IN FLOOD AREAS

Flood Swirls About Marooned Autoists

Rapidly Rising Waters Threaten Sterling And Fort Morgan Region

Pueblo Flood Loss Greatest Since Disaster of 1921, Officials Study Conservancy Plans

Property Damage in Devastated Districts Will Reach Several Millions

Sterling Left in Darkness As South Platte Overflows

Floods Claim Heavy Toll In Southwestern States

Attachment 2q - 1935

Attachment 2r - 1935

photo shows the men's doritory at sttae hospital annex tumbling into the swollen river

Attachment 2s - 1904

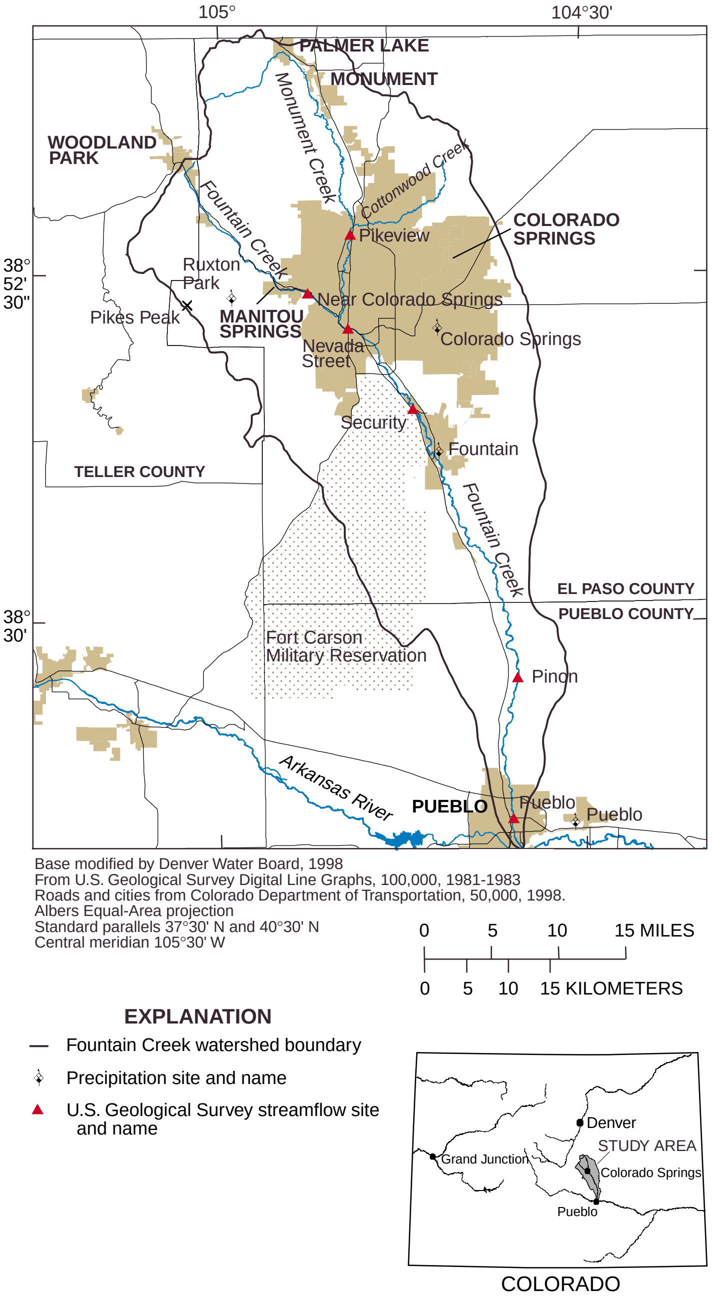
1904 Aug. 7−−a flash flood north of pueblo washed a train from the tracks, killing 89 passengers file photo

Attachment 3a

Prepared in cooperation with the Turkey Creek Soil Conservation District, El Paso County Soil Conservation District, Central Colorado Soil Conservation District, and Pueblo County

Trends in Precipitation and Streamflow in the Fountain Creek Watershed, Southeastern Colorado, 1977–99

—Robert W. Stogner, Sr.



Base modified by Denver Water Board, 1998
From U.S. Geological Survey Digital Line Graphs, 100,000, 1981-1983
Roads and cities from Colorado Department of Transportation, 50,000, 1998.
Albers Equal-Area projection
Standard parallels 37°30' N and 40°30' N
Central meridian 105°30' W

Figure 1. Location of Fountain Creek watershed, precipitation and streamflow sites.

Introduction

The Fountain Creek watershed drains about 930 square miles of parts of Teller, El Paso, and Pueblo Counties in southeastern Colorado (fig. 1). Land use within the watershed includes forests, urban areas, military reservations, agriculture, and rangeland. Forested lands are located predominantly in the northwestern mountainous part of the watershed. The major urban center in the watershed is the Colorado Springs metropolitan area that includes Colorado Springs and several smaller communities in El Paso County. Since 1977, population in El Paso County has increased by about 75 percent. As population increased, the amount of impervious area increased. Research has shown that as impervious area increases, infiltration decreases, runoff increases, and a quicker hydrologic response in the receiving streams occurs, which enhances streambank erosion (Goudie, 1986; Douglas, 1983; Dunne and Leopold, 1978). Agriculture and rangeland are located predominantly south of Colorado Springs. Agriculture is common along the alluvial valley from Fountain to Pueblo and relies heavily on water diverted from Fountain Creek. A large expanse of rangeland is included within the boundaries of the military reservation at Fort Carson.

Concerns by landowners, farmers, resource managers, and municipal, county, and local agencies that (1) flooding and associated streambank erosion may be worsening over time, and (2) increases in precipitation, especially during the 1990’s, may be exacerbating the problem, resulted in a study to determine whether precipitation and streamflow in the Fountain Creek watershed has changed over time. The study was done by the U.S. Geological Survey (USGS), in cooperation with the Turkey Creek Soil Conservation District, El Paso County Soil Conservation District, Central Colorado Soil Conservation District, and Pueblo County.

Stogner (2000) indicated that no significant trends were detected in precipitation or streamflow prior to 1977. Therefore, this Fact Sheet summarizes trends in precipitation and streamflow from 1977 through 1999. Readers interested in a detailed discussion of trends in precipitation and streamflow for the Fountain Creek watershed from 1939 through 1999 are referred to Stogner (2000).

U.S. Geological Survey
U.S. Department of the Interior

USGS Fact Sheet 136–00
October 2000

How were Changes or Trends in Precipitation and Streamflow Determined?

Trends in precipitation and streamflow were determined by compiling precipitation data at four sites and streamflow data at six sites from 1977 through 1999 (fig. 1). Statistical trend tests were done on daily, seasonal, and annual precipitation data for each site to determine whether precipitation had changed since 1977. To determine whether streamflow had changed since 1977, statistical trend tests were done on several high (annual peak, Q100, Q90, Q70) and low (Q30, Q10, Q0) streamflow statistics computed for each site (table 1). The statistical trend test used was the Kendall test, which provides a probability of precipitation or streamflow to increase or decrease over time. The trend was defined as highly significant if the probability that a trend existed was 99 percent or greater, significant if the probability was between 95 and 99 percent, and moderately significant if the probability was between 90 and 95 percent. No trend was indicated when the probability was less than 90 percent. The Kendall test also provides an estimate of the average annual rate of change.

Table 1. Description of streamflow statistics used to evaluate trends in streamflow

Streamflow statistic and description
Annual peak streamflow is the single highest instantaneous recorded streamflow for the water year[1].
100 percentile (Q100) streamflow is the highest daily mean[2] streamflow for the water year.
90th percentile (Q90) streamflow indicates 90 percent of the annual daily mean streamflows are below this streamflow or 10 percent are above it.
70th percentile (Q70) streamflow indicates 70 percent of the annual daily mean streamflows are below this streamflow or 30 percent are above it.
30th percentile (Q30) streamflow indicates 30 percent of the annual daily mean streamflows are below this streamflow or 70 percent are above it.
10th percentile (Q10) streamflow indicates 10 percent of the annual daily mean streamflows are below this streamflow or 90 percent are above it.
Annual minimum streamflow (Q0) equals the lowest daily mean streamflow for the water year.

[1] A water year extends from October 1 through September 30 of the following year and is identified by the year in which it ends.

[2] Daily mean streamflow is the average of all instantaneous streamflow recordings made each day.

To determine whether streamflow changed within certain reaches of the watershed, differences in the daily mean streamflow between the upstream and downstream sites within a stream reach were computed. The differences then were divided by the intervening drainage area, resulting in streamflow data normalized to drainage area, and trends were evaluated on the normalized data.

Precipitation

Precipitation is highly variable throughout the watershed; annual precipitation ranges from about 30 inches at the summit of Pikes Peak, an elevation of 14,110 feet, to about 12 inches at Pueblo, an elevation of 4,640 feet.

Depending on location, from 40 to 60 percent of the daily precipitation that occurs is less than or equal to 0.1 inch, and from about 70 to 80 percent of daily precipitation that occurs is less than or equal to 0.25 inch. Daily precipitation of greater than 0.25 inch occurs most frequently from July through September. Many of the precipitation events that occur during this period are associated with thunder storms that generally are strong, localized storms that occur during the late afternoon and early evening. These localized storms frequently result in large variations in annual precipitation over short distances.

Trends in Precipitation

During 1977 through 1999, annual precipitation generally was above average, and increasing trends were detected at the Ruxton Park and Pueblo sites. No trends were detected in precipitation at the Colorado Springs and Fountain sites. Additionally, seasonal trend analysis indicated moderately significant increases in spring (April–June) precipitation at the Ruxton Park and Pueblo precipitation sites. This analyses indicates that the increasing trends detected in annual precipitation at these sites were likely the result of trends in spring precipitation and were not associated with changes in precipitation that occurred during the summer season or throughout the entire year.

Streamflow

Streamflow in the Fountain Creek watershed varies seasonally and has three distinct flow regimes: base flow, snowmelt, and summer flow. The base-flow period begins in late September or early October and extends until the following April. During the base-flow period, streamflow is fairly uniform. Depending on temperature and winter snowfall amounts, the snowmelt period begins about mid-April and extends until about mid-June. Early in

Attachment 3c

the snowmelt period, streamflow increases substantially from base-flow conditions. Streamflow decreases fairly quickly after peaking in early to mid-May. The summer flow period follows the snowmelt period and generally begins about mid-June and extends through September, sometimes into October. Streamflow during the summer period is highly variable. Changes in streamflow during the summer are primarily affected by afternoon and evening thunderstorms.

Trends in High Streamflow

A significant increasing trend in annual peak streamflow at the Pikeview site was detected for the post mid-1970’s. No trends were detected in annual peak streamflow at the other five sites during this period. Evaluation of long-term streamflow data at Pueblo (1941–65, 1971–99) indicates instantaneous streamflows of 10,000 cubic feet per second or greater occurred more frequently during the 1990’s than any decade since the 1940’s. Annual peak streamflows during 1994–97 and 1999 ranked in the top 27 percent of all time recorded annual peak streamflows. However, although large streamflow events occurred more frequently during the 1990’s than during previous decades since the 1940’s, the magnitudes of streamflows that occurred during the 1990’s were not atypical of historical peaks.

Examination of streamflow data and historical accounts of the period indicates that the four largest streamflow events at Pueblo occurred during the spring snowmelt period, mid-April to mid-June. Each of these events were caused by several inches of rainfall that fell during intense storms over large areas of the Fountain Creek watershed. In some areas, rainfall amounts that occurred during these intense storms exceeded the average annual rainfall in the Colorado Springs area. Also significant is that the most recent event, the flood of April 30, 1999, was estimated to be about a 15-year flood for the Pueblo site (Stogner, 2000). A 15-year flood is a streamflow with a probability of recurring once every 15 years.

Since 1977, highly to moderately significant increasing trends in at least one high-streamflow statistic were detected at all sites; most sites had increasing trends in all three daily mean high-streamflow statistics (Q70, Q90, and Q100). Analysis of changes in streamflow for five stream reaches also indicated that significant increasing trends in the 70th percentile (Q70) streamflow statistic occurred in four reaches: Pikeview to Nevada Street, Near Colorado Springs to Nevada Street, Nevada Street to Security, and Security to Pinon. No trends in high streamflow were detected for the reach from Pinon to Pueblo. **In the reach from Nevada Street to Security (fig. 1), the average annual per-square-mile increase in streamflow for the Q70 and Q90 statistics was about five times greater than the other reaches that had increasing trends. Additionally, the reach from Nevada Street to Security showed the greatest annual change in total streamflow during high flows (fig. 2). This indicates that, on average, the intervening drainage area for the reach between Nevada Street and Security contributed more total flow and more flow per square mile than any of the other drainage areas studied.** This trend probably is attributable to changes in land use from rangeland to urban that occurred in the intervening drainage area over the past 23 years, which altered the hydrologic response and increased storm runoff.

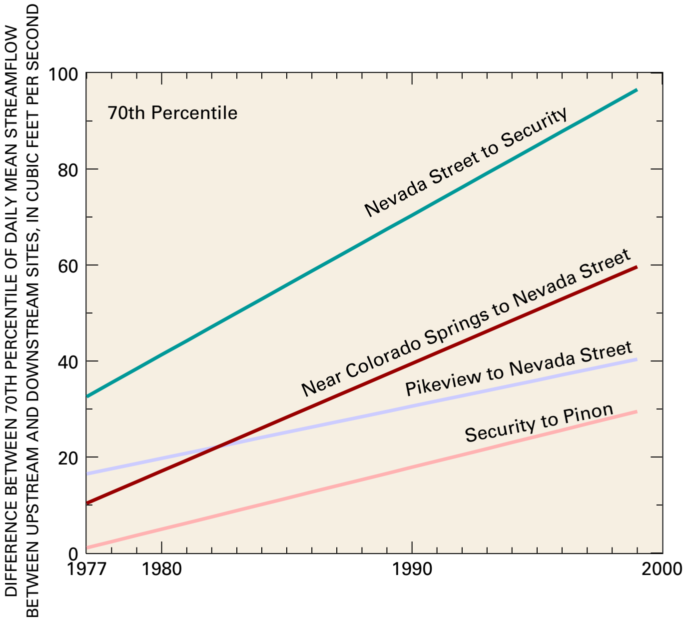


Figure 2. Trend of change in the 70th percentile of daily mean streamflow for selected stream reaches, 1977–99.

The larger frequencies and high significance level of trends detected in the 70th percentile streamflow statistic may indicate that changes in land use within the watershed have increased the rate and magnitude of runoff for more moderate rainfall events that occur more frequently in the watershed than extreme rainfall events that affect the instantaneous peak and annual maximum daily mean streamflows.

Attachment 3d

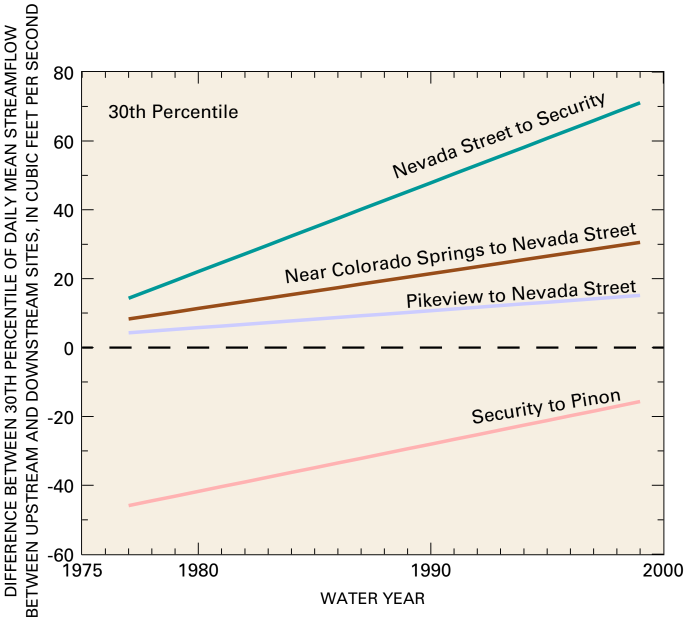


Figure 3. Trend of change in the 30th percentile of daily mean streamflow for selected stream reaches, 1977–99.

Trends in Low Streamflow

Analysis of low streamflow statistics generally indicates that low streamflows have significantly increased throughout most of the watershed, particularly since the early 1980’s. In addition, the average annual rate of increase in the low streamflow statistics have tended to be largest at the sites downstream from Nevada Street. Downstream from Nevada Street, effluent from the Colorado Springs Waste-Water Treatment Plant (WWTP) and several other WWTP’s discharge to Fountain Creek. Analysis of changes in streamflow for five stream reaches indicated that significant increasing trends in the 30th percentile (Q30) streamflow statistic occurred in four reaches: Pikeview to Nevada Street, Near Colorado Springs to Nevada Street, Nevada Street to Security, and Security to Pinon.

The average annual increase in streamflow for the low streamflow statistics (Q0, Q10, Q30) generally was from 5 to 10 times greater in the reach from Nevada Street to Security than the other reaches that had increasing trends. Additionally, the reach between Nevada Street and Security generally showed the greatest annual change in total streamflow during low flows (fig. 3). The large annual increases in the low streamflows in the reach between Nevada Street and Security have resulted from increased waste-water treatment-plant discharge associated with population growth, importation of transbasin water, and management of the Fountain Creek transbasin return-flow exchange decree, which allows Colorado Springs to exchange return flows from transbasin imports to other locations in the Arkansas River basin.

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(719) 544–7155, ext. 106

Printed on recycled paper

(Attachment 4a)

This trend in imperviousness corresponds to the type of land use predominately found in urban areas. The Colorado Springs Composite (CSC@) had the highest current and future projected level of imperviousness (45%). The current and future imperviousness for watersheds classified as Non-Supporting are shown in Table 2.

Table 2: Current and Future Imperviousness for Non-Supporting Watersheds

	Current	Future
Colorado Springs Composite (CSC2)	45%	45%
Lower Monument Composite (MC6)	39%	42%
Cottonwood Creek (MC7)	29%	44%
Sand Creek (CSC6)	27%	43%
Jimmy Camp Creek (CSC7)	7%	37%
Cheyenne Mountain Composite (CSC5)	26%	28%

Table 3 shows changes in watershed classification based on current and future imperviousness.

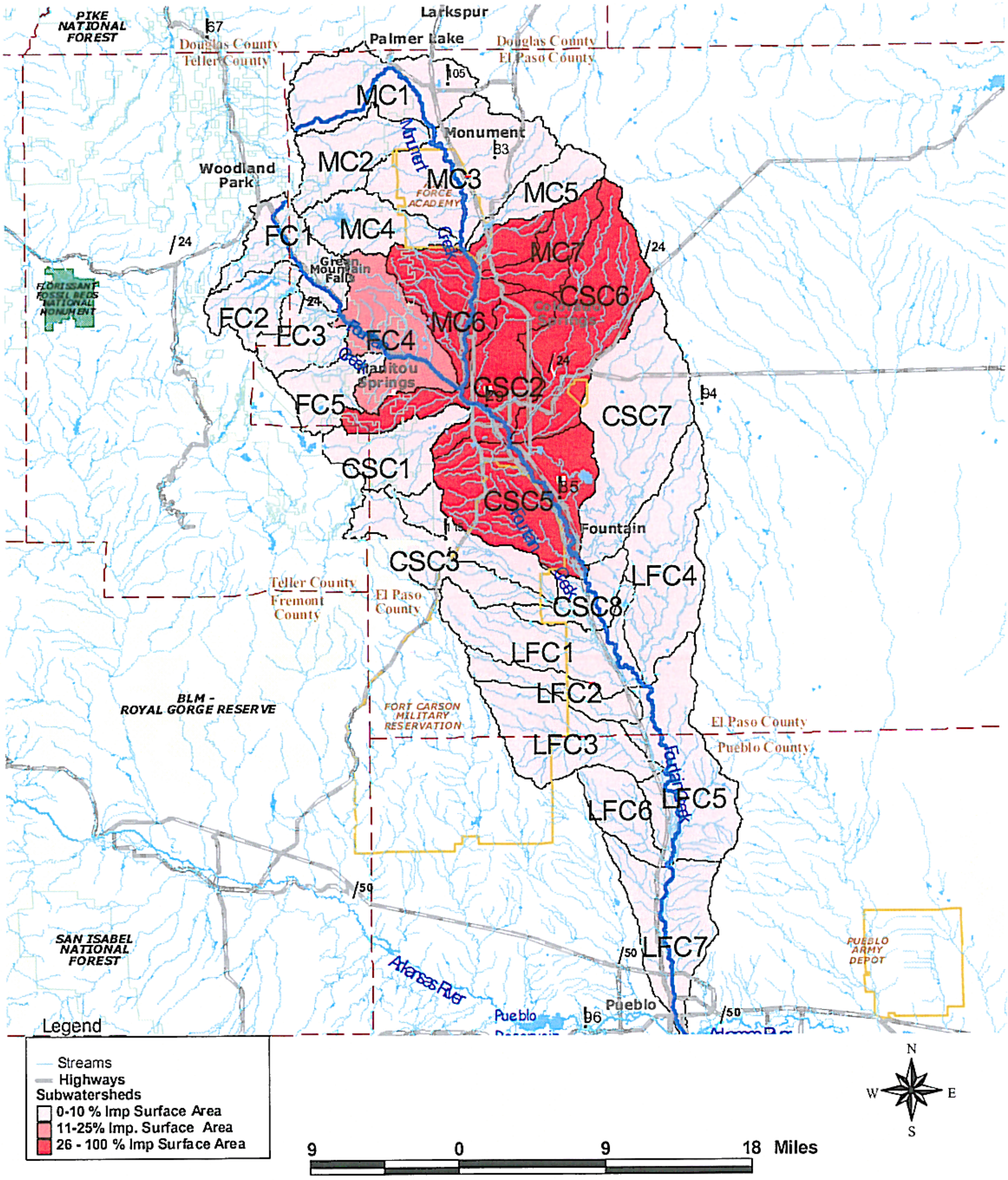
Table 3: Current and Future Watershed Classification

	Current	Future
Sensitive (9 – 10%	21	15
Impacted (11 – 25%)	1	6
Non-Supporting (26 – 100%)	5	6

The changes in percent imperviousness show that most future growth will be concentrated in existing areas and continued pressure will be placed on the stream and creeks in these areas. Current levels of imperviousness are color coded on Figure 1 and future levels of imperviousness are color coded on Figure 2. Most of the eleven subwatersheds identified as having increasing levels of imperviousness were located in the northern and eastern portion of the watershed.

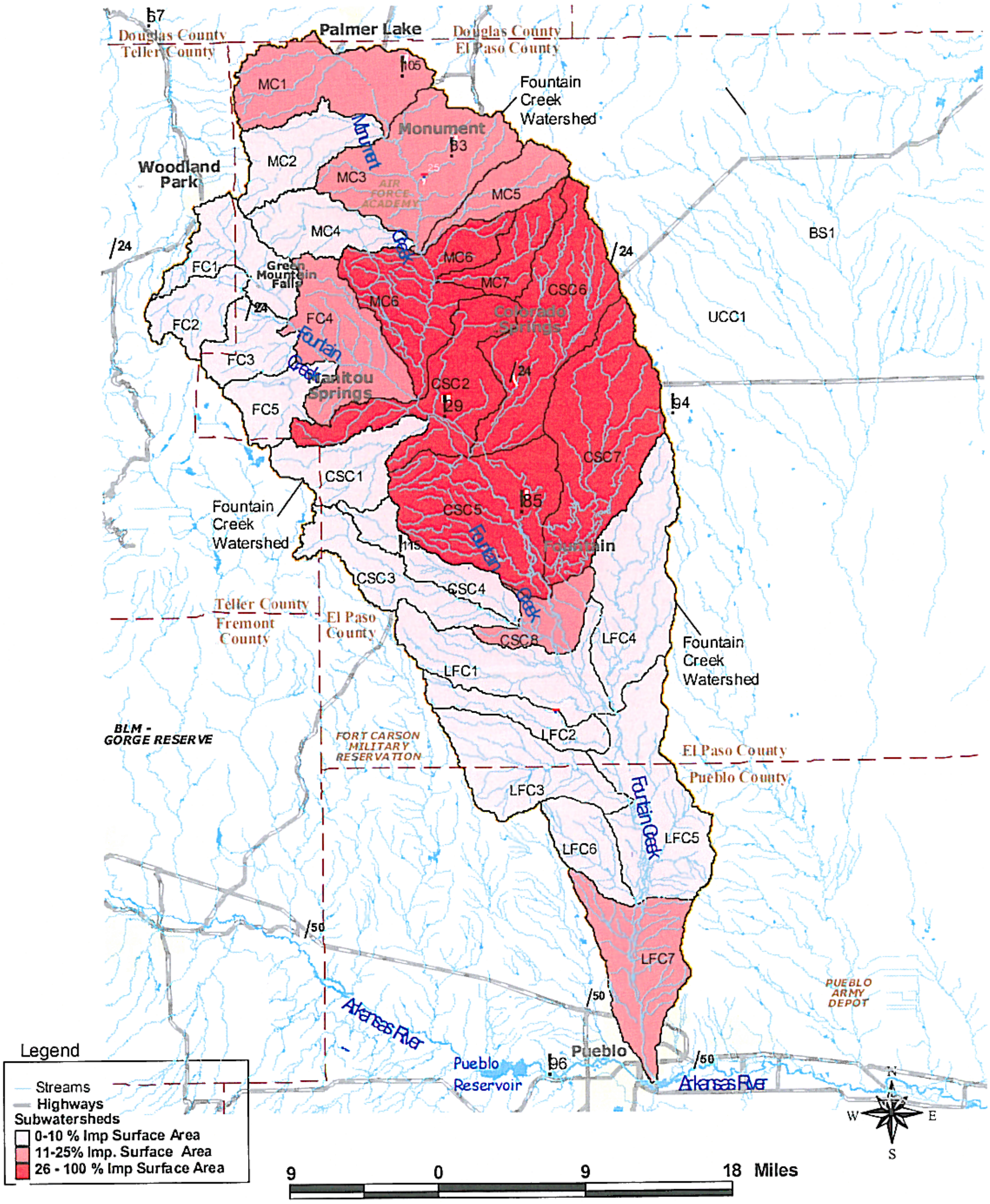
(Attachment 4b)

Figure 1
Fountain Creek Subwatershed Analysis: Current Impervious Surface Area



(Attachment 4c)

Figure 2
Fountain Creek Subwatershed Analysis: Future Impervious Surface Area



(Attachment 5)

Fountain Creek Watershed Study
Initial Recommendations
August 17, 2007

General Recommendations

- Modify development policy to include more consideration of open space needs in development (focus on more habitat development within traditional parks).
- Rehabilitate riparian areas to a healthy, functioning condition.
- Preserve existing wetlands and create additional wetlands where opportunities exist.
- Limit sediment sources during construction by minimizing overlot grading in large scale developments.
- Modify development policy to include the concepts put forth by the Center for Watershed Protection (cwp.org) and Low Impact Development (lowimpactdevelopment.org).
- Modify development policy to require the post-development hydrographs to match the predevelopment hydrographs for peak, volume, and timing.
- Modify development policy to require the post-development sediment transport to match the pre-development sediment transport.
- Collect sediment load data for the Fountain Creek Watershed so that appropriate sediment transport modeling can be calibrated for all future development in the watershed.
- Modify development policy to require assessment of downstream impacts, and particularly the impacts due to small frequently occurring storm events such as the 2-yr. event.
- Modify development policy to include involvement by regulatory agencies and stakeholders as soon as possible in the development process.
- Entities must follow through with review of development plans, adherence to approved plans through the construction process, and inspection/maintenance of completed projects.
- Staff must be educated/trained in the principles of geomorphology and sediment transport to support the review process for new development and to support the ongoing efforts of their entities in the watershed.
- Entities should use the hydrologic and hydraulic models developed as a part of the Fountain Creek Watershed Study to update their FEMA floodplains.
- Entities should use the models developed as a part of the Fountain Creek Watershed Study to certify their levees.
- Remedial projects that affect Fountain Creek or its tributaries should utilize stable channel design.
- Entities constructing remedial projects in the watershed should develop a consistent approach and methodology for project design and construction.
- Create a Fountain Creek Watershed Authority that could serve as a funding source for large scale projects, and to assist entities with training, review, and/or maintenance.

Flooding on Fountain Creek

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Problem Statement:

Fountain Creek lies within a 930-square-mile watershed with an elevation range of 14,140 feet to 4,640 feet. Development within the watershed continues to increase with associated increase of impervious areas generating increased runoff and more frequent flood events. Significant flood events have occurred on Fountain Creek causing damage to public infrastructure, utilities, adjacent farmlands and residential communities. Flooding compounds problems associated with increased sedimentation and erosion.

Facts:

New studies conducted by the US Army Corp of Engineers (CORPS) indicate a reduction in flood peaks from prior Federal Emergency Management Agency (FEMA) hydrology (see attachment 1). However, channel capacities have been reduced in the lower reaches of the Fountain Creek due to sediment build up and heavy vegetative growth restricting channel widths and reducing channel depths. Critical reach analysis was studied on Monument Creek, Black Forest Tributary, Cottonwood Creek and Jimmy Camp Creek. The study was conducted to evaluate sedimentation, erosion and flooding on the selected tributaries and the full report is contained in the US Army CORPS study, “Critical Reach Study” for the Fountain Creek watershed. Study results indicate problems with sediment, flooding and channel degradation ultimately threatening buildings and infrastructure.

FEMA is currently studying Fountain Creek to develop new DFIRM (Digitized Flood Insurance Rate Maps) mapping for the Fountain Creek corridor. New mapping will utilize hydrology and hydraulic analysis completed in the US Army CORPS study of the Fountain Creek watershed. FEMA mapping will require the certification of all levees and floodwalls providing flood protection, before flood plain maps can reflect areas protected by levee and floodwall systems. Preliminary DFIRM mapping by FEMA reflect flood plain changes on Fountain Creek. Recent 100-year hydrologic and hydraulic interim studies indicate freeboard deficiencies on the Fountain Creek levee system in the Pueblo area. Lower reaches of the Fountain Creek levee system do not provide 3’ and 4’ height above water surfaces required by FEMA due to loss of channel capacity because of sediment build up. While we cannot document specifics on consumptive and non-consumptive use, flooding does generate excess water for low priority downstream water rights on Fountain Creek and the Arkansas River.

Hydrologic and Hydraulic studies have determined a multiple number of flood events at various locations along Fountain Creek as shown in the CORPS Watershed Study. (See Watershed Study, www.fountain-crk.org, for detailed hydrology of all sub-basins within the watershed.) Fountain Creek generates the majority of flooding events on the Arkansas River since the Pueblo Dam controls releases from the Arkansas River.

Historic flood events have occurred routinely on Fountain Creek with the most recent occurring in 1999 with a flow of 20,000 cubic feet per second (cfs) recorded at the United States Geological Survey (USGS) gauge in Pueblo. Embankment failures in May 2007 caused additional flooding in low-lying North Side neighborhoods in Pueblo. Flood events are documented with photos and news reports from many sources within the watershed (see attachments 2a-2s).

Flood attenuation (peak flow reduction) occurs in downstream segments of Fountain Creek due to off-line storage and channel storage. In 1989, levee systems were constructed through Pueblo to protect the East Side community and the downtown area from flooding caused by a100-year flood event. Private properties were purchased by the City of Pueblo to remove development from the flood plain and provide additional hydraulic capacity within the channel. Current efforts by federal and state agencies, railroads, cities, counties and stormwater enterprises strive to maintain channel stability by constructing detention facilities, grade control structures, hard points (jetties), embankment protection (riprap) and other channel improvements. Vegetation controls and debris removal have been implemented on Fountain Creek to increase channel capacity and improve flow characteristics. LID (low impact development) source controls are under review and study by the Fountain Creek Vision Task Force to reduce impacts of future development. The reduction of runoff volumes through the utilization of source controls will provide a reduction in erosion, sedimentation and flooding as well as improvement in stormwater quality. NPDES (National Pollutant Discharge Elimination System) permits require implementation of BMP’s (Best Management Practices) including runoff reduction techniques to address runoff volume reduction and improved stormwater quality. The City of Colorado Springs, El Paso County, the City of Pueblo and Pueblo County are all responsible for the implementation and enforcement of NPDES permit.

As impervious areas increase in the watershed, Fountain Creek will experience more frequent flood events from storms of lesser magnitude (attachment 3 USGS Report, “Trends in Precipitation and Streamflow in the Fountain Creek Watershed). The Fountain Creek Watershed Study predicts minor increases in flood peaks for major storm events because saturated conditions in the watershed more closely match runoff from impervious surfaces. Future development within the watershed will continue to increase instabilities on Fountain Creek because of increased runoff, volumes and peak flows.. PPACG studies indicate significant increases in imperviousness in 11 sub-basins within the Fountain Creek watershed with major impervious area increases in Jimmy Camp Creek, Sand Creek and Cottonwood Creek (see attachments 4a, 4b & 4c) The USGS report also indicates significant increases in high streamflows in Fountain Creek between Nevada Street and Security because of development within this area of the watershed. "In the reach from Nevada Street to Security, the average annual per-square-mile increase in streamflow was about five times greater than the other reaches that had increasing trends. Additionally, the reach from Nevada Street to Security showed the greatest annual change in total streamflow during high flows. This indicates that, on average, the intervening drainage area for the reach between Nevada Street and Security contributed more total flow and more flow per square mile than any of the other drainage areas studied. This trend probably is attributable to changes in land use from rangeland to urban that occurred in the intervening drainage area over the past 23 years, which altered the hydrologic response and increased storm runoff. …..changes in land use within the watershed have increased the rate and magnitude of runoff for more moderate rainfall events." Attachment 4c notes the impacts of increasing impervious surface in the future for the entire watershed and the need for mitigation going forward.

This USGS Report also notes significant increases in low streamflows in the same reach between Nevada Street and Security. "The average annual increase in streamflow for the low streamflow statistics generally was from 5 to 10 times greater in the reach from Nevada Street to Security than the other reaches that had increasing trends. Additionally, the reach between Nevada Street and Security generally showed the greatest annual change in total streamflow during low flows. The large annual increases in the low streamflows in the reach between Nevada Street and Security have resulted from increased waste-water treatment-plant discharge associated with population growth, importation of transbasin water; and management of the Fountain Creek transbasin return-flow exchange decree, which allows Colorado Springs to exchange return flows from transbasin imports to other locations in the Arkansas River basin." Future flows on Fountain Creek will likely reflect similar increases in areas experiencing continued growth and development.

As a result of projected changes within the watershed and documented changes in streamflows in Fountain Creek, the US Army Corps of Engineers has made some general recommendations regarding future development within the watershed (see attachment 5). These general recommendations address policies and strategies to reduce flood risk, sedimentation and erosion including the rehabilitation of riparian areas, creation of off-channel diversion and storage, and the preservation of existing wetlands, as well as the creation of additional wetlands. The recommendations predominantly stress LID (low impact development) as the means to mitigate existing conditions and wisely manage future impervious surface areas and increased runoff. In addition to the items mentioned in attachment 5, the Army Corps study also identified potential projects and sites for flood risk reduction, eco-system restoration, and channel stability.

The Fountain Creek Vision Task Force is currently evaluating existing land use regulations and the impact of future development on sedimentation, erosion and flooding on Fountain Creek.