BOULDER'S FLOODS AND FLOOD MANAGEMENT: PAST & PRESENT

Silvia Pettem

Boulder's Floods and Flood Management: Past & Present is the third in a series of books published by the City of Boulder's Public Works/Utilities Department.

The previous books in the series are:
- Boulder's Waterworks: Past & Present (2015)
- Boulder's Wastewater: Past & Present (2015)

Boulder's flood management history rests on the shoulders of many people, both in Boulder's past and present. The process started with members of the Boulder City Improvement Association who, in 1908, looked into the future and invited landscape architect Frederick Law Olmsted, Jr. to suggest new floodplain management plans for Boulder. After Olmsted's many suggestions, along with those from additional outside studies, the City, in 1944, brought in landscape architect/city planner S. R. DeBoer. Both Olmsted and DeBoer left lasting recommendations that influenced Boulder as we know it today.

Then, in the 1950s, came geographer Gilbert F. White, known as "the father of floodplain management." He was in Boulder for the 1969 flood, followed, in 1976, by a major wake-up call — the Big Thompson flood in nearby Larimer County. After that, flood management policies really got underway with the City's own experts in the field overseeing plans and master plans, greenways programs, new utilities, and flood management policies. All got tested — and all passed —during the unprecedented rains that fell on Boulder in September 2013.

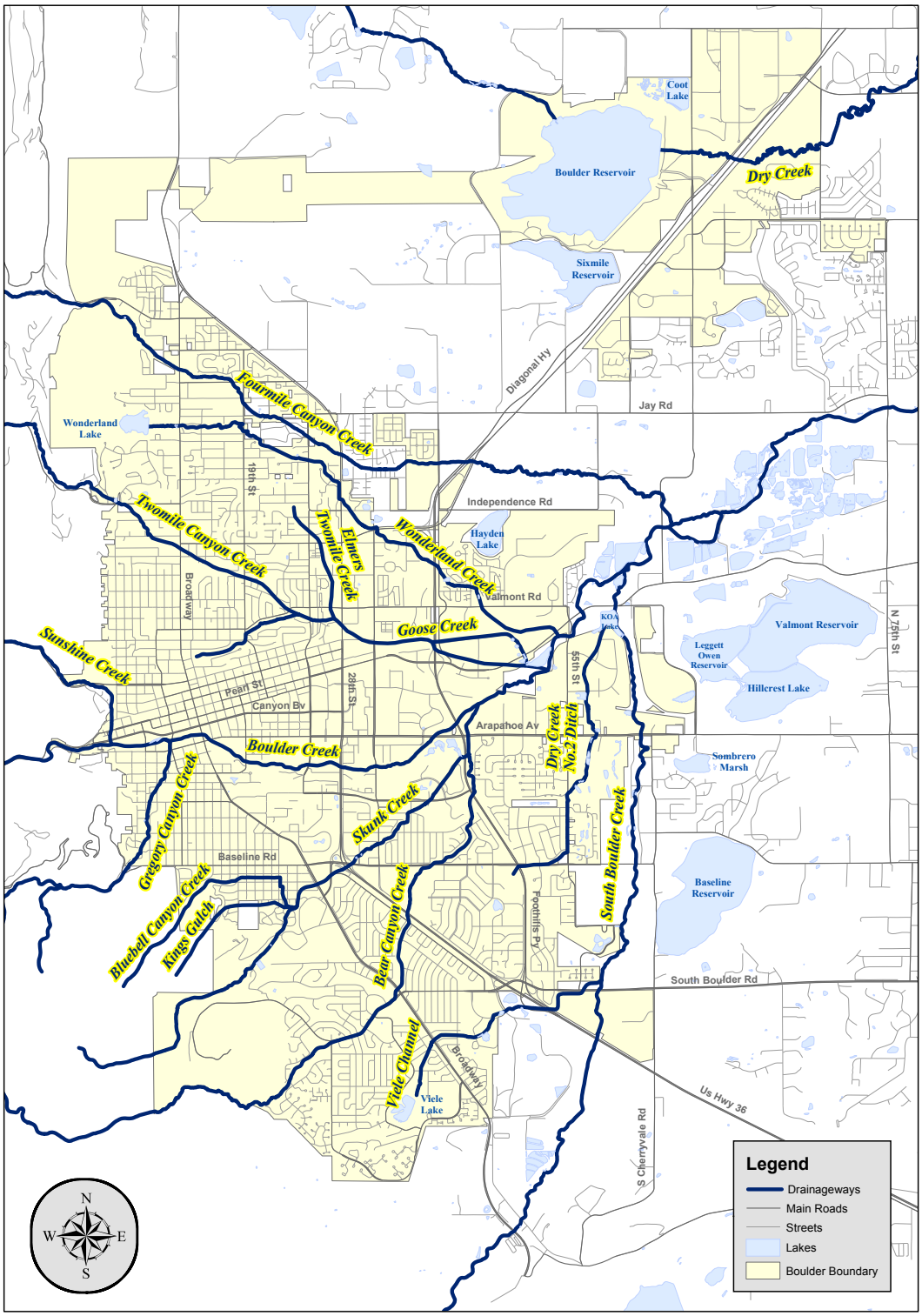
This book would not have been possible without Bob Harberg, Principal Engineer for the City of Boulder's Utilities Department, who spearheaded the publication of *Boulder's Floods and Flood Management: Past & Present*, as well as the previous books in the series. Harberg also acted as chief editor, proof-reader, and consultant, graciously answering the author's frequent technical questions. Thanks, too, to Jeff Arthur, Ken Baird, and Annie Noble for their input.

I also appreciated the assistance of Kaaren Davis, Ryan Martin, and Christin Shepherd. Thanks goes, too, to Marti Anderson, Hope Arculin, and Wendy Hall for their assistance in obtaining photographs from the Carnegie Branch Library for Local History's collections.

Silvia Pettem

(Front cover: Boulder Creek during the flood of 1894, *Carnegie Branch Library for Local History, Boulder Historical Society collection, 715-2-40 #1;* Gilbert White Memorial, photo by Silvia Pettem. Back cover: Gilbert White Memorial, photo by Bob Harberg.)

BOULDER'S FLOODS AND FLOOD MANAGEMENT: PAST & PRESENT



City Of Boulder

Major Drainageways

CFS Utility Master Plan, October 2004,
Courtesy City of Boulder

Figure 3-1

Introduction

The Comprehensive Flood and Stormwater Utility Master Plan defines the Boulder Creek Watershed as encompassing 440 square miles, extending from the Continental Divide to the high plains east of Boulder. The City is impacted by the following 15 major drainageways/creeks which all eventually feed into Boulder Creek north of the Valmont Reservoir.

- Bear Canyon Creek
- Bluebell Canyon Creek
- Boulder Creek
- Boulder Slough
- Elmer's Twomile Creek
- Fourmile Canyon Creek
- Goose Creek
- Gregory Canyon Creek
- King's Gulch
- Skunk Creek
- South Boulder Creek
- Sunshine Creek
- Twomile Canyon Creek
- Viele Channel
- Wonderland Creek

Boulder's area is nearly "built out," resulting in a highly urbanized drainage setting. Natural hazards related to stormwater and flood management are, in particular, complicated by limited building space in a floodplain that is already massed with structures.

This publication addresses Boulder's flood and flood management history — particularly how Boulder's residents have interacted with their natural environment. The historic perspective is important, as learning how we have dealt with our past will shape how we deal with our future. And, it is up to us — residents of Boulder, Colorado.

As Gilbert F. White wrote in his 1942 doctoral dissertation, "Floods are acts of God, but flood losses are largely acts of man."

(KNOWN) MAJOR FLOODS IN BOULDER, COLORADO

NINETEENTH CENTURY
1844, Month unknown
1864, May and June
1876, May
1894, May
1897, June

TWENTIETH CENTURY
1909, July
1914, June
1919, August
1921, June
1938, September
1942, April
1969, May

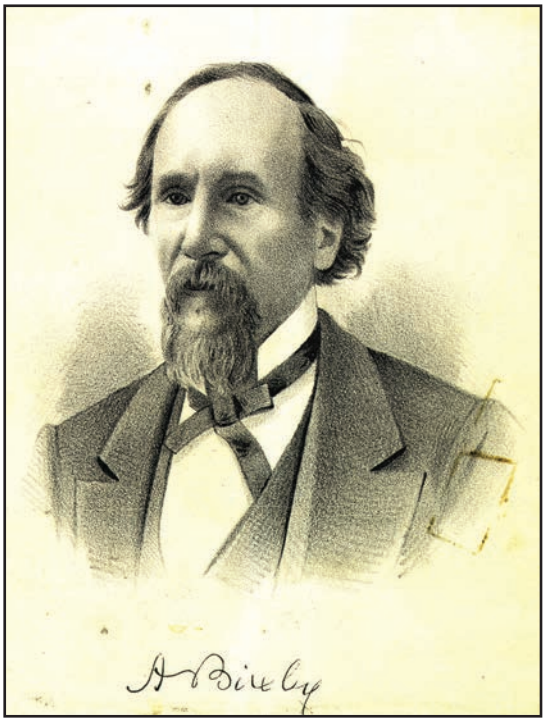
TWENTY-FIRST CENTURY
2013, September

Nineteenth century

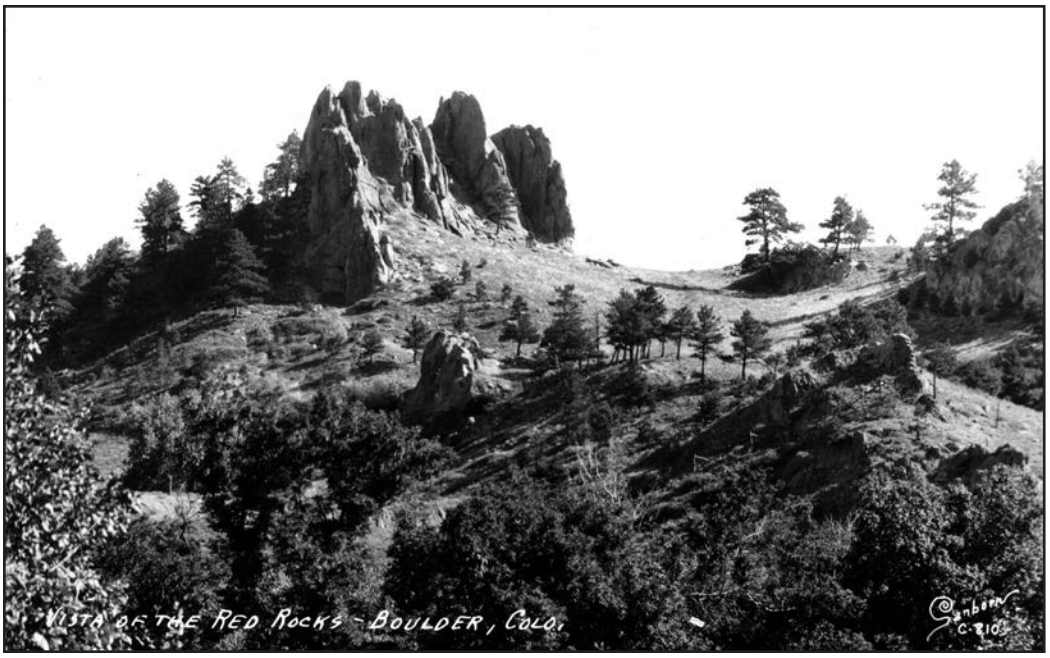
PRE-SETTLEMENT

In October 1858, gold prospectors led by Captain Thomas Aikins camped at Red Rocks, near the mouth of Boulder Canyon. Twenty years later, Aikins gave an account of his party's arrival to journalist Amos Bixby, who, at the time, was compiling a (then-brief) history of Boulder County. According to Aikins, Arapaho Chief Niwot (also known as Chief Left Hand) initially told the white men, "Go away. You come to kill our game, to burn our wood, and to destroy our grass." Instead of leaving, however, Aikins and his men invited the Arapahos to a feast. Bixby stated, "In a gush of gratitude, the Chief promised that Indian and white man should live together in peace."

As the story goes, another chief named Bear Head felt that Niwot had made a mistake. So Bear Head gave the Aikins party three days to leave. On the third day, Bear Head went to the prospectors' camp and related a dream.



Amos Bixby wrote the first book that included a history of Boulder. *Carnegie Branch Library for Local History, Boulder Historical Society collection 220, Bixby, Amos*



Captain Aikins and his party of gold prospectors first camped near Boulder's Red Rocks, overlooking Boulder Creek. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 208-4-14 #7*

As Bixby stated:

> He [Bear Head] dreamed that he stood on a hill and saw the Boulder Creek swell to a flood; how his people were swallowed up by the rush of water while the white people were saved. It was supposed that this story--the invention of savage imagination--was made up as an excuse for declining to fight for the possession of the country, as the Indians had threatened to do. (Bixby, Amos, *History of Clear Creek and Boulder Valleys, Colorado, p.380*)

Although the Arapahos did not leave records of floods and flood dates, the Front Range, in the early 1800s, was crisscrossed by explorers and fur traders who did pass on this information. The earliest remembered flood in the South Platte River Basin (which may have affected the Boulder Creek area as well) occurred in 1844. This flood was later noted in an undated article in the *Weekly Commonwealth* (a Denver newspaper):

> In the summer of 1861, we were one of Lieutenant Berthoud's exploring party to and from Salt Lake City. Major James Bridger, one of the most thoroughly practical explorers in the West, was guide on that trip. He proceeded to tell us that many years ago [in 1844], while on a journey from Fort Laramie to some other point, he found the bottoms between Cherry Creek and the [South] Platte River covered between bluffs of the two, which compelled him to remain on the opposite bank from [the present site of] this city [Denver]. It was nine days before he was able to effect a crossing." (*Weekly Commonwealth*, May 25, 1864 and Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado, p.13*)

LAY OF THE LAND

Boulder Creek Basin

Boulder Creek has its sources at 13,500 feet on the Continental Divide, twenty-two miles west of Boulder. The source waters, which form in rough terrain, drain into North Boulder Creek and Middle Boulder Creek; these two creeks meet at Boulder Falls and continue as Boulder Creek down to Orodell, in lower Boulder Canyon, where Fourmile Creek flows down from the north to join the waterway.

Barker Reservoir, east of Nederland, was built in 1910 and flows into Middle Boulder Creek.

In the early days, two stream gauges operated along Boulder Creek. One gauge, located at a site approximately two-and-one-half miles downstream from Orodell, in Boulder Canyon, operated intermittently from 1887 to 1916 and continuously from 1916 to the present. Another gauge at Orodell operated intermittently from 1906 to 1914 and continuously from 1916 to present. (Oaks, Sherry D., *Floods in Boulder County, Colorado, A Historical Investigation*)

Fourmile Canyon Creek (not to be confused with Fourmile Creek) is the most northern stream in the Boulder Creek Basin. South of Fourmile Canyon Creek are Wonderland Creek, Twomile Creek, Elmer's Twomile Creek, and Goose Creek. Further to the south, Sunshine Creek flows down a gulch and turns south at Mapleton Avenue, moving toward its confluence with Boulder Creek.

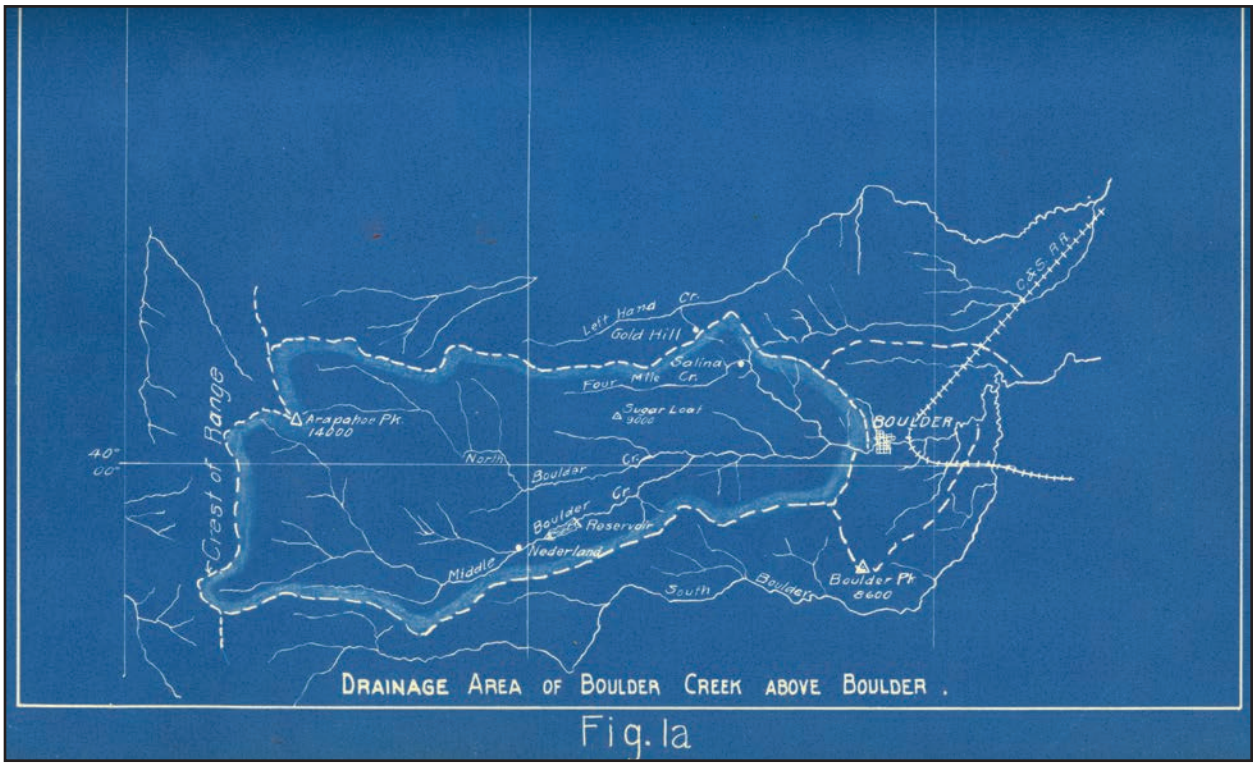
From the first draw south of Boulder Canyon, Gregory Canyon Creek runs along Baseline Road, then wanders through the University Hill neighborhood to merge with Boulder Creek at Ninth Street. South of Gregory Canyon Creek lies Fern Creek, King's Gulch, Skunk Creek, and Bluebell Canyon Creek. Further south, Bear Canyon Creek flows out of the foothills, travels along Table Mesa Boulevard, then turns north to join Boulder Creek. South of this is Viele Lake, a man-made channel, and David's Draw is farther south.

Finally, South Boulder Creek rushes down Eldorado Canyon and eventually wanders northward for 9.3 miles to join Boulder Creek two miles east of the foothills. Gross Reservoir, which was built on the South Boulder in 1955, is seven miles upstream from the town of Eldorado Springs. A stream gauge operated intermittently on the South Boulder, one mile east of Eldorado Springs from 1888 to 1904, and then was operated continuously.

St. Vrain, Coal Creek, and Rock Creek Basins

Boulder Creek and its tributaries are not the only drainages along the Front Range with a potential for flood hazard. To the north lies St. Vrain Creek — its tributaries are James Creek and Left Hand Creek — which flows through the Longmont area and has caused flood damage along its course from cloudburst activity.

South of the Boulder Creek drainage are Coal Creek and Rock Creek, which swing to the north into broad floodplains near Superior, Louisville, and Erie. All of these Front Range creeks eventually flow into the South Platte River east of Longmont, eighteen miles east of the mountains, which, in turn, joins the North Platte River in Nebraska.



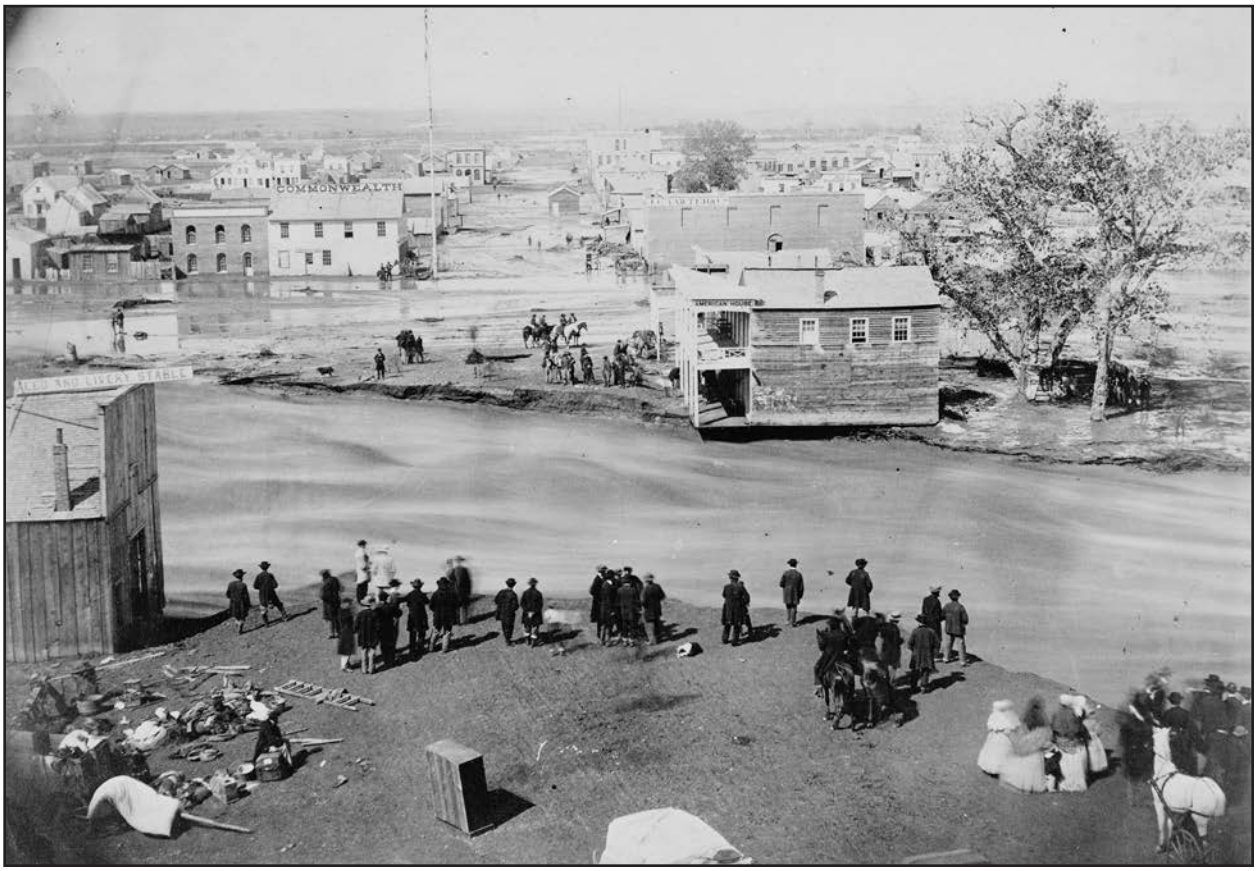
Boulder Creek drainage area, from the Metcalf and Eddy 1911 report.
Carnegie Branch Library for Local History.

FLOODS THAT MADE THE NEWS: Settlement through the 1890s

Other than Bridger's memories of the 1844 flood, no known first-hand accounts of Front Range floods existed until there were newspapers and newspaper writers to report the days' events. In 1858, when Captain Aikins and his party prospected west of present-day Boulder, gold-seekers and others to the south searched for gold along Clear Creek and the South Platte, as well as their tributaries. These miners and prospectors relied on fledgling settlements in the Denver area for their news and supplies.

Denver was founded in November 1858, and cranked out its first newspaper, the *Rocky Mountain News*, in May 1859. Boulder was founded in February 1859, but it didn't have a newspaper until the *Boulder Valley News* printed its first edition on April 3, 1867. The short-lived publication was followed by more than a dozen others that included the *Boulder County Courier, the Boulder County Herald,* and the *Boulder Sentinel*—all prior to 1891 when the *Boulder Daily Camera* (now known simply as the *Camera*) ran its first stories.

The water along Denver's Cherry Creek began rising on May 19, 1864, making that year's flood the first well-documented flood on the Front Range. In this rare photo, the American House Hotel hangs over the river bank. The *Commonwealth* newspaper office is in the background on the left.
Courtesy Library of Congress



On Cherry Creek, the raging flood waters engulfed the office of the *Rocky Mountain News,* even tearing its printing press from a stone floor and washing the press a half mile downstream. Due to the damage, the *Commonwealth* printed the *Rocky Mountain News's* stories for more than a month.

In a May 23, 1864, account, a writer noted that the flood "was caused by two or three days heavy consecutive rains at its head, on the great watershed known as the Divide, where the water runs off as fast from the roof of a house." As soon as the *News* was literally back on its foundation, its owner, Byers, bought out his former competitor.

How much rain fell in Boulder, and how Boulder-area drainages were affected is unknown. In Denver, however, heavy rains came again on June 9, 1864, and lasted about fifty hours. According to historian Phyllis Smith, the resulting flood also ravaged the homestead of William Hake, in Superior, where the waters uncovered a vast seam of coal. On this land south of Boulder, the coal lay undeveloped until 1895 when Hake contracted with James Hood to sink the first shaft of the Industrial Mine, a major coal producer in the Boulder area. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado,* p.13)

Other reports of the June 1864 flood in the Boulder area were limited to short items sent to Denver and mountain newspapers by correspondents. The *Daily Mining Journal,* in Black Hawk, noted that the flour mill in Boulder was "swept off." (*Daily Mining Journal*, June 11, 1864) Another brief item from the *The Mining Journal* noted, "Mr. Griswold came in from the Valley last evening. Says crops look fine on Boulder, St. Vrain's, and Left Hand [creeks]. Were not damaged so very tremendously." (*The Mining Journal*, June 29, 1864)

Although crop damage was of concern to farmers, floods often brought good news for miners. Just as the flood uncovered the coal seam on Hake's farm in Superior, Denver-area gold prospectors were encouraged by the changing streambeds. A writer for the *Rocky Mountain News* reported:

> In the recent floods, good prospects were found in the floating sands brought down, whenever and wherever tried. A prospect hole sunk in the bed of the creek within the city limits gave from two to three cents to the [gold] pan, at the depth of three or four feet. A few months ago, a boulder was picked up in the bed of the creek (by an employee of the *News* office) which was composed of white quartz and pyrites. The recent floods have, of course, laid bare many new indications of leads, so that no better time than now for prospecting will ever be found. The dry ravines and gullies are all cut out anew, and if leads exist, they will doubtless show themselves in such localities. We have every confidence that some valuable discoveries will soon be made, and, if so, they will prove of incalculable advantage to Denver. (*Rocky Mountain News*, June 29, 1864)

A Boulder County gold prospector is shown panning in a stream. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 141-6-79*

Another flood hit the Front Range on May 22, 1876, and this time there were newspapers in Boulder to report the latest news. That same year, Colorado was granted statehood. The following article in the *Colorado Banner* was published three days after the rain storm began:

> GREAT HEAVINGS, DIDN'T IT RAIN!
> The Doings of the Storm of Sunday and Monday -- Cellars Flooded -- Railroad Damaged -- Trains Stopped -- Telegraph Down -- Erie Afloat
>
> Sunday evening one of Colorado's zephyrs began blowing from the mountains, raising clouds of dust as usual. There was a dampness in the air which betokened rain, but none would have predicted what came, for "it never rains in Colorado." A little after eight o'clock, the first drops fell, but soon ceased. At nine o'clock, a heavy hail storm came up, making a tremendous racket as the icy boulders from the skies fell thick and fast.
>
> Vivid flashes of lightning leaped across the sky, and peal on peal of thunder rolled along the clouds, as if all the artillery of heaven had been let loose on Boulder and vicinity. The storm abated none during the night, but torrents

came down ceaselessly, making pools and ponds all about town. It kept up Monday without intermission, now in heavy masses, now as if resting in lighter quantities.

THE DAMAGE

The first note of damage done was the partial flooding of the cellar beneath Woodruff, Squires & Co.'s store. Austin's cellar, where the new building is to rise, was a perfect pond. During the forenoon, the ground which had been thrown on the outside of the eastern wall began settling, and, acting like a wedge, threw down about one-third of it and badly damaged about one-half. Some of the ground in the rear of Boettcher's building went into his cellar. The cellar of Welch Bros. was flooded, and six tons of oats [and] a number of bales of hay [got] wet. The cellar of Pell & Nicholson's Hotel was full to the top and was overflowing. At places the foundation, just rising, fell in. Many cellars in East Boulder were flooded. The ditch leading water to Sternberg's Mill was broken.

ELSEWHERE

At Gold Hill, almost two feet of snow fell. At Sugar Loaf it was fifteen inches. The roads into the mountains are badly cut up, in places the gathering waters cutting deep ravines. The coach to Caribou came to a stand near the falls, large boulders, snow, and dirt having come down the mountainside and obstructing the way. Frank Carpenter unhitched the horses and took passengers and mails up on horseback. The road up Four Mile was put in a fearful condition and many bridges washed away. Telegraphic communications were cut off with the outer world, and Sunshine and Gold Hill only could be reached by wire. The Boulder Valley [Rail] Road was torn up at several places, and no mail has come over the road since last Saturday.

At Valmont the Boulder Creek spread havoc abroad, swelling beyond its bed, washing out the road, carrying off bridges, and spreading over nearly a half mile of ground. At Erie the storm played especial havoc. It is here where the railroad makes a large curve around a bottom, in which bottom the town is situated. Coal Creek comes through the valley between the railroad and the town, and by the gathering of water, the small stream became a river. About seventy rods of embankment of the railroad was washed away, and the waters crowded upon the town, being in some places as high as seven feet.

Of course all the cellars were filled with water, outhouses went floating toward Omaha, the foundation of Mr. Donnelly's house caved in, one of the buildings was lifted off its foundation and turned partly around. In the afternoon, on Monday, most of the houses were uninhabitable, the water rushing into the lower floors, and the inhabitants fled to the high land for safety. One man came

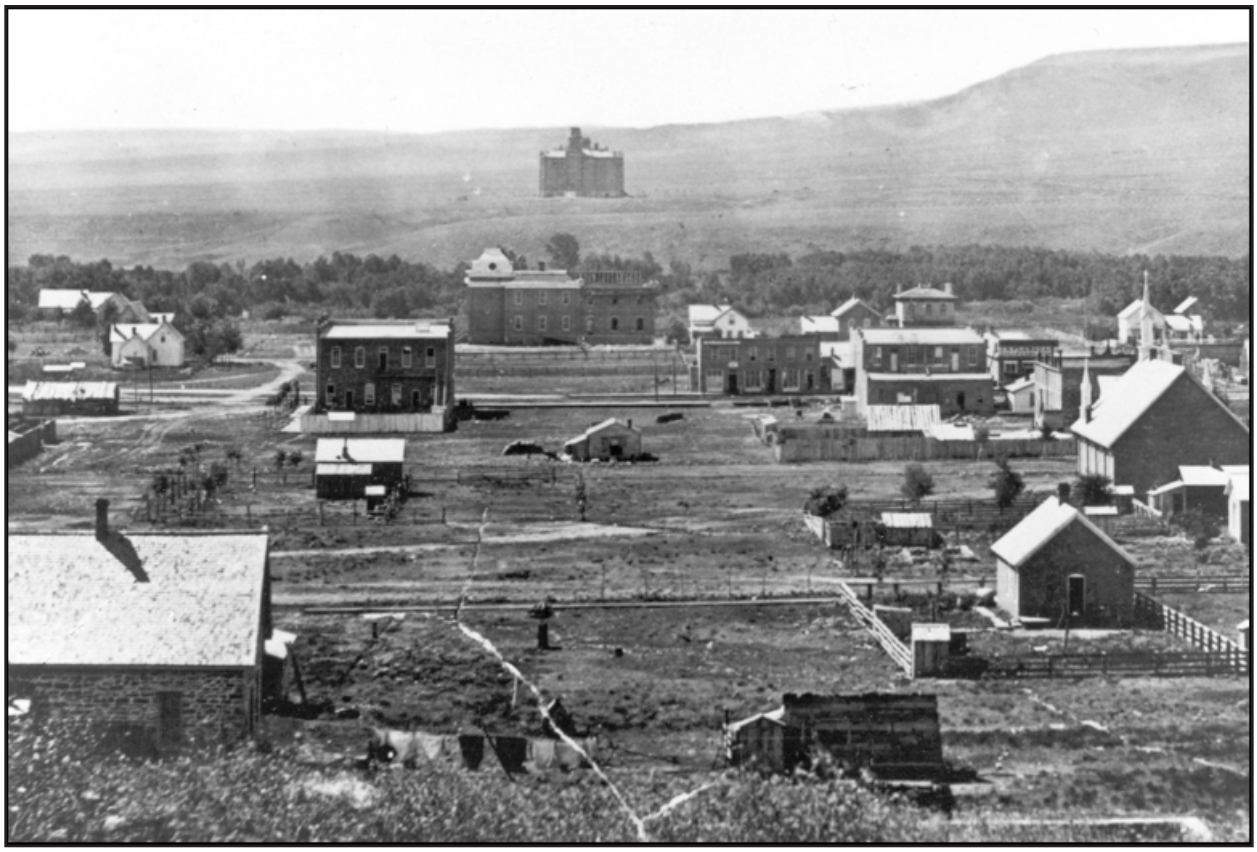
> near drowning and was barely saved by his friends. The water is said to have covered a bed of almost a quarter of a mile in width. The amount of damage done is unknown, almost every person suffering more or less. What damage was done beyond Erie is not definitely known at time we go to press, all communications being cut off. The bridge across the Platte at Hughes is gone, and some damage done on Dry Creek.
>
> The Colorado Central [Railroad] was torn up near Wellman's, just out of town. At Church's [Ranch] considerable track was washed away, so also at Mitchell's. The train which left Denver Monday morning found the Clear Creek bridge impassable, then backed down to Denver and found both ends of the Platte bridge gone. No mail has yet been received over either route. (*Colorado Banner,* Boulder, May 25, 1876)

Greeley newspapers reported on the flood, as well, describing Boulder Creek as: "Swollen into a great river, in many places fully a mile and a half wide, inundated the land and farms and meadows and swept away fences and bridges." (undated, *Greeley Tribune*, as cited in Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado*, p.15)

Another Greeley newspaper added, "Coal Creek inspired terror on Monday last, if never before. About noon the streets of Erie began to fill with water, and before an hour had elapsed, houses were flooded and the whole flat on which the town is located was swept by a muddy, roaring flood, over a quarter of a mile in width. People waded through the boiling flood with children on their shoulders, when the current threatened every moment to dash their feet from beneath them and to hurl them helpless and drowning down the roaring tide." (*Greeley Sun*, May 31, 1876)

After the flood, trains carrying mail into and out of Boulder were delayed for a week. When the first train on the Boulder Valley Railroad did arrive, the *Colorado Banner* stated, "The engineer was so happy to get back to Boulder that he greeted the town with hearty whistling." (*Colorado Banne*r, Boulder, June 1, 1876)

Unfortunately, no flood (or train) photographs were left to posterity.



This section of Boulder was photographed in 1876. The church, on the right, was the first building of the First Methodist Church, at Spruce and 14th streets. The solitary building in the background is Old Main, still-standing and the first building on the University of Colorado campus. The large building in the rear center is Central School, located at Walnut and 15th streets. *Author's collection*

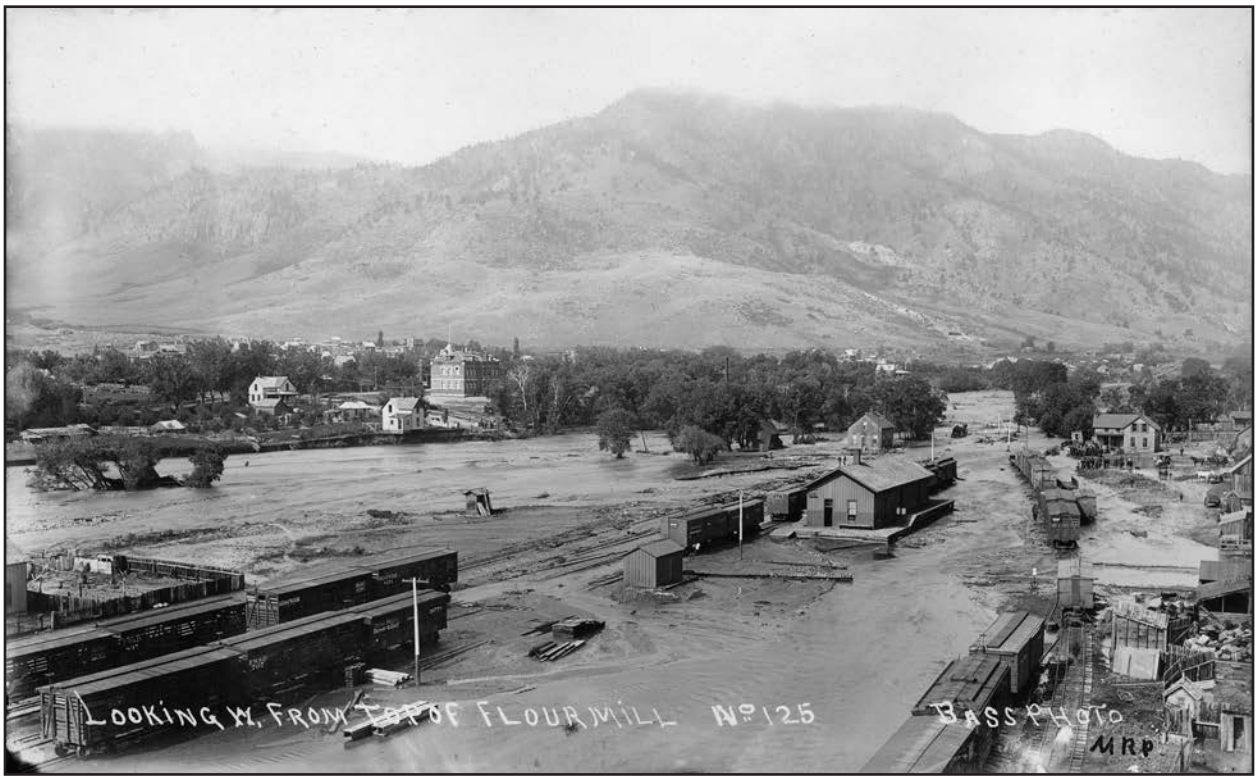
THE "HUNDRED-YEAR" FLOOD: 1894

Even after the rain/flood event of September 2013, the flood of May 31-June 2, 1894 is still the biggest flood in recorded history for Boulder Creek. In addition to newspaper reports on the event, several photographers in Boudler visually documented it, as well. The only problem was that when the bridges over Boulder Creek washed out, Joseph Sturtevant—Boulder's most prolific photographer at the time—was on the opposite side from his heavy camera, tripod, and glass plate negatives. As a result, most of Boulder's 1894 flood photographs were taken by one of Sturtevant's competitors, future police chief Lawrence Bass.

The snowpack in the spring of 1894 was unusually heavy. On May 31, after a torrent of rain that had lasted for sixty hours, Boulder Creek roared down Boulder Canyon and into the city of approximately 5,000 people. Trees, buildings, and everything in the water's path were tossed around and torn apart. The commercial district along Pearl Street and the homes of the well-to-do on Mapleton Hill had been spared. However,

the low-lying Goss-Grove neighborhood—then known as Culver's Subdivision—and the railroad yards, along parts of today's Canyon Boulevard, were under several feet of water. Also near the creek were the homes of immigrants, minorities, and prostitutes.

"Officer Ed Knapp gallantly carried Madam Kingsley through the flood to dry land," stated the *Daily Camera* in its news coverage immediately afterwards. "The rescue was a gallant one, as the madam sat astride the shoulders of the stalwart night watchman—a pug dog in each arm and misery depicted on her countenance."

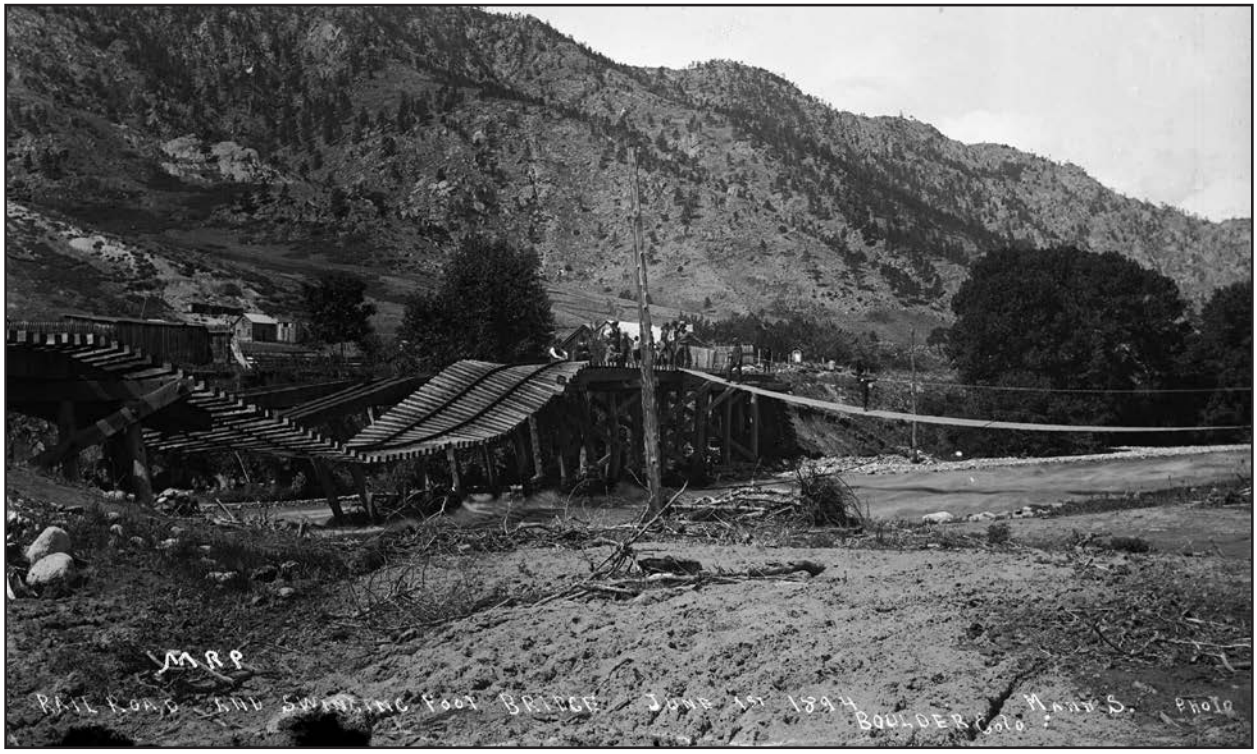


Lawrence Bass took this photo from the Sternberg Flour Mill, on the southeast corner of Walnut and 11th streets. The frame building right of center is the freight depot at the intersection of 10th Street and today's Canyon Boulevard. The large building left of center, on the far side of Boulder Creek, is Highland School. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 715-2-1 #1*

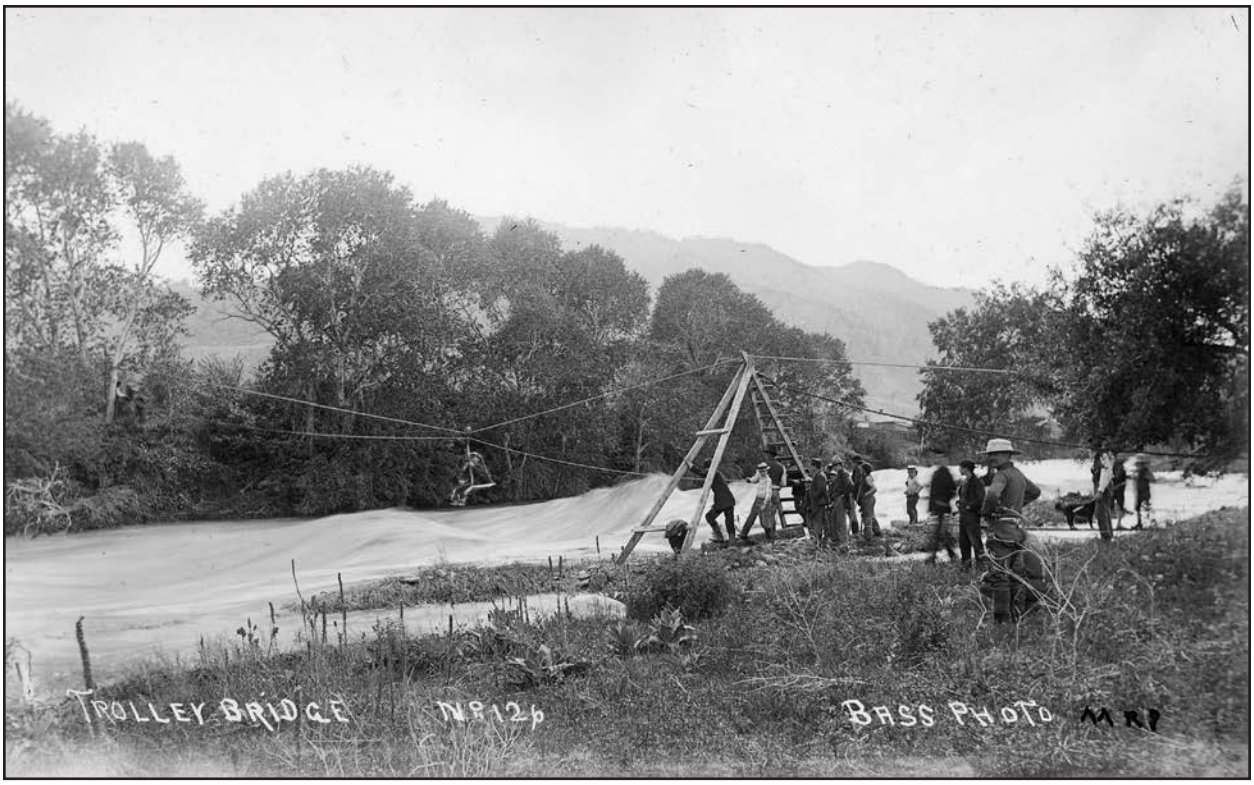
A few blocks upstream, the railroad bridge at 4th Street had twisted into a semi-circle. At first, timbers blocked the stream's flow and sent the water far out upon low-lying land, inundating a wide tract between University Hill and downtown. When the timbers and blocked debris gave way, the bridges at 6th, 9th, 12th (now Broadway), and 17th Streets collapsed like dominoes. Before long, no bridges remained over Boulder Creek at all. Residents south of the surging stream were cut off from downtown. Boulder residents, however, were inventive and rigged up a makeshift pulley, and later a temporary footbridge, to cross from one side to the other. Kegs of beer were hoisted across the raging waters from the Crystal Springs Brewery near 9th Street and Arapahoe Avenue to thirsty customers downtown. Before the day was over, all of the main

roads into Boulder were washed out. Mail and all outside communication stopped when the trains couldn't get in from Denver or Fort Collins. For four days Boulder was completely cut off from the outside world.

Although several people reportedly fell into the swollen waters, no one died and no major crimes were reported. Yet many people suffered severe property losses. In June 1894, the *Daily Camera* stated, "There will have to be some changes in the Assessor's Office. Some citizens of Boulder who owned real estate now find that they have none."

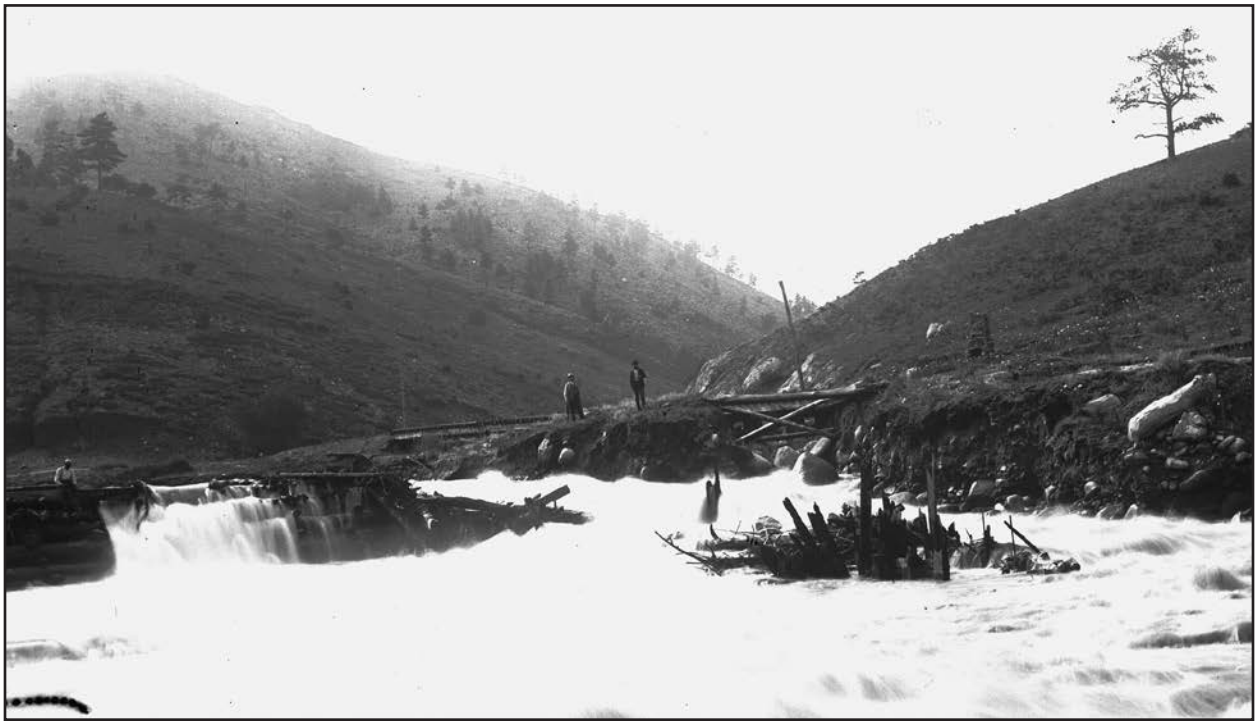


The railroad bridge over Boulder Creek, at 4th Street, looked like this after the 1894 flood. See page 21 for a later photo of the flood water level mark under this bridge. *Carnegie Branch Library for Local History, Boulder Historical Society collection, S-1292 (715-2-23 #1)*



Above, a "trolley bridge" ferries a man across Boulder Creek during the 1894 flood. Below is the scene at Orodell (intersection of Boulder and Four Mile creeks, in Boulder Canyon), after the 1894 flood.

Both photos, Carnegie Branch Library for Local History, Boulder Historical Society collection , 715-2-27 #1 and S-1310.



Boulder County Sheriff Warren Dyer, traveling on horseback, surveyed the damage near Lyons and told a newspaper reporter that his view to the east was "a lake three miles wide, all the way to Longmont." Jamestown, Balarat, and many of the mountain towns were especially hard hit, as well. In Four Mile Canyon, Crisman lost six buildings, while eight washed away from the town of Sunset. Parts of Sugar Loaf (later renamed Wallstreet) and Salina were gone, as was the two-year-old boom town of Copper Rock.

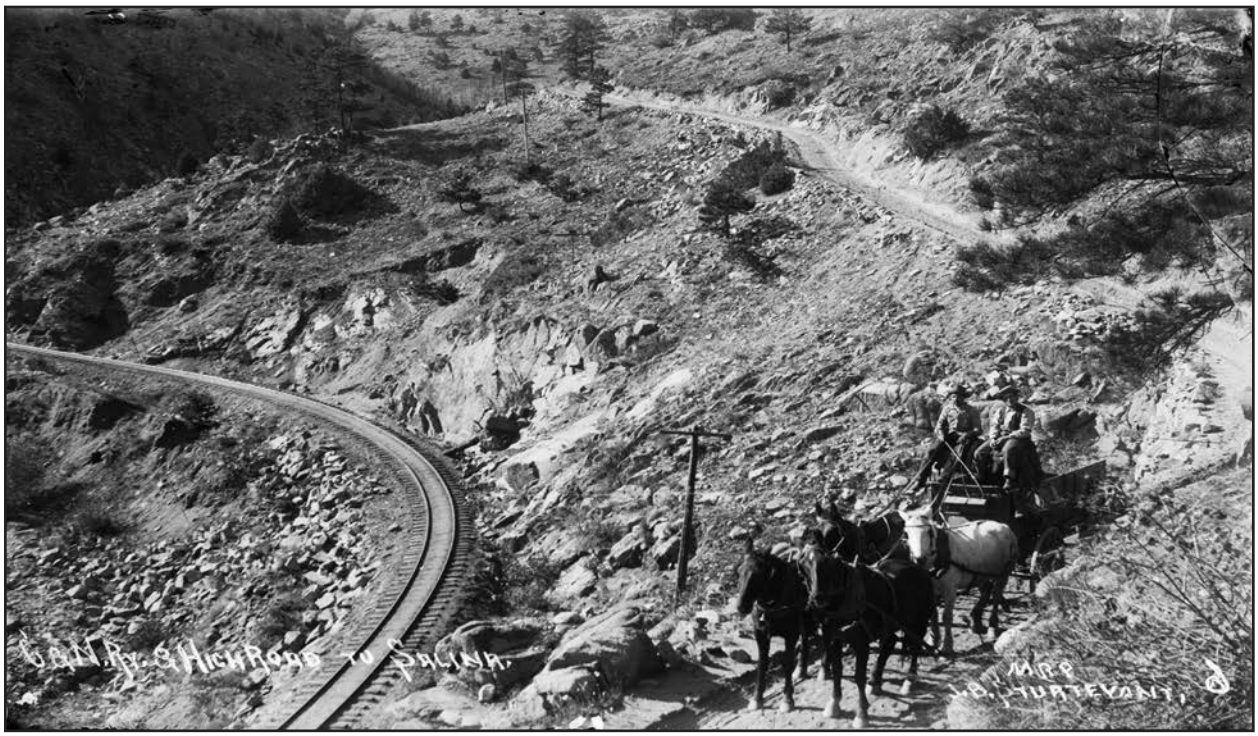
According to the *Daily Camera*, Left Hand Creek had turned into a "howling river," measuring three hundred yards across. A new bowling alley in the mountain community of Sunnyside (off of today's Peak to Peak Highway) broke up in the floodwaters and sailed downstream to Niwot, on the plains. At Glendale, the entire creek bed, from one side of the canyon to the other, was described as a "seething mass of black water." Nearly every tree had been torn out by the roots, and the road bed was entirely destroyed. The narrow-gauge railroad (at the time, the Greeley, Salt Lake & Pacific) that ran the length of Four Mile Canyon was so washed out that it was unable to run for the next four years.

After losing her brothel, Madam Kingsley and a portion of the red-light district relocated downtown. The sun came out by the time the trains finally arrived with newspapers and mail. The Boulder newspaper editor reflected, "One touch of Nature makes the world kin."

At the University of Colorado, commencement was postponed, and the new graduates had to wait a few days to receive their diplomas. One news item, overshadowed by the reports of the flood, mentioned that Mrs. Jeanette B. Durham, a faculty wife, had received the first law degree ever granted a woman in Colorado.

By June 4, five days after the beginning of the 1894 flood, life returned to normal in Boulder. The first mail arrived, along with news from the outside. Boulder residents discovered that they were not alone, as flooding was extensive up and down the Front Range. All available men were urged to work on the roads, and miners started to pump water out of their mine shafts. Newspaper articles focused on rebuilding. A committee of eleven was chosen to coordinate clean-up activities. A newspaper writer urged readers to "Cheer up those despondent ones, remembering that their calamity is ours, and all who are not stricken will comfort those who are."

The Boulder County Commissioners paid laborers two dollars per day for two crews of men to rebuild the Four Mile Canyon road below Salina. One crew of forty-five men worked from Salina down, while another crew of forty-two worked up from the mouth of the canyon. County officials insisted on building a "high line road" far above the creek.



In Four Mile Canyon, below Salina, a "high-line road" was built well out of the path of future floods. This photo was likely taken in 1898, after the rebuilding of the narrow-gauge railroad track. *Carnegie Branch Library for Local History, Boulder Historical Society collection S-2509*

The following undated and unsigned first-hand account titled "FLOOD OF 1894" was written years later and is now preserved in the Carnegie Branch Library for Local History:

> The flood of 1894 was caused by a warm rain that fell on the heavy accumulations of snow at the headwaters of Four Mile, North Boulder, Middle Boulder, and South Boulder creeks. Three of these streams are tributary to Boulder Creek west of the City of Boulder. The stream bed was insufficient to accommodate the flood waters, and bridges (broken), trees, houses, saw logs, drift wood, and a deal of debris were carried through the town by the force of the stream.
>
> The late Harvey Poole and myself were standing on the 6th Street Bridge watching the flood. Suddenly we heard a loud crash and turned around and scampered off to the north side of the creek, as the bridge broke in two and departed down the stream. The flood waters from Sixth Street through the city did immense damage, carrying away bridges, some houses, and many out-buildings, besides pouring mud and sand into basements and the first floors of many houses. The head-gate at 12th and Broadway was destroyed by the water, and much of the flood followed the Beasley Ditch [now called the Boulder & White Rock Ditch] for 6 1/2 blocks through the residential section, then veered southeast through another residential section.

[Note: It's not clear as to the location of this head-gate, as 12th and Broadway don't intersect. Also, prior to the mid-1940s, Broadway was named "12th Street."]

The waters covered almost the entire territory from Walnut Street to beyond Arapahoe [Avenue], and from Ninth Street to the city limits, with the exception of some high ground east of Highland School and a portion of land on Walnut Street east of 15th Street. The southeast part of Boulder, from 15th Street east and south of Water Street, was formerly known as "Toad Hollow," and many places in this section were benefited by the flood because the ground level was raised from a few inches to several feet by sand and mud that washed in, filling and leveling the many depressions.

This aided greatly in future street and sidewalk construction –– formerly some of these walks were built on trestles three feet above the ground level, as on 17th Street and 18th Street north of Grove Street. The maple and box elder trees in this section put out a new root growth just beneath the surface of the new-made soil at 1622 18th Street –– in fact, on both sides of this street.

The late Judge Harry P. Gamble, then a University of Colorado student, and others rode horseback through the flooded area rescuing victims of the flood and taking them to places of safety. Marinus Smith was rescued from the top of his chicken house, where he had sought safety from the flood.

Many people living on the south side of the creek were unable to cross the stream to secure provisions. A steel cable was thrown across the creek, at 5th Street, and made fast to trees on either side. From this, a platform three-feet square was suspended from a pulley, and this was used to convey people across the stream. At the Broadway Bridge (12th Street), heroic efforts were made to confine all the waters to the main channel of Boulder Creek, and after several days the creek water subsided sufficiently so that this object was accomplished by means of bags filled with sand and by the use of timber. A few days later, foot bridges were made available for pedestrian use.

A little lake east of 13th Street on Arapahoe was filled with sand and rubble–– thus our skating pond disappeared. The flood water was several hundred feet wide on level ground between Boulder and Valmont. Access to the mountain towns was only by the Gregory Canyon and Sunshine Canyon roads. New roads had to be built.

Boulder Canyon and the tributary mountain canyons have never regained their original beauty since this flood. Lovers' Leap, the most scenic attraction in Boulder Canyon, was blasted down, in front, to make room for the new canyon wagon road.

MARINUS SMITH — A "RAVING MANIAC"

As noted above, Boulder resident Marinus Smith was rescued from the flood. However, the threat of his house being washed away landed him in the state insane asylum. A *Daily Camera* reporter noted that by the time rescuers arrived at Smith's home, at Grove and 16th streets, he was a "raving maniac."

Marinus Smith's property at Grove and 16th streets, during the flood of 1894. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 715-2-19 #1*

Smith had settled in Boulder in 1859, after he left Illinois for the Colorado gold rush. In his better days, he ran an express and mail line between Denver, Boulder, and some of the mountain towns. He homesteaded a considerable amount of land and donated 25 acres to the University of Colorado at the time of its founding. He was also one of the first fruit and vegetable growers in the Boulder area, and his home, called Smith's Grove, was a popular spot for picnics and civic gatherings. His gardens surrounded the intersection of today's 17th Street and Arapahoe Avenue, in the vicinity of today's Boulder High School.

As the flood waters rose, the longtime resident became irrational and refused to leave his home. He even told his would-be rescuers that he believed that he was responsible for the flood. Finally, three days after the first rescue attempt, Boulder's Sheriff and a party of volunteers succeeded in forcing Smith from his home, despite his ranting and raving that someone was trying to steal his property. He was placed in the "insane cell" in the jail in the basement of the Boulder County Courthouse.

Smith sat in jail and refused to eat for two days while attorneys arranged a trial in order to determine whether he was sane or insane. He was released from jail only to be taken back a few days later. The second time he was found naked, except for a shirt tied around his loins. In jail, Smith cried and prostrated himself before buttons, knives, and other articles he placed on what he imagined to be an altar, all the while telling authorities that he was about to be crucified.

When it was time for his insanity hearing, Smith was moved upstairs to the county courtroom. Witnesses included his daughter, his physician, and the Sheriff. Smith was declared insane because of his "mania on the water question" and was sent to the insane asylum in Pueblo.

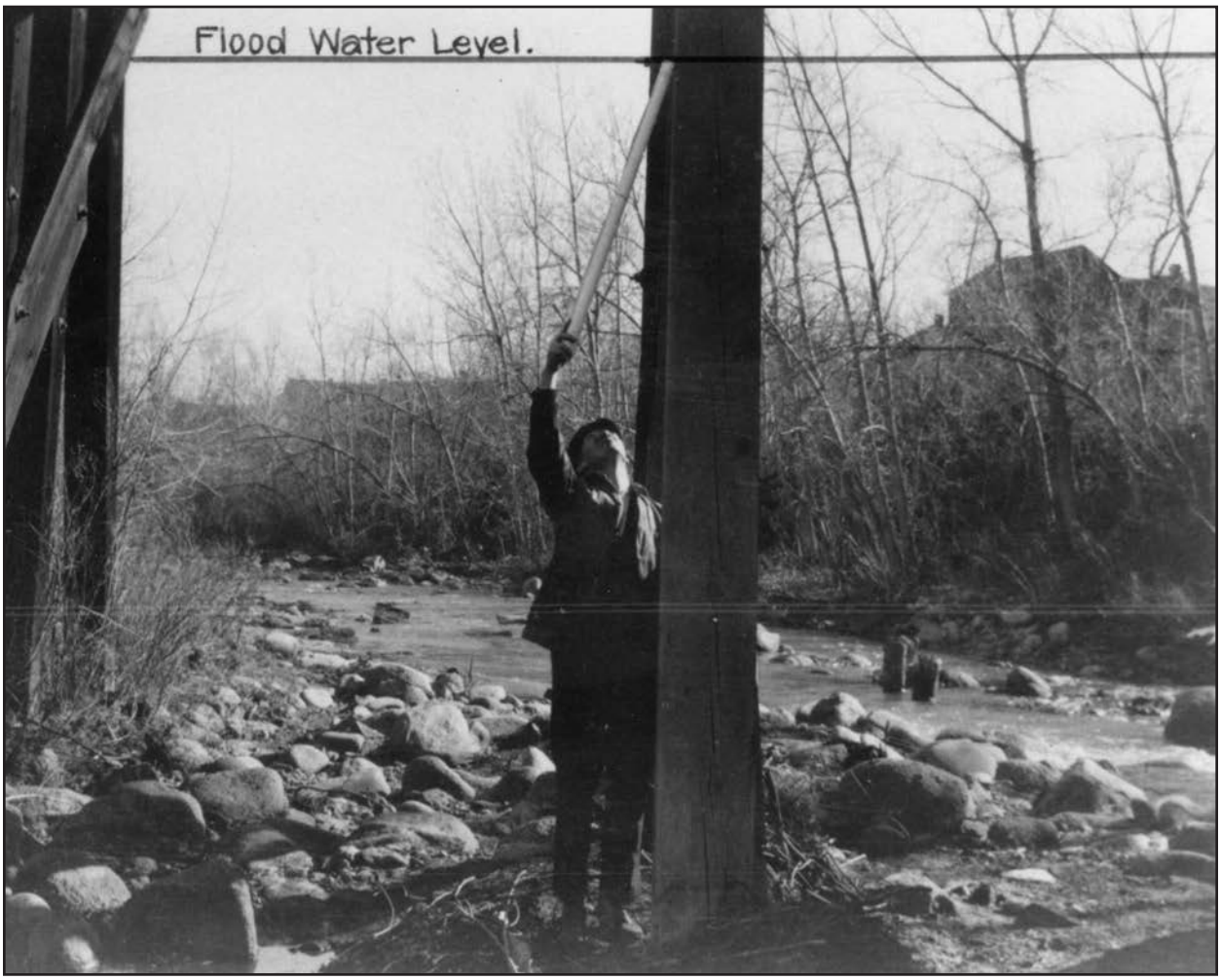
Meanwhile, on July 12, 1894, "Mrs. Farnsworth and a bevy of young ladies" held a benefit, from dusk to 10p.m., on the courthouse lawn to raise money for those who suffered from the flood. According to the *Daily Camera*, the ladies at the "lawn fete" ladled out immense amounts of lemonade, along with cake, strawberries, and 35 gallons of ice cream. The Boulder Band played while clergy from the Catholic, Protestant, and African Methodist churches mingled with the crowd.

"Democracy was supreme," stated the *Camera* writer. "The flood and its awful woes had broken down the cold, stony walls of prejudice and caste. It was a sight for God and men. It taught the useful lesson of the equality of man, the oneness of the church, and the fact that color is but a veneer—all hearts could beat as one for the common wealth and common loss, the common hope. It was a delightful affair and yielded about $163 to the flood sufferers' fund." (*Daily Camera*, June 13, 1894) A few days later, the continuing flood relief fund had risen to $180 and residents were asked to donate clothing, especially for children.

Five months after the flood, in October 1894, the City of Boulder appropriated $10,000 for seven new bridges and the "general repair" of streets. The following year, the City took what might have been the first recorded step in local flood control and considered a plan to "build a barrier along the banks of the creek because of the danger of another overflow." (Perrigo, Lynn I., *A Municipal History of Boulder 1871-1946*, p.246-247)

As to Marinus Smith, a few years after he was sent to the insane asylum, one newspaper account reported that he was recovering, then another stated, "He seems to be losing his mind again." Eventually, he was returned to Boulder and allowed to spend his final days in his old home. At the time, Smith's Grove was said to have been a "wild paradise of shrubbery, fruit and shade trees." Smith died in 1901 and is buried in Columbia Cemetery. His house, built in the 1860s, was torn down in 1934. Nothing remains today, even of his gardens, although Marine Street is named in his honor.

Historians will find it interesting that the words Marinus and Marine mean "of, or pertaining to, the sea," and Marinus Smith's demise was related to water.



This photo was taken in 1911 below the railroad bridge that crossed Boulder Creek at 4th Street. The man in the photo is showing how high the flood waters got during the flood of 1894. (See Part II, Metcalf and Eddy Report.") *Carnegie Branch Library for Local History, Boulder Historical Society collection, 225-3-27 #1*

FLOOD OF 1897

Because of the planned barrier on Boulder Creek, the City of Boulder was somewhat prepared for another flood, which came in 1897. On May 31, crews began placing sandbags at strategic locations. Then a cloudburst produced some flooding on June 10. The sandbag barricade remained in place until June 19. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado*, p. 31)

During the years before the turn of the twentieth century, a private group of Boulder citizens formed the Boulder City Improvement Association, with local businessman Charles Dabney as its first president. The association members were concerned with the general appearance of their community and discussed the advantages and disadvantages of sub-division, annexation, growth, park acquisition, and planning, as well as what to do about future flooding along Boulder Creek.

Sandbags (shown above at Central Park) were in place in time for the June 1897 flood. Below, the 1897 flood destroyed the then-recently rebuilt 9th-Street bridge.
Both photos, Carnegie Branch Library for Local History, Boulder Historical Society collection, above 225-4-10 #1, below 225-4-2 #1

Twentieth century: early 1900s

At the turn of the twentieth century, Pearl Street, along with all other thoroughfares in Boulder, was still unpaved. The streets were either dusty or—when the rains came—rutted and muddy. A cloudburst on May 12, 1904 in Bummer Gulch caused localized flooding in the Sugarloaf area. Otherwise, the heavy rains skipped over Boulder until 1906 and 1909.

FLOODS OF 1906 and 1909

A cloudburst in July 1906 brought water and debris into Boulder. "The water spread at the point where the dry gulch comes into Pearl Street, rushed down through gardens at the corner of Third Street, through Pearl and down into Walnut and Railroad streets," reported the *Daily Camera*. "Vast quantities of sand and debris were deposited on lawns and gardens. Water stood two feet deep on the platform at the Colorado and Southern passenger depot, and the yards were so flooded that the tracks were invisible. The engineers could not see the rails, nor could the passengers alight or get on the trains."

A plea by the *Daily Camera's* writer (or editor) stated, "Wanted: Storm sewers and sewers leading across Pearl to the [Boulder] creek to protect property at the corners of Pearl, which are too frequently flooded by storms. Also, a containing wall to confine within a natural channel the floods that once in several years rush down Third Street, and spread out over a wide territory, inflicting great damage to property owners." (*Daily Camera*, July 8, 1906)

July 1909 brought another flood. A *Daily Camera* headline read, "After the flood comes sadness." A family outing to Mount Sanitas resulted in "two in the [University] hospital and two in the morgue." The two injured persons were a nine-year-old girl and a woman who was vomiting mud. The deceased were the injured girl's twin sister, along with a 28-year-old-male store clerk from Greeley. Perhaps a premonition of future tragedies, the deaths occurred near Two Mile Canyon Creek. (*Daily Camera*, July 24, 1909)

In Four Mile Canyon, between Orodell and Crisman, the rain washed out 100 yards of track of the narrow-gauge Denver Boulder & Western Railroad. The "regular" morning train managed to get by on a construction track, but two special excursion trains had to postpone their day trips. Boulder Creek reportedly rose higher than it had been

for years. Railroad officials were so concerned that the first bridge in Boulder Canyon would be destroyed that they placed loaded box cars on the bridge for added weight.

The Eastern Colorado Power Company, then in the process of building the Boulder Canyon Hydroelectric Plant, lost two of the railroad bridges that had been built solely to extend the railroad line between Orodell (at Boulder Canyon's intersection with Four Mile Canyon) and the hydroelectric plant in Boulder Canyon. Also washed downstream, from a railroad siding, were 10 barrels of oil, 25 telephone poles, and 15 joints of high-pressure pipe. The pipe was so badly damaged that the *Daily Camera* noted that new pipe would have to be ordered. On its editorial page, the *Daily Camera* suggested that the City consider doing something about Two Mile Canyon Creek, which, it stated, "filled north Twelfth Street [now Broadway] several times this season." (*Daily Camera*, July 24, 1909)

OLMSTED REPORT

Help was on the way. In 1908, members of the Boulder City Improvement Association had invited Harvard-trained landscape architect Frederick Law Olmsted, Jr. to visit Boulder, then a city of 9,000 residents. He commented on flood control, parks, sewers, and many other topics in "The Improvement of Boulder, Colorado," a report to the Boulder City Improvement Association, published in March 1910.

On flood control, Olmsted said the City needed to form a serious estimate or forecast of the maximum volume of flood water which the creek would be likely to discharge in the future. "The principle," he stated, "does not differ one whit from the process through which a woman goes [through] when she looks at the bowl into which she is about to turn a can of peaches and makes up her mind whether it will hold what is in the can. Either it will or it won't, and she is a foolish woman if she gives no heed to the probabilities until the peaches slop over on the table." (Frederick Law Olmsted, Jr., *The Improvement of Boulder, Colorado,* p. 58)

Olmsted noted that Boulder Creek's principal function is to carry off the storm-water which runs into it from the territory from which it drains. He explained that if the community is lulled by the security of a few seasons of small storms and permits the channel to be encroached upon, "it will inevitably pay the price in destructive floods."

The noted landscape architect outlined possible structural changes to the Boulder Creek channel, but he dismissed most of them as unrealistic and expensive solutions to the problem. He did recommend, however, the construction of low walls at the edge of the floodway below Twelfth Street (now Broadway). And, since the area in question would hold floodwaters only on rare occasions, Olmsted suggested the development of a Boulder Creek "Park," but "not something highly polished and exquisite with costly flowers and other decorations of a kind that would be ruined by flooding." That, he said would be "foolishness."

"But the plan of keeping open for public use near the heart of the city a simple piece of pretty bottom-land of the very sort that Boulder Creek has been flooding over for countless centuries, of growing a few tough old trees on it and a few bushes, and of keeping the main part of the ground as a simple, open common, where the children can play and over which the wonderful views of the foothills can be obtained at their best from the shaded paths and roads along the embankment edge—this would give a piece of recreation ground worth a great deal to the people. And, at the same time, it is probably the cheaper way of handling the flood problem of Boulder Creek." (Frederick Law Olmsted, Jr., *The Improvement of Boulder, Colorado,* p. 59)

This section of Olmsted's 1910 map of Boulder shows the downtown area, as well as Boulder Creek between approximately 5th and 20th streets. *Author's collection*

Olmsted urged Boulder residents to act immediately to restrict construction in the floodplain, or else dealing with a catastrophic flood in the future would prove costly. So, what did Boulder residents do? Basically, they put Olmsted's long and detailed plan on the shelf. It was enthusiastically received at the time by the Improvement Association, but not everyone shared its members' views. "We shall refer to the report from time to time," wrote a *Daily Camera* reporter, "if ever given the time to read it."

METCALF AND EDDY REPORT

Although Olmsted's report may not have been read by the average citizen, the Boulder City Improvement Association was still on top of city planning. In 1911, the Association

hired consultant Leonard Metcalf, from the internationally recognized engineering firm of Metcalf and Eddy, based in Boston, to give his flood control recommendations. Apparently Harrison P. Eddy stayed home, but, in the resulting report, Metcalf wrote that he visited Boulder from November 10 through November 18, 1911, gathering data and studying the local conditions. Improvement Association Secretary and tuberculosis physician Dr. William Baird made available meteorological and other records and arranged meetings with Boulder's Mayor Alfred A. Greenman, as well as Boulder's city engineer and other authorities.

Store owner, Alfred A. Greenman was Boulder's mayor when the Boulder City Improvement Association brought in Leonard Metcalf as a consulting engineer.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 220-Greenman, Alfred

Flood-related problems that Metcalf was asked to address included:

- the improvement of Boulder Creek, to prevent flooding of the lower parts of the city, as far as practicable.
- the construction of storm water drains.

Metcalf noted the following:
1. The proximity of the mountains to the city presented an exceedingly difficult problem for the control of flood waters.
2. Boulder's population, at the time, was approximately 10,000.
3. Annual precipitation increased rapidly with increases in altitude. Stated Metcalf, "This variation shows clearly the futility of trying to determine stream flow by a study of drainage area and rainfall records, in the manner generally adopted in the East."
His further explanation of "The River Problem" was (in his own words) as follows:

*The River Problem: "*Boulder is traversed by Boulder Creek, a stream draining a rectangular catchment area of approximately 179 square miles. The slope of the riverbed through the city is fairly uniform, and about 1.1-feet-per-hundred. One of the tributaries of this creek, known as Sunshine Canyon, having a drainage area of somewhat less than 3 square miles, traverses the westerly boundary of the city, discharging into Boulder Creek at its entrance to the city."

*Rainfall: "*Rainfall records are submitted, showing an approximate annual rainfall of 13 inches at Boulder; 26 inches at an altitude of 9,000 feet above sea level; and 40 inches, more or less, at the Continental Divide."
Yield or Runoff from Boulder Creek: "The rainfall records from this drainage area furnish little evidence of its runoff."

Metcalf elaborated by stating,

"The Government and State records indicate a maximum recorded flow of a little less than 1,000 cubic feet per second (979 cubic feet per second on June 10, 1897; 948 cubic feet per second on July 3, 1907). These records are not, however, indicative of the maximum runoff from this stream.

A number of photographs are submitted showing the river heights and the character of flow during certain flood discharges. The best evidence, which was found of the maximum flow in the stream, was that corresponding to a water level observed by two different persons upon the trestle bridge of the Denver, Boulder & Western Railroad. The marks of this flood indicate a cross-sectional stream area of 700 to 800 square feet, a depth of from 10 to 11 feet, and an estimated maximum discharge of 12,000 to 13,600 cubic feet per second. The hydraulic elements and cross-sections at the bridges, as well as in the main channel, were studied in their bearing upon the maximum flood discharge, and while it is recognized that a certain amount of pooling action undoubtedly exists at these bridges during freshet conditions, the results seem to be fairly consistent. *[Author's note: See flood water level photo on page 21.]*

It is concluded that the discharge of this stream has probably been as much as 10,000 cubic feet per second, perhaps at intervals of twenty years."

*Runoff to be provided for: "*It is recommended that the creek improvement should provide for a possible runoff of 12,000 cubic feet per second, under extreme freshet flows, with a cross-sectional area of 700 square feet or more, including a depressed channel in the bottom of this river section, about 8 feet wide at its base, 4 feet deep, and with side slopes 1-1/2 to 1 feet-per-hundred. This depressed channel will discharge about 1,000 cubic feet per second and take care of ordinary high water conditions."

Sequence of Construction in Boulder Creek Improvement: "In view of the substantial cost involved in the entire improvement of Boulder Creek, it is suggested that:

1. The necessary strip of land adjacent to Boulder Creek be purchased.
2. The depressed channel in the middle of the stream be built at once of concrete of rubble masonry laid in Portland cement mortar or concrete, protected on its margins by a 4-foot strip of heavy stone riprap or paving; and that the rest of the channel and its embankments be built in final form as far as practicable and that it be seeded with alfalfa to protect the earthwork until such time as the rest of the channel bottom and its side slopes be paved.
3. The straightening, deepening, and widening of the river channel at certain points is suggested."

Sunshine Creek: "The same general method of improvement as that outlined for Boulder Creek is suggested for Sunshine Creek. As the lower portions of the city have been flooded by its waters on several occasions, the deepening and widening of the channel is obviously imperative." In summary, Metcalf stated, "The total cost of the river improvement may amount to approximately $150,000, depending upon the scope and character of the work undertaken. It is assumed that the land damages will be insignificant." (Metcalf and Eddy, *Report to the Boulder City Improvement Association Upon the Improvement of Boulder Creek and the Sewerage, Drainage, and Disposal of the Sewage of Boulder, Colorado*, April 27, 1912)

According to Metcalf, the creek presented special problems at Twelfth Street (now Broadway). The engineer indicated that the "sharp angle" in the river at that point was "objectionable and should be modified."

Metcalf's summary recommendations on the "Storm water drainage system" included:

Local flooding. "Local flooding has already caused serious complaint in different parts of the city, and these conditions will become more aggravated with increase in density of population and in area of paved streets."

Intensity of rainfall. "The intensity of rainfall records of this region, which are submitted herein, have been carefully studied, and the runoff has been estimated by the use of the McMath formula and the so-called 'Rational Method.' "

Proposed drainage system. "It is assumed that the rivers and the natural waterways or marked depressions may be used as outlets for the proposed drains."

"The relative desirability of laying the drains in such a way as to lower the ground water level and thus to relieve the present sewerage system of some of the ground water which now leaks into it, and of laying them in the ordinary way with tight pipe joints to take care of the surface runoff only, was carefully considered," Metcalf stated. "It was concluded that it was undesirable to lower the ground water level in a dry country such as this, where the natural difficulty of maintaining gardens, lawns, shrubs, and trees is already great." (Metcalf and Eddy, *Report to the Boulder City Improvement Association Upon the Improvement of Boulder Creek and the Sewerage, Drainage, and Disposal of the Sewage of Boulder, Colorado,* Boston: 1912)

Phyllis Smith, in her *History of Floods and Flood Control in Boulder, Colorado,* published in 1987, stated that the Metcalf and Eddy report was placed on the shelf next to Olmsted's. So much for early day flood control.

THE "BIG SNOW" OF 1913

From December 3 through December 5, 1913, a two-day snowfall with a total of 43 inches blanketed the City of Boulder. Transportation came to a grinding halt, communication was virtually non-existent, and residents suffered hardships, but they weathered their record-breaking storm quite well. The following spring, the mountain snowpack would be 50 per cent above normal, but most Boulder residents weren't thinking that far ahead. Instead, they were just trying to go about their normal lives. (U.S. Army Corps of Engineers, *Boulder's Flood Protection Decision: A Choice to Live With,* Omaha: 1977, p.2)

Hours into the storm, telephone and power lines collapsed under the weight of the snow. Switchboard operators at the telephone company's office on Spruce Street couldn't get home from work. With the phone lines down, there wasn't anything to do anyway. Instead, the women dragged their long skirts through the snow to the Hotel Boulderado where they spent the night.

Trees, hanging street lamps, and roofs fell in as well. Daily routines changed as schools and businesses closed their doors. Mail service was canceled. The *Daily Camera* announced that the Catholics couldn't even confess their sins, as the priest was unable to get to Sacred Heart Church for daily mass. But homes and businesses started to run out of coal, and liverymen were forced to ration their hay and grain. Grocers low on food were under police control to sell milk only for babies. Children, however, got out their sleds and enjoyed a holiday.

The University Hospital was the only surgical facility in town. On 17th Street south of Arapahoe Avenue, two men pushed through four-foot drifts to break a trail up the hill. Following them, four exhausted horses pulled a coal wagon that carried a young woman with appendicitis. Six men struggled alongside, ready, if necessary, to carry her the rest of the way on a stretcher.

A stagecoach carrying mail for Magnolia slid off the Boulder Canyon road into Boulder Creek. Nels Pederson, the driver, was thrown free, but the horses were pinned underneath the heavy wagon. Pederson spent two hours in the icy knee-deep water and managed to save the horses, then walked along the railroad tracks to Boulder for help.

Public transportation didn't fare much better. The electric commuter train (the Interurban) that usually ran hourly between Boulder and Denver, was stuck all night near Marshall where cold and hungry passengers shivered in unheated rail cars. The northbound main-line passenger train couldn't even get into Boulder, while the one from Cheyenne couldn't get out.

When the snow finally stopped, the *Daily Camera* urged the employment of all "idle men." Merchants paid $2.50 per day, a good wage at the time, to anyone willing to shovel the snow from the sidewalks into the street.

After the December 1913 snow storm, downtown merchants managed to get their sidewalks shoveled, as shown in this photo of the 1100 block of Pearl Street, looking east. Note the horse-drawn wagon (or sleigh) a couple of feet higher, on packed snow on the street. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 129-14-54 #2*

Entrepreneurs with horse-drawn sleighs replenished the dwindling stocks of groceries and coal, and most people walked to wherever they needed to go. Luckily, there were no fires, because the firemen couldn't get out of their Pearl Street station.

Two weeks after the storm, eight-horse teams finally were able to pull wooden plows to open up Pearl Street and the other main thoroughfares. Potholes weren't a problem, as none of Boulder's streets were paved.

Gradually, the city returned to normal. The woman with appendicitis had a successful operation, no major crimes were reported, and no lives were lost. One newspaper reporter called the storm "the hour of Boulder's trial," proud that the city had pulled through.

In western Boulder County, the narrow-gauge Denver, Boulder & Western Railroad couldn't budge for a week. The engines plowed through drifts only to have the wind pile up the snow even more. Finally, on January 16, 1914, the Colorado & Southern Railroad came to the rescue with a rotary plow. And, crews of men were hired to shovel parts of the track by hand.

A section of the Denver, Boulder & Western track was photographed near Cardinal on January 16, 1914, when the DB&W borrowed a rotary plow, barely visible on the front of the train, above.
Carnegie Branch Library for Local History, Boulder Historical Society collection, 218-4-30 #3

FLOOD OF 1914

On June 1, 1914, heavy rains on top of the 1913-1914 winter's unusually large snowpack caused what the *Daily Camera* called the "worst that Boulder has experienced since 1894." Twenty years had passed since Boulder's "100-year flood." The news went statewide. An article from Aspen titled, "Flood at Lakewood Swept Everything Before It," stated that, at 11 p.m., water overflowed Silver Lake Dam and flooded the waterworks downstream. Other reports stated that the dam actually broke.

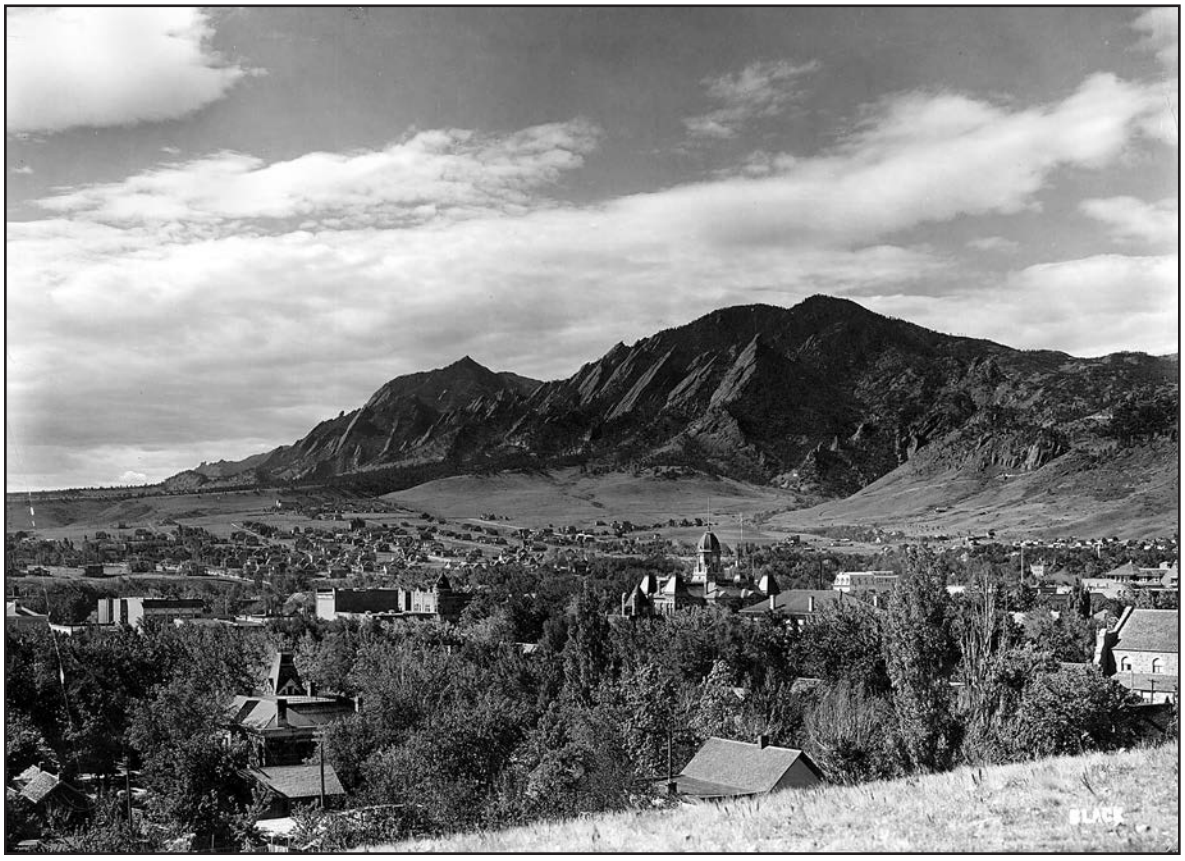
[Note: The tungsten-milling town of Lakewood was north of Nederland on Boulder's Lakewood pipeline, installed in 1906 to bring water from Silver Lake to Boulder.]

Raging waters washed away three bridges in Boulder Canyon, and the Lakewood pipeline was damaged in five places for a distance of between 200 and 300 feet. Someone, perhaps by telegraph or telephone, warned the residents of Boulder and Boulder Canyon. Many spent the night on Lovers' [later renamed Sunset] Hill, just north of downtown. The next morning, at 8 a.m., the *Daily Camera* reported that a "huge crest of water" had flowed into Boulder. Then the 28th Street Bridge washed away, the railroad bridge at Valmont was under water, and crops along Boulder Creek were ruined.

Meanwhile, residents in Boulder received conflicting reports that the four-year-old Barker Dam, at Nederland, had weakened and given way. If that did happen, stated a newspaper writer, at the time, the lower part of the city would suffer "immense damage." ("City of Boulder Threatened with Serious Floods," *Fort Collins Weekly Courier*, June 5, 1914)

Also on June 5, 1914, it was reported that Boulder was in the clutches of a "serious water famine." Two of the largest water mains in the City were washed out, cutting off the water supply to much of the city. Local reservoirs were so low that there was practically no pressure. A reporter noted that "small boys" were walking through the residential districts selling water at five cents per gallon. ("Water Famine in Boulder as Result Flood," *Daily Journa*l, Telluride, June 5, 1914)

Unfortunately, Joseph Sturtevant, Boulder's most prolific early photographer, was not available to take photographs. He had died in 1910 by either jumping or falling off of the Interurban Railroad between Boulder and Denver. His body was found on the railroad tracks and later buried in Columbia Cemetery.



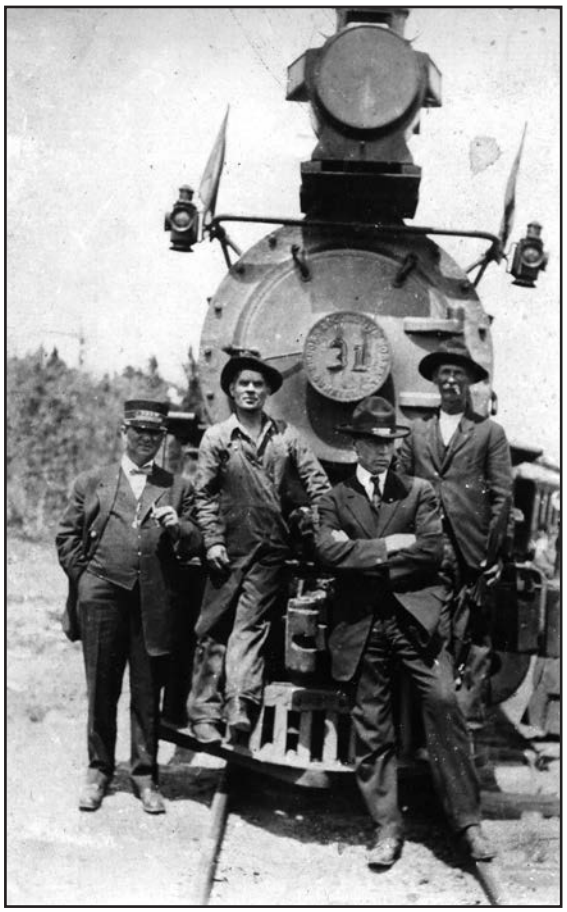
This view of Boulder was taken from Lovers' (Sunset) Hill, circa 1914. The large building right of center is the Boulder County Courthouse (built 1882 and burned 1932). The large building left of center is the Masonic Temple, which burned in 1945. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 208-1-34 #4*

FLOOD OF 1919

The next major flood to hit Boulder came on July 30, 1919. According to *Daily Camera* reports at the time, Boulder received 4.8 inches of rain in one night. A motorist made the news when he had to have his automobile pulled out of the mud by a team of horses. Others weren't as fortunate. A newspaper report stated that as a result of several rock slides, 35 "automobile tourists" were marooned overnight eight miles up Boulder Canyon.

Washouts were reported on the Interurban Railroad line, but there was much more damage to railroad grades and tracks on the Denver Boulder & Western, Boulder County's only narrow gauge railroad.

After the flood of 1894, the mountain railroad reopened in 1898, eventually reaching both Eldora and Ward. By 1919, though, it operated on shaky financial ground. Then, heavy rains on July 30 pounded the foothills, and Four Mile Canyon was flooded again. Even though most of the railroad's damaged roadbed and bridges were confined to the area between Boulder and Crisman, the line was sold for salvage. No longer would the former "Switzerland Trail" haul supplies to mountain towns or take flatland tourists to see stunning views of the Continental Divide.



A conductor, engineer, and brakeman of the Denver, Boulder & Western posed with a miner on the front of Engine No. 31. The Railroad already was having financial losses before the flood of 1919. But, the Railroad's days were over, and the flood marked the end of the line. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 218-4-6 #4*

In Lyons, the postmaster stated that he had lived in the northern Boulder County town for 30 years, and the 1919 flood was the worst he had seen, even worse [for Lyons] than the flood of 1894. The only dry place in town was a church, where residents assembled in the sanctuary while riding out the storm. Former Sheriff Buster had a farm nearby, in Hygiene, where he reported buckets of hail one-and-one-half feet deep.

Meanwhile, four-to-six-feet of water rushed down South St. Vrain Canyon and deposited sand up to a foot deep on some of the county's first gardens and orchards. Seven bridges in Lyons were washed out, and the Commissioners quickly built a temporary bridge to help automobiles gain access to the mountains. (*Daily Camera*, July 31, 1919)

Twentieth century: 1920s – 1940s

FLOOD OF 1921

Much of Colorado's Front Range was affected by the flood of June 3-6, 1921, with the worst damage and loss of life in Pueblo, in southern Colorado. There, hundreds of people died, 600 homes were washed away, and downtown Pueblo was decimated. The governor declared martial law. When the flood hit the county and city jails, all prisoners were set free. Boulder's mayor announced that his city stood ready to offer aid in the form of money, clothing, tents, and urgently needed rubber boots. (NOAA National Climatic Data Center, "This Month in Climate History, June 3, 1921, Colorado Flooding" and *Daily Camera* June 4-8, 1921)

But, Boulder County received its share of the storm, as well. A cloudburst broke at 3:30 p.m. on June 3, spilling flood waters from Coal Creek Canyon to Erie, Lafayette, and Louisville, while Boulder Creek and the North and South St. Vrain creeks inundated Longmont.

In Boulder, the home of department store owner Frank Ronsholdt, at 1225 17th Street, collapsed into Boulder Creek, *Carnegie Branch Library for Local History, Boulder Historical Society collection, 129-6-52*

No road damage was reported in the mountains, although a break was reported in the "pipeline below the intake" making the water muddy. As a result, Boulder's Director of Public Health recommended that residents should boil all of their drinking water. (*Daily Camera*, June 6, 1921)

By 1921, the horse-and-buggy days were over. Boulder was a railroad hub with trains in and out to every direction, and many people traveled by automobile, as well. But there were instances when autos got stuck, and horses were needed to pull them out.

This photo of horses pulling an automobile on Arapahoe Avenue in front of the Lincoln School (now Naropa University) was not taken during the flood of 1921, but it dates from the same time period. *Carnegie Branch Library for Local History, Boulder Historical Society collection 217-4-25 #7*

Most of the flood damage was on the plains. Motorists from Denver to Boulder were stranded in Broomfield, where one farmer took in 18 people and many others slept in the Broomfield Church. Railroad passengers spent the night in stalled trains. In Lafayette, three houses had been washed from their foundations near the Standard mine. Many of the coal miners, who had been living in the low-lands along the creek, had nothing left but their land.

This car, identified as "Park's car at Hixon's, 1921," was stuck near Valmont and, likely, did need a horse. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 129-10-52*

The flood hit particularly hard in Erie, as noted by the following reporter:

> Erie was put almost completely under four feet of water, and the flood poured through the streets like a mill race, carrying away houses, buildings, livestock, and every movable article. One man reported the loss of 26 head of cattle and several hogs and chickens. Another man had just purchased a brand new piano and moved it into his home. After the flood, not a trace of the house or the piano could be found anywhere. *(Daily Camera*, June 4, 1921)

Lawrence Bass, main photographer of the 1894 flood, had been, in the intervening years, appointed Boulder's Police Chief. In 1920, he was killed in the line of duty; rushing to a fire while riding as a passenger in the police department's brand new Buick. Boulder photographer Charles F. Snow, however, was on hand to survey the flood damage in Erie. When he arrived, the flooded area varied from a few hundred feet in width to a half a mile or more.

These residents are standing in the midst of flood debris at the railroad trestle in Erie. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 225-4-51 #3*

Charles Snow was well-known in Boulder as a portrait photographer, but that didn't stop him and a member of his staff from leaving the studio to take photographs of the flooded eastern county districts.

Two farms north of Boulder were hit by a cloudburst and a cyclone. The *Daily Camera* reported:

> The cyclone did the most damage at the ranches of Alfred C. Wetterberg and C.W. Carpenter, where several buildings were wrecked and several of the fields swept clean. Mr. Wetterberg stated this morning that he and a friend were seated in the shelter of a shed watching the clouds form when they noticed a peculiar funnel-shaped cloud approaching. It did not occur to either of them that it would be dangerous until they noticed as it approached that it was picking up things, whereupon they started for the house. The cyclone stuck before they reached the house, and they were forced to crawl the remaining distance on their hands and knees. The next instant they saw the garage lifted from off its foundations and moved bodily several yards, leaving a Ford car that was inside the garage standing unharmed on the ground underneath. The cow barn was next to go and was raised thirty feet in the air and dashed to pieces, parts of it being scattered across the field for nearly a mile, while a flock of 200 chickens in the barnyard were whisked away like straws.

The bodies of some were later found in the field. At the L.W. Carpenter place, one of two large trees were snapped off and the roof of the granary lifted off and dashed to pieces.

At the same time one mile west of the Wetterberg ranch there was a terrific cloudburst which caused water to flow down thru the arroyos on the Six Mile farm to a depth of 16 feet. Several head of cattle were caught in the flood and could be seen bobbing up and down like corks as they were swirled along in the water. Most of them, however, finally escaped alive and were rounded up later, badly bruised, but otherwise unhurt. (*Daily Camera*, June 4, 1921)

BURNS and McDONNELL REPORT

Rainfall totaled 3.36 inches in Boulder from June 2 through June 7, 1921. (U.S. Army Corps of Engineers, *Boulder's Flood Protection Decision: A Choice to Live With,* Omaha: 1977) By June 7, 1921, Boulder Creek was high, but was considered "quiet." Every hour throughout the previous night, members of the Boulder Fire Department visited the Twelfth Street bridge and were under orders from the City Manager to notify him if the stream was carrying debris and/or if there was any danger of a dam at any of the bridges in Boulder. Other men worked all night to pile sandbags along the creek-bank to protect the Lakewood pipeline. Once the danger from the June 1921 flood was over, it was obvious to City administrators that more flood control measures needed to be done.

According to a contract dated June 28, 1921, the City of Boulder wasted no time in hiring consulting engineers from the Burns and McDonnell Engineering Company. The consulting team bemoaned the lack of accurate local records as to rainfall, storm activity, and drainage statistics. Evidently, Frederick Olmsted, Jr.'s recommendation that good records be kept had not been heeded.

One of the Burns and McDonnell's representatives, L.B. Reynolds, submitted a preliminary report on October 17, 1921. Most likely, he was the engineer who inspected the City's waterworks and sewage flow, along with "Boulder Creek within the City Limits with reference to proper bridge openings, bank protection, flood control, and general beautification." (Burns and McDonnell, *Preliminary Report: Water, Creek & Sewer Improvements, Boulder, Colorado, 1921,* Kansas City: 1921)

The main points and problems that were addressed, were:

1. the proper and safe spans and waterways for bridges and other viaducts within the city limits of Boulder.
2. recommendations for permanent bank protection and flood control.
3. recommendations for straightening and maintaining [a] permanent channel.

Under "General," Reynolds stated:

Boulder Creek as it flows through the City of Boulder has a drainage area of approximately 137 square miles, including the drainage of Middle Boulder, North Boulder, Four Mile Creek, Bummer Gulch, Sunshine Canyon, and other small tributary canyons and gulches. The drainage area as given was measured and computed from the United States Geological Survey topographical sheets or quadrangles. The western limits of the drainage area is on the eastern slope of the Continental Divide at elevations ranging from 12,000 to 14,000 feet above sea level. The lower portion of the drainage area and the outlet waterway through Boulder is approximately 5,400 to 5,350.

Practically the entire drainage area above Boulder is a rough mountainous district with precipitous rocky slopes and may be considered fairly well covered with timber and underbrush. The three principal tributaries have relatively long and narrow drainage areas. The upper portions of these areas have much higher rainfall and snowfall rates than the lower portions, and certain small areas are covered with practically perpetual snow banks.

The mountainous area is subject to storms of intense rainfall, commonly called "cloud bursts," during the summer seasons. On account of the character of the watershed, the varying intensity of the storms and rainfall over this area, and other uncertain factors, the percentage of run-off is indeterminate. However, this percentage must be relatively high. The streams within the canyons have tortuous rough beds containing many large boulders. The grade of the streams increases from approximately 1.1. per cent as it flows through the corporate limits of Boulder, to 4 or 5 per cent on the larger streams and much higher toward the sources and on smaller tributaries.

The general course of the Creek through the City is fairy straight except for the bend at Twelfth Street. The main channel for ordinary stage of water varies from 30-to-50-feet wide, and any stage above this puts the Creek out over a wide flat area. There are numerous artificial and natural obstructions, such as trees, underbrush, gravel pits, and wooden retaining walls that hinder the flow during high water. The stream bed, although fairly well defined, shifts during floods and by deflecting the current at such high velocity causes the stream to wash or cut into the banks.

The normal high water stages commence during the latter part of April or in May, depending upon the seasonal temperatures, and extend to the middle of July or the first part of August. This normal high water is caused by melting snows and general rains over the watersheds. Maximum flood stages occur when a cloud burst occurs over a part or whole of the drainage area, adding increased volume to the normal high stage flow. ("Preliminary Report: Water, Creek & Sewer Improvements, Boulder, Colorado," by Burns and McDonnell, Consulting Engineers)

In a discussion of "Maximum Stream Flow," Reynolds noted:

> There are no recent reliable records of maximum floods of Boulder Creek within the City of Boulder. Old records covering the years of 1889 to 1892, 1896 to 1900, and 1905 to 1908 are available in the State Engineer's Office. These are taken about 1-1/2 miles above Boulder. The largest runoffs recorded during these periods were 1,200 second feet in 1890, the accuracy of which seems to be in question, and 979 second feet in 1897.
>
> From information obtained in Boulder, the largest flood occurred in 1894, and there are no records of this year and no reliable information available as to the maximum runoff. From high water marks on [the] bridge opening, this was roughly estimated at 4,765 second feet, but driftwood at [the] bridge may have caused the water to back up or pool and make these estimates too large.
>
> Records are available on Boulder Creek at Orodell for the years 1888, 1907 to 1914, and 1916 to date at the State Engineer's Office. These records are for a drainage area of 105 square miles and do not include Four Mile Creek and several smaller tributaries. The highest stage recorded at this station was on June 6, 1921, lasting about thirty minutes when the gauge height was 4.25 and the discharge was 2,050 cubic feet per second (cfs). This gives a maximum run-off of 19.5 second feet per square mile of drainage area.
>
> With so many variable and indeterminate factors, it is almost useless to attempt to estimate maximum floods from rainfall records. In the absence of reliable actual records, the most logical method of estimating maximum floods is by comparison of maximum flood flows of streams in the same section of the country and similar in character as to general conditions of shape and topography of drainage area, rainfall rates, storm intensities, and slope of streams. Then, by computing the run-off per square mile of these streams, the data may be applied to Boulder Creek by multiplying the maximum run-off per square mile by the entire drainage area. ("Preliminary Report: Water, Creek & Sewer Improvements, Boulder, Colorado," by Burns and McDonnell, Consulting Engineers)

Reynolds then put forth his recommendations in a section on "Recommended Channel Area:"

In determining the required channel area to carry the maximum flood flow, the velocity must be first estimated. The velocity depends upon slope or grade of stream, the hydraulic radius or shape of the cross-sectional area, the alignment of the channel and roughness and obstructions in the stream bed.

The slope of the stream is approximately 1.1 feet fall in 100 feet of length. The hydraulic radius will vary at different stages of water, as this term is a relation of the cross-sectional area of the water to the length of the wetted perimeter. The alignment of

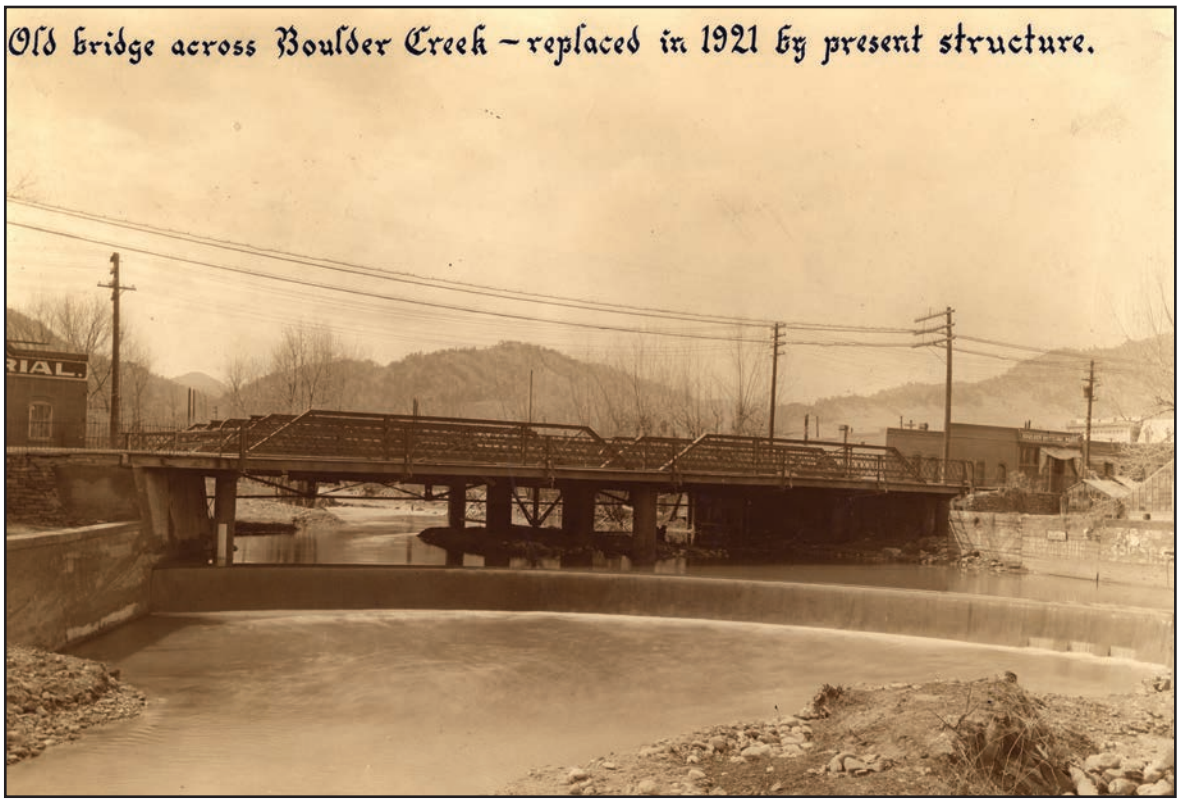
Boulder Creek would be considered good for a stream with a small fall and relatively low velocity, but in this case with high velocity, any bends or more or less abrupt change in direction of flow has the effect of producing eddies and causing a slackening of velocity and "piling up" of the water. The stream bed is covered with small boulders and coarse gravel deposits, and along the low banks is a growth of trees and underbrush which obstructs flow. The alignment and conditions of the stream are taken into account in a "coefficient of roughness" factor. This has been assumed as .035, as this is used by the United States Geological Survey engineers on streams of this type. Also, Mr. J.H. Bailey, Chief Hydrographer, Colorado State Engineering Department, states that from investigations on streams of the type of Boulder Creek, .035 is the proper factor.

Using the above facts and assumptions, the mean velocity during high water is 6.8 feet per second. The maximum flood flow of 2,740 second feet [feet-per-second] would require an area of 403 square feet. From the topographic map prepared by the City Engineer's Office in 1914, covering the Creek from Sixth Street to Thirteenth Street, the general elevation of ground along the Creek banks is from six (6) to eight (8) feet higher than the Creek bed. Unless considerable filling was done, the water elevation should be kept below seven (7) feet to prevent overflowing. Assuming a depth of 6.2 feet as a maximum depth, the width of channel should be [approximately] 75 feet.

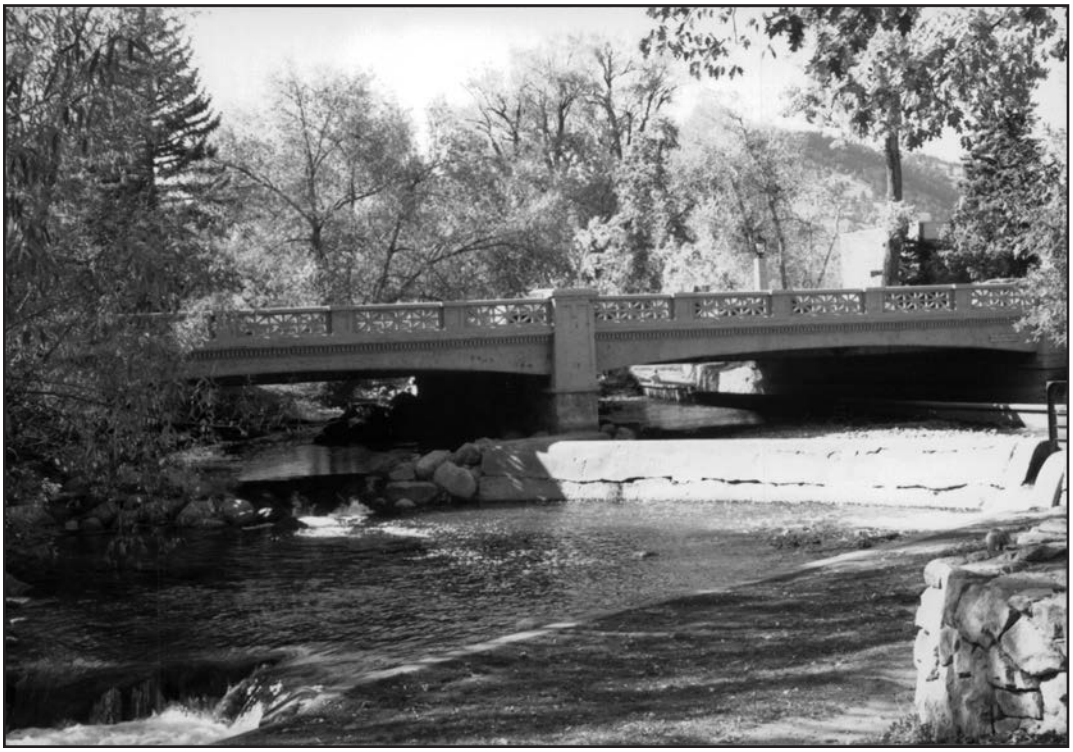
In the eastern section of the City, from Nineteenth Street to Twenty-Eighth Street, the ground elevation at present is not more than three (3) or four (4) feet above the Creek bed for some distance from the bank, so that the water would spread over this territory during floods for stream width of 100 to 150 feet. This low land is covered with willow, cottonwood, and other trees and underbrush that would form considerable obstruction to the velocity causing a piling up of the water and widening of the stream still farther.

Until a permanent bank improvement is made in this territory we would recommend the clearing of all timber and underbrush from this ground located below a five or six foot water stage. There are also a number of constructions of the channel in the western part of the City, caused by trees and also artificial dikes and contrivances built for gravel pits, that should be removed in order to secure a full flow of the channel area as estimated. There has been no topographical map made of the Creek and adjacent territory east of Thirteenth Street, and it may be that the Channel should be widened to one hundred feet (100) and maintain a four (4) foot depth or stage in order to better fit the conditions of the lower ground. ("Preliminary Report: Water, Creek & Sewer Improvements, Boulder, Colorado," by Burns and McDonnell, Consulting Engineers, Kansas City, Mo.)

According to historian Phyllis Smith, the Burns and McDonnell report, too, joined the others on the shelf. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado*).



1921 also was the year that the 12th Street (now Broadway) Bridge, over Boulder Creek, was replaced by a new bridge of reinforced concrete. The former bridge had been built after the Flood of 1894 and was designed for horse-drawn vehicles. The new bridge remained until 2002 when it, too, was replaced. Above photo taken in 1921, below in 1995. *Both photos, Carnegie Branch Library for Local History, above 207-3-50 #1 and below, 780_bridge_12th_1, 1995*



FLOODS of 1938 and 1942

Heavy rain fell in Boulder County on September 2, 1938. Boulder was considered "drenched but not damaged," with most of the flooding along South Boulder Creek. The creek spilled into the then-resort town of Eldorado Springs. Residents rushed from their homes and sat all night on the mountainside.

At the time, the community's main attraction was its dance hall. Big band leader Glenn Miller had played there as part of Holly Moyer's Jazz Band when Miller was a University student in the early 1920's. The dance hall burned in 1929 but had been quickly rebuilt in 1930. On the night of the flood, eleven University of Kansas musicians, known as the Matt Betton Orchestra, were tuning up for one of the final performances of their five-week contract.

One of the players told a reporter that the orchestra members managed to save two saxophones. Then they, too, joined the crowd and watched as a swimming pool pavilion was damaged and the dance hall was swept downstream. By then, water in front of the town's post office was four feet deep, and falling rocks from the steep canyon walls knocked two houses off of their foundations.

The following morning, two of the orchestra members walked to the town of Marshall where they hitched a ride into Boulder to report the damage. In state-of-the-art communications for the time, the men gave first-hand descriptions over a short-wave radio from the Boulder County Sheriff's Office. Their report was then rebroadcast to a larger audience by a Denver radio station.

This car, submerged in Eldorado Springs in 1938, needed more than a horse. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 225-4-24 #11*

The swimming pool at Eldorado Springs was badly damaged in the 1938 flood. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 225-4-23 #2*

A flood hit much of the Front Range in April 1942. Residents along the Platte and Arkansas rivers were ready to evacuate, while 20-30 inches of snow fell in western Boulder County. Meanwhile, on April 24, Boulder received 2.36 inches of rain in 24 hours.

A few weeks earlier, the *Daily Camera* reflected on Boulder County's "extraordinary long and severe winter," adding that the caretakers at Silver Lake, in the City's watershed, had been isolated since the previous fall due to 8 and 10-foot snowdrifts on the road to their cabin. (*Daily Camera*, April 24, 1942)

After debris blocked a bridge over Two Mile Creek, water rushed down Iris Avenue (formerly 9th Avenue) during the April 24, 1942 flood. Boulder County crews rushed to sandbag the creek at Broadway and divert the water into Farmers Ditch. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 225-4-31 #1*

By the 1920s, Boulder had three major flood control reports:

Frederick Law Olmsted, Jr., in 1910
Metcalf and Eddy, in 1912
Burns and McDonnell, in 1921

More were to come.

S. R. DeBOER PRELIMINARY CITY PLAN

In 1944, city planner and landscape architect S. R. DeBoer submitted his "Preliminary City Plan for the City of Boulder." He discussed history, population, employment, and climate, which included his flood comments and flood control recommendations.

Despite the three earlier reports, DeBoer noted a "serious lack of information in regard to flood hazards in Boulder." After stating that the 1894 flood came chiefly from Four Mile Creek, he explained (as had the Burns and McDonnell report) that the gauging station at Orodell didn't even account for Four Mile Creek. DeBoer recommended a gauging station "below the mouth of Four Mile Creek and above the irrigation canals."

According to DeBoer, one of the major contributing factors in flood danger in streams flowing out of the mountains was, and is, debris (mainly trees). During floods, trees fall into the water and pile up against bridges and obstructions and in low places of the channel. DeBoer advocated reservoirs for debris storage at the mouth of Four Mile Creek above the mouth of Sunshine Creek, "at the gravel pit near the Sixth Street Bridge." This was the location of several metal processing mills but now is in the vicinity of the "Kids Fishing Pond" and the parking lot for the Boulder County Justice Center. DeBoer advocated careful supervision of gravel pits in floodplains.

The city planner added: "These debris reservoirs should have ample capacity to take care of all floating material, trees, brush, rocks, and sand. They should be arranged so that they have equipment to drag the logs from the stream, and power saws to cut them up quickly after the flood has past. They should have places for piling sand for disposal to buildings and, in general, should be able to clean out the reservoir quickly to allow for the next runoff."

DeBoer praised the City of Boulder for acquiring much of the land along Boulder Creek and urged the City to buy up some more. He was concerned, however, with low beams on some of the bridges. "A new bridge," he stated, "at 17th Street should be designed for a greater height, and the buildings on the creek-front at this place removed."

DeBoer's PROPOSED TREATMENT is outlined below:

a. Acquisition of bottomland to a width of at least 350 feet, and prohibition of building by zoning on all privately owned land in this section.

b. Retention of the present channel and the trees along it, but cleared of all obstructions.

c. An emergency floodplain to parallel the stream. This land to be used as a major park and recreation area in which the central section is kept open for the flow of water.

d. A levee of seven or eight feet on the city side of this open park strip to prevent water from running into the business district.

e. A major cross-town parkway and traffic artery to be placed on this levee, designed for limited access and no frontage and treated as a park road.

f. Raising of existing bridges and their approach roads or, until that is accomplished, a free flow of water around them with proper protection of the back of abutments.

g. Consideration of a debris-catching reservoir at the upper end of the stream.

h. Elimination of all railroad switch lines west of Broadway except for one line to service industrial blocks, and exchange of railroad property in this section for better industrial blocks in the east section of the city.

The following items applied to areas outside of the city limits:

i. Consideration of a debris and retarding reservoir on Sunshine Creek above the Sanitarium.

j. Consideration of a debris reservoir on Four Mile Creek above the mouth. Subject to detailed studies, it would seem that an open dam of iron rods might be used to catch logs coming down this stream.

k. Consideration of reservoirs on North Boulder and Four Mile Creeks.

l. Consideration of the possibility of using part of Nederland Reservoir for flood storage.

m. Prevention of building in the floodplain of Boulder Creek both above and below the city.
(DeBoer, S. R., *Preliminary City Plan for the City of Boulder,* 1944, Volume VI, pp. 1-13)

UNITED STATES ENGINEER OFFICE, SURVEY REPORT – FLOOD CONTROL

A survey report on flood control of the South Platte River and its tributaries (prepared in 1945 by the U.S. Army Corps of Engineers) discussed Boulder's watershed. The report mentioned that Barker Reservoir, built in 1910, provided limited flood protection for Boulder, but that its operation was solely in the interests of power generation with no reservoir storage allocated to flood control.

The authors' suggestions for Boulder Creek were similar to DeBoer's in that they recommended a dike be constructed along the north bank of Boulder Creek with a boulevard-parkway on top of the diked land. They also recommended that the creek be straightened, the banks be revetted, and the waterway edged with concrete walls.

The report added:

The exposure of the Boulder Creek basin to disastrous cloudburst floods which would exceed in peak discharge the record 1894 flood is definitely established and constitutes a potential hazard both to the welfare and the economic stability of Boulder. The absence of destructive floods since the occurrence of the 1894 flood has resulted in a general lack of knowledge on the part of the residents of Boulder of the flood possibilities of the stream such as to induce a *false feeling of security* [author's emphasis] and make it probable that considerable loss of life would result even from the re-occurrence of the 1894 flood. The flood problem of Boulder, consequently, includes flooding due to sustained floods such as that of 1894, as well as from limited area and major cloudburst storms. (U.S. Army Corps of Engineers, *Survey Report on Flood Control: South Platte River and Tributaries: Colorado, Wyoming, and Nebraska,* 1945)

In reflection, Frederick Law Olmsted, Jr., back in 1910, made a statement similar to the Engineers' comment on a false feeling of security. Olmsted wrote that Boulder was a community that was "lulled by the security of a few seasons of small storms" and that it "will inevitably pay the price in destructive floods."

In August 1945, the U.S. Army Corps of Engineers presented its formal report to the Boulder City Council and suggested that the City take advantage of federally sponsored stream enhancement. According to historian Phyllis Smith, the Council never formally responded. Instead, it authorized the building of the City's new Municipal Building in the floodplain, on the banks of Boulder Creek. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado,* p. 46)

In 1951, the Municipal Building was under construction. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-3-60 #12*

Edgar Emerson took this photo of laborers enclosing the Farmers Ditch at 9th Street and Portland Avenue, on May 5, 1953. *Carnegie Branch Library for Local History, 208-4-30 #9*

Twentieth century: 1950s to the BIG THOMPSON

The 1950s ushered in big changes. The grand opening of the Municipal Building came in July 1951, six months before cars first drove on the Boulder-Denver Turnpike (now U.S. 36), in January 1952. Operations began at the Rocky Flats plant of the Atomic Energy Commission in April 1953, and the Bureau of Standards (now NIST) opened in September 1954. Boulder experienced a building boom, as developers rushed to provide housing and city services to an exploding population. For the average resident, flood control was not a concern.

PROPOSED FLOOD CONTROL DISTRICT

Boulder did have, however, a few floods during the early 1950s (August 3 and 31, 1951; June 7, 1952; and July 15, 1954), but none made the history books (except for this book). The August 3, 1951 storm, however, flooded basements and storm sewers. By the time everyone had mopped up, the August 31 storm soaked residents all over again. The *Daily Camera* called the August 31 storm a "furious hail storm and a deluge of rain." Ironically, just when the rain had started, Boulder author Paul Friggens was speaking before the Rotary Club on the topic of rain-making. (*Daily Camera*, August 31, 1951)

With the City's post-World War II growth, floods and flood control weren't even topics of discussion. That changed in February 1955, when Edgar Emerson, a Boulder chemist and president of the Boulder Valley Soil Conservation District, began what turned out to be an unsuccessful campaign to establish the Boulder Mountain Valley Flood Control Conservancy District.

Emerson gave speeches, prepared pamphlets, took photos, and wrote newspaper articles on previous floods in the area. When Emerson came before the City Council, he spoke of the benefit of receiving federal money under Public Law 566—the Watershed Protection and Flood Prevention Act. The Council was favorably convinced and voted on April 18, 1956, and again a month later, to seek a hearing in Boulder District Court to form a flood control district.

After three years of legal wranglings, the proposal went to court. Then it was thrown out. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado,* p.47)

OCCUPANCE IN THE FLOODPLAIN

In 1957, Gilbert F. White and his family spent a summer in Sunshine Canyon, then they decided to make Boulder County their home. At the time, White was Chair of the Department of Geography at the University of Chicago. The following year, with several University of Chicago colleagues, White published a study titled, "Changes in Urban Occupance of Flood Plains in the United States." Seventeen cities across the country were included, and one section was on Boulder. The group studied the change in population *within the floodplain*, from 1930 to 1950, and found a 78 per cent increase!

When members of the community were interviewed about adopting flood-control measures, the majority were not concerned. Most had not even heard of the flood of 1894, and others (incorrectly) felt that the presence of Barker Reservoir served to limit flood danger. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado,* p.47)

Although White and his group were aware of Boulder's rapid post-war growth at the time, they didn't know that many more residents would be moving into Boulder in the coming years. According to the Federal Census, Boulder's population in 1950 was 19,999. By 1960, it had almost doubled to 37,718. And, by 1970, it had more than tripled to 66,870. Of course, not all of the growth was in the floodplain — but much of it was.

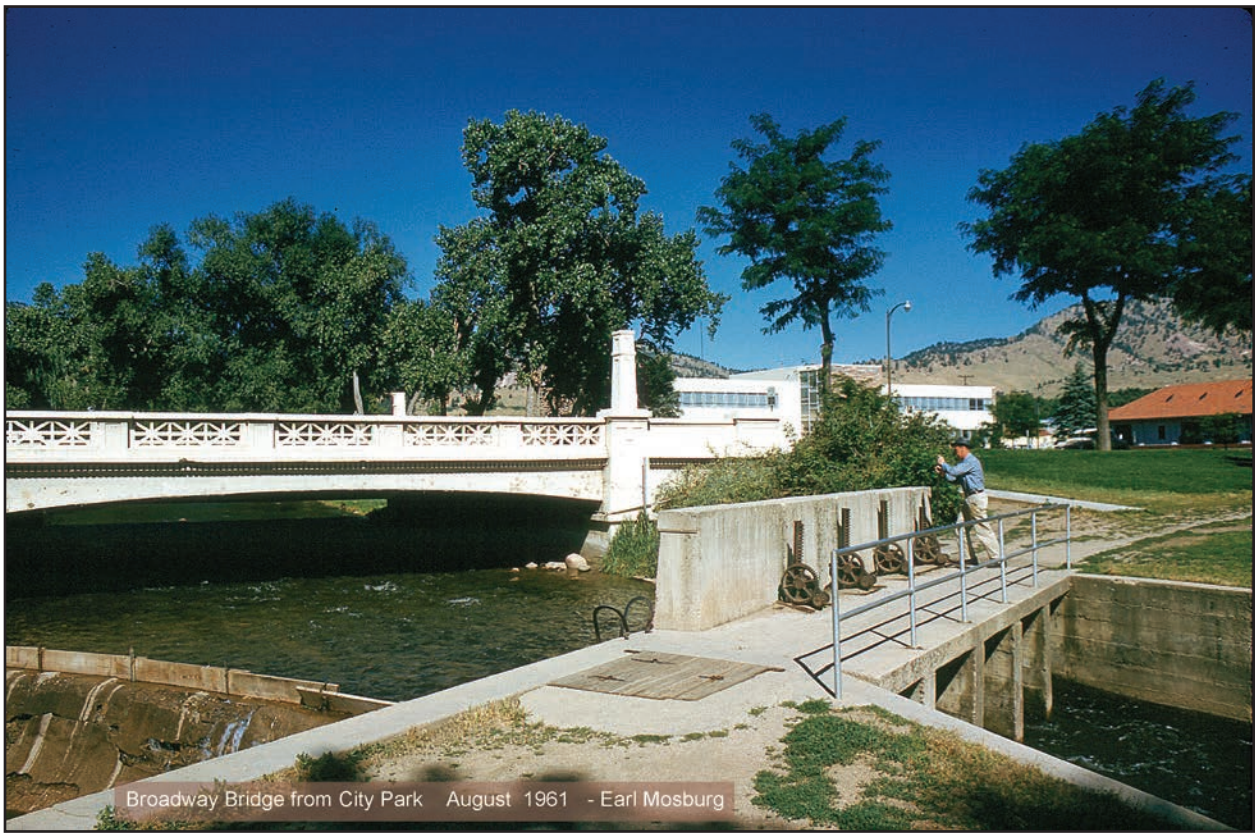
THE 1960s AND THE 1969 FLOOD

Also in the floodplain was Boulder High School, as well as married-student housing for the University of Colorado. And, in 1961, west of the Municipal Building, the City built Boulder's new public library, expanding from its first library (now the Carnegie Branch Library for Local History) on Pine Street.

According to historian Phyllis Smith, at least one resident warned the City Council that the land in and around the library was unstable, since the fill dirt had been brought down by earlier floods and the stream channel had changed. Although no one made the direct correlation, the unstable soil may have contributed to the death of acting Boulder Mayor Michael Trent in 1971, when he was crushed during a cave-in during a dig at a bottle-dump site along Boulder Creek near 9th Street. (*Daily Camera*, Dump Site Near Library Contains Hidden Treasures, May 7, 2006)

By the early 1960s, the City was growing quickly, but it still felt like a small town. The rest of the country, however, was beginning to change. In 1963, the Reverend Martin Luther King preached his "I have a dream" speech to civil-rights demonstrators in Washington, D.C. That same year, in Dallas, Texas, Lee Harvey Oswald assassinated U.S. President John F. Kennedy. In 1964, President Lyndon B. Johnson made a major military commitment in Vietnam, and musician Bob Dylan sang his latest hit song, "The Times They Are A-Changing."

The new building of the Boulder Public Library, at 1000 Canyon Boulevard, above, was photographed shortly after its completion in 1961. The photo, below, of the Broadway Bridge over Boulder Creek was taken the same year. The Municipal Building and, also, the Union Pacific Freight Depot are visible in the background. *Both photos, Carnegie Branch Library for Local History, Boulder Historical Society collection; above 207-5-5 #5, below 750-9-10 #4*



Weather-wise, heavy rains fell in the Denver area in June 1965, with flooding along the South Platte River. Boulder was spared, but the event alerted Boulder residents to the possibility of a similar deluge affecting Boulder Creek. That summer, a Denver-area group of city and county engineers (including representatives from Boulder who had followed Edgar Emerson's ideas from the 1950s) sought a higher level of standards in all areas of municipal construction. The small group of flood control supporters had increased, but, in January 1966, the City Council still voted down a proposed amendment to the City's zoning ordinance on flood control regulations.

Even so, the City Council hired Gilbert White to study land use regulations and flood hazards. In January 1967, even though he was still teaching in Chicago, White came before the Council and debunked the "Barker Dam Myth," stating, "It is a mistake for citizens of Boulder to assume that either because of new works since 1894, such as the construction of Barker Reservoir, or of recent developments in the mountain area, the flood hazard is less severe than it was in earlier years. On the contrary, the hazard has grown."

White recommended a floodway zone in which no further construction would be permitted, and he asked that buildings constructed near the floodway be proofed according to the standards of the National Building Code. After reading and discussion by the Council, those plans, too, were shelved. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado,* p.53-55) No doubt White would have welcomed Edgar Emerson's ideas and enthusiasm, but Emerson died in Boulder, in 1968, at the age of 60.

Residents were jolted back into reality on May 6 and 7, 1969, when a four-day rainstorm hit Boulder and Boulder County. Boulder Creek and the downtown area were not as directly affected as South Boulder. There, Bear Canyon Creek overflowed its banks and inundated Table Mesa Drive, sending flood waters through the new Table Mesa Subdivision, as well as residential areas downstream. 1969 was also the year that White left the University of Chicago to join the faculty at the University of Colorado.

Lyons incurred flood damage, as did several of the mountain towns including Crisman. Hardest hit, however, was Jamestown. Current Boulder County resident Jeanney Horn lived in Jamestown at time. "I watched, mesmerized," she said in a recent interview, "as the strangest things floated by... refrigerators, cars, houses, outhouses, fences, propane tanks, and massive trees, their roots sticking up high out of the water."

Horn lost some personal belongings, but she had friends who lost everything. There was no viable access in or out of town. Residents were stranded without power or drinking water. One man fell into the creek, suffered a serious head injury, and lost an eye. At least two women were expecting babies, and one of the women was three weeks overdue. She was evacuated by an Estes Park doctor who managed to get a military vehicle down Overland Road. Two other doctors hiked fifteen miles from Boulder to treat the injured man, who could not be moved.

In May 1969, in Table Mesa, Bear Canyon Creek overflowed its banks. *Carnegie Branch Library for Local History, Boulder Historical Society collection, above 511-4-14 #3, below 511-4-14 #4*

People cheered when a helicopter brought in bread, milk, and cheese, as well as two-hundred gunny sacks for sandbagging. As residents built dams, they also dumped old cars into the raging waters to build a make-shift dike that protected the church, town hall, and mercantile building.

Again, the townsfolk joined together to rebuild, as Jamestown and every other flood-damaged community had done before. Horn returned years later, amazed to find that in the collective memory of the residents, the flood (like the flood waters) had faded into the past. (*Daily Camera*, "Then as Now: Numerous floods cut swaths of destruction, sorrow, in county," September 22, 2013)

Buildings along James Creek were washed downstream in Jamestown, in May 1969. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 225-4-50 #2*

THE 1970s USHERED IN FLOOD CONTROL/MANAGEMENT POLICIES

Directly influenced by the 1969 flood, a group of engineers from the counties of Denver, Adams, Arapahoe, Jefferson, Douglas, and Boulder formed the **Urban Drainage and Flood Control District (UDFCD)**, http://www.udfcd.org/index.html. The UDFCD assisted with early warning systems and also helped municipalities qualify for the National Flood Insurance Program. During the next 30 years, the City of Boulder would map its 100-year floodplains to identify flood-hazard areas, develop master plans to pursue mitigation of flood impacts, and create what initially was called the **Storm Drainage and Flood *Control* Utility**.

As evident in the Utility's eventual name change to the **Stormwater and Flood *Management* Utility,** public perception of flood policies evolved, with a change in semantics, from the word "control" to "manage." For the next couple of decades, however, "control "and "manage" seemed to be used interchangeably.

On August 17, 1969, the City Council adopted its first **"Floodplain Regulations" (Ordinance 3505)**, which defined flood storage and **Floodway** areas within the **Floodplain**. The Council also adopted a flood protection elevation for both residential and commercial structures of two feet above the 100-year flood elevation. Floodway and flood storage areas, however, were not delineated at that time.

Then, in 1969 and 1970, and in conjunction with the UDFCD, Wright-McLaughlin Engineers prepared **t**he **City's first major drainageway master plan**, referred to as the **Wright-McLaughlin Masterplan.** The plan's improvements covered Boulder Creek - 24th to 30th Streets; Boulder Creek Flood Slough; North Boulder Tributaries; and South Boulder Tributaries. (Boulder City Council Study Session, 2002)

Meanwhile, the social changes of the late 1960s had brought new faces to the City Council in the early 1970s, tipping Boulder's political climate from conservative (yes, it really was, up to this time) to liberal. Although flood control was not a partisan issue, historian Phyllis Smith perused letters to the editor of the *Daily Camera* and noted that Boulder residents were overwhelmed, and irritated, with the number of reports, studies, reviews, surveys, master plans, and proposals thrown at the average resident.

This attitude was sensed by the U.S. Army Corps of Engineers, as well. In 1970, the agency realized that without local community support for its recommendations on flood control, implementation of structural improvements on flood-prone creeks in a number of municipalities would be an uphill battle. So, the Corps fostered the formation of the **Corps of Engineers Citizens Committee on Environmental Planning (CECEP)**, with subcommittees in various regions across the country. Boulder's subcommittee focused on plans for flood control along Boulder Creek.

The **first official floodplain map** was adopted by Ordinance 3701 on April 6, 1971. The map contained detailed information for Boulder Creek and South Boulder Creek from a study by the U.S. Army Corps of Engineers and estimated floodplain limits for the tributaries determined by Wright-McLaughlin Engineers. (2002 Council Study Session)

The CECEP's study evaluated more than 50 variations of flood control concepts, involving both structural and management measures, of which only two were economically justified. These were a "channel enlargement" concept and a levee floodwall concept (floodway), but neither were accepted. An environmental analysis of these major concepts, including the two feasible ones, was completed in November 1972 by the Thorne Ecological Institute of Boulder. The City Council's preference was for a diversion channel, but this option was not cost-efficient.

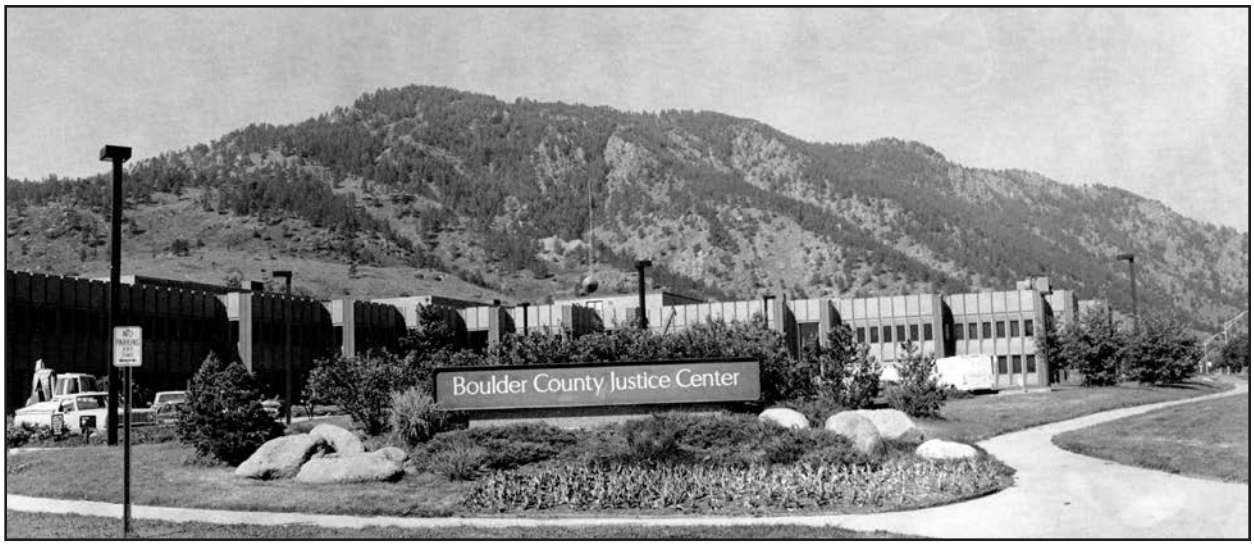
Although not in Boulder, and not even in Colorado, a flood took more than 200 lives in Rapid City, South Dakota, in June 1972, sending shock waves across the country. Fifteen inches of rain had fallen in six hours on already saturated ground. Those with their eyes on Boulder Creek knew it could also happen there. The **UDFCD** wasted no time in preparing a *Special Flood Hazard Information Report* for Boulder Creek. In a section titled "Future Floods," the authors, in 1972, echoed the words of their U.S. Army Corps of Engineer predecessors who, in turn, had reflected on the words of Frederick Law Olmsted, Jr.'s comments — way back in 1910 — on Boulder residents feeling a false sense of security.

The **UDFCD** concluded that a definite flood hazard existed in Boulder (in the Boulder Creek floodplain), adding, "A future flood of the magnitude of that in 1894 would result in staggering residential, commercial, and municipal damages. No flood prevention measures that would significantly reduce flooding at Boulder have been constructed in the Boulder Creek basin." The authors also noted that the statistical frequency of the 1894 flood has less than 1 in 100 chance of occurrence, but such a flood could happen in any year. (UDFCD, *Special Flood Hazard Information Report, Boulder Creek, City of Boulder, Colorado,* May 1972)

At the time, Gilbert White and J. Eugene Haas were in the process of writing "Assessment of Research on Natural Hazards," in which they discussed Boulder's lack of concern toward floods. The men noted that, from 1945 to 1973, the City Council had commissioned twenty flood studies, two-thirds of which recommended some kind of structural adjustment to Boulder Creek and its tributaries.

Although the City Council had made it clear that it did *not* want to build walls, berms, dikes, or excavate or cement the creek channel, it did agree to **CECEP's** suggestion of replacing several of the bridges on Boulder Creek to make them less prone to catching debris. (Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado,* 1987, p.64-67) Meanwhile, construction in the floodplain continued. At the time, the "ruins" of Allen Lefferdink's Park Allen Hotel stood west of 6th Street and along Boulder Creek. Lefferdink, the failed financier wheeler-dealer of the 1950s, had once promised Boulder that the building would be the City's ultimate luxury hotel, but construction ended when Lefferdink went bankrupt and, eventually, landed in prison. During the 1960s, the site became a crash pad for hippies and transients.

By the mid-1970s, Boulder County had acquired the former hotel site and built the Boulder County Justice Center. Like the Municipal Building and the Boulder Public Library (expansion across and south of the creek was approved in 1973), the Justice Center, too, was in the floodplain. Nevertheless, the courts, jail, and Boulder County Sheriff's Department (now Office) relocated from the downtown Boulder County Courthouse, while the Boulder Police Department moved from the Municipal Building. For the first time in Boulder's history, all of these law-enforcement entities became housed under the same roof.



The Boulder County Justice Center opened in January 1976, six months before the Big Thompson flood in Larimer County. *Carnegie Branch Library for Local History, Boulder Historical Society collection, 207-18-9 #5*

STORM DRAINAGE AND FLOOD CONTROL UTILITY

Progress did continue, however, in the field of flood management. On August 21, 1973, the City Council adopted Ordinance 3927, which created the **Storm Drainage and Flood Control Utility** (later renamed the **Stormwater and Flood Management Utility**) and also approved the **first drainage master plan**. This measure created a separate utility, segregated funds for drainage and flood control, and provided for the collection of a service charge to generate local funding.

In order to collect the utility fees, a fair and equitable method of assessment was needed, requiring the physical inspection of more than 13,000 buildings within and outside the 100-year floodplain. The survey information was used to develop a runoff coefficient expressing the amount of water per square foot which would run off a property as opposed to being absorbed or retained on the land. The coefficient was used to calculate fees to be paid by non-residential property owners. Residences were charged a flat rate based on lot size.

On October 8, 1973, the Boulder Creek Subcommittee on the Corps of Engineers Committee on Environmental Planning **(CECEP)** presented the City Council with a nonstructural improvements policy for Boulder Creek. Titled the **Flood Control Plan – Boulder Creek**, these nonstructural improvements for floodplain purposes included methods that did not involve structural changes or channelization of the main creek, except for limited structural features such as bridges at roadways. On August 20, 1974, the City Council adopted the plan by **Resolution No. 141 as "Nonstructural Flood Control Policies for Boulder Creek."**

The nonstructural improvement policy was implemented through preservation and restoration of the Boulder Creek greenway, through acquisition and removal of high hazard structures (such as the acquisition and removal of the 299 Arapahoe, 20-unit apartment building at Eben G. Fine Park), through construction of flood barriers (including the Canyon Point berm/levee along Canyon Boulevard and Crossroads floodwall), through elevating and flood proofing buildings, and through grading modifications outside of the riparian creek corridor, i.e. Boulder Creek Acquisition Project at Boulder High School. (Boulder City Council Study Session, 2002)

During the following years, additional modifications were added to the city's flood control and management programs and ordinances. Among these were:

- Development of floodway and floodplain maps in 1974. (A revision of these maps was made in 1983.)
- In 1975, adoption of a **definition of a floodway** as an area where water velocities are two feet per second or greater, where depths are two feet or greater, and where a 100 per cent development of the flood storage area would not create a rise of more than one-half foot.
- 1975 version of the floodplain regulations which eliminated the issuance of permits for dwellings in the floodway.
- Beginning in 1975, participation in the **National Flood Insurance Program (NFIP)** under the direction of the FEMA. The goals of the insurance program were to reduce flood hazards, regulate floodplain activities, adopt floodplain policies, map floodplains, and educate the public about floods and floodplains. (City of Boulder, Stormwater and Flood Management Background Information, 2003)

Viele Channel, which extends from Viele Lake to its confluence with South Boulder Creek, was funded with the **UDFCD**, completed in 1976, and was **the City's first major drainageway improvement.** The channel was improved in such a manner that, at the time, it was believed to have removed south Boulder's Keewaydin and Frasier Meadows neighborhoods from the floodplain. (Boulder City Council Study Session, 2002) *That was before the City realized the hazards posed by South Boulder Creek.*

BIG THOMPSON FLOOD IN LARIMER COUNTY

The Boulder County Justice Center had only been open for six months when, on July 31, 1976, the Big Thompson flood severely damaged communities from Estes Park to Loveland, in Larimer County, 30 miles north of Boulder. A nearly stationary thunderstorm in upper Big Thompson Canyon had dumped 12 inches of rain in less than four hours, sending a wall of water that washed out most of U.S. 34 and claimed the lives of 143 people.

Could the same disaster strike Boulder?

The Big Thompson Flood became the wake-up call, and Gilbert F. White, then Director of the Institute of Behavioral Science at the University of Colorado, responded. Assisted by research assistants Eve C. Gruntfest and Thomas E. Downing, White interviewed many of the Big Thompson Flood survivors, then authored an article in a civil engineering magazine expressing the need for a better flood reaction system in Boulder.

Using the Big Thompson Flood as an example, White and his assistants described what had happened before and during the flood, they proposed a more effective warning system, and they explained how to escape from a flash flood.

Although the heavy rains had begun at 6:30 p.m. near the communities of Estes Park, Drake, and Glen Haven; the National Weather Service didn't issue a flash flood *watch* until 7:30 p.m. Additionally, a flash flood *warning* wasn't issued until 11 p.m., after most of the damage had occurred. Most of the residents and vacationers in the canyon received no warning at all. At the same time, many in the lower end of the canyon didn't appreciate the gravity of the situation and simply ignored the warnings they did hear.

Those in the canyon who survived the flood were the ones who climbed to higher ground. Several people tried to drive out ahead of the wall of water and were drowned. A few made it, but White, et. al. noted that they were the lucky ones.

White and his assistants emphasized that the "most effective means of preventing loss of life and property damage during a flash flood is to simply avoid flood-plain development" — the same message expressed in every report since Frederick Law Olmsted, Jr.'s in 1910. However, the authors admitted that avoiding development was a difficult task, as many canyons already were developed. In those cases, they agreed that one safeguard is a warning system. As they stated, however, any warning system is only as strong as its components — weather forecasts, observation networks, reliable and speedy communication, preparedness planning, and a public education system. (Gruntfest, Eve; Thomas Downing, and Gilbert White, "Big Thompson flood damage was severe, but some could have been prevented," *Civil Engineering-ASCE*, February 1978, pp. 72-73)

The authors also determined that the content of the warning (from television to face-to-face communication) greatly influences how people respond. They came up with nine guidelines for wording a warning message:

- Convey a moderate sense of urgency.
- Estimate the size of the expected flood.
- Estimate the time before impact.
- Provide specific instructions for action.
- Confirm the threat, if possible.
- Describe actions of others.
- Tell number of warnings previously issued.
- Mention present environmental conditions.

- Advise people to stay clear of the hazard zone.

One of the recommendations was the now-popular "Climb to Safety" sign designed by then-Boulder County flood control engineer Mike Serlet. (Gruntfest, Eve; Thomas Downing, and Gilbert White, *"Big Thompson flood damage was severe, but some could have been prevented,"* p. 73)

The Big Thompson Flood inspired the design of the "Climb to Safety" signs, in place in Boulder County mountain canyons. This one is at the mouth of Boulder Canyon. *Pettem photo, 2015*

Twentieth century: wake-up call

The Big Thompson Flood was in Loveland, not Boulder, but the City of Loveland was (and is) closer to Boulder than Rapid City, South Dakota, and the event became a wake-up call for Boulder residents. Shortly after the flood hit Big Thompson Canyon, then-Colorado State Geologist John Rold released the locations of the 10 most dangerous canyons in the state for flooding potential. Boulder Canyon led the list.

"Although any area of steep terrain which experiences intense rainfall is apt to suffer damage from geologic processes, these 10 represent the areas of great exposure to potential property damage and loss of life." Rold added that a flood like the one in Big Thompson Canyon could just as easily have happened in Boulder Canyon. The only reason it was so devastating was because a "freak storm" dumped 14 inches of rain in Big Thompson Canyon during a four-to-six-hour period. (*Daily Camera*, March 31, 1977)

In the 1977 booklet *"Boulder's Flood Decision — A Choice to Live With,"* the U.S. Army Corps of Engineers also emphasized that the Big Thompson flood was a catastrophic event that could happen in Boulder Canyon.

DISASTER PREPAREDNESS

Also in 1977, the Boulder City Council commissioned Leonard Rice Consulting Water Engineers, Inc. to complete an early warning system for the city. The **Urban Drainage and Flood Control District (UDFCD),** the agency that helped Boulder with many of its programs, cooperated in the project, as well. The system was titled, **"Early Flood Warning Planning: Boulder Creek."**

Rice came up with five alternative warning systems:

- Automatic Stream Gauge Network
- Automatic Rain Gauge Network
- Volunteer Rainfall and Streamflow Observers
- Automatic Rain and Stream Gauge Network
- Combination Automatic and Volunteer Rain and Stream Gauge Network

The combination alternative ranked the best. (Leonard Rice Consulting Engineers, *Early Flood Warning Planning: Boulder Creek,* Boulder: 1977)

Meanwhile, in May 1977, the City brought in the U.S. Army Corps of Engineers, who stated, "Without a highly effective emergency evacuation program and without the channel capacity to convey the floodwaters through Boulder, loss of life and property could be devastating." (U.S. Army Corps of Engineers, *"Boulder's Flood Decision — A Choice to Live With,"* p.9)

The Army Corps' planning objectives were to:
- eliminate existing flood hazards to the extent practicable.
- minimize the impacts of remaining flood hazards.
- prevent the creation of additional flood hazards.

Their proposed plans to achieve these objectives were:
- Plan 1, enlargement of the Boulder Creek Channel.
- Plan 2, an excavated floodway.
- Plan 3, relocation and flood-proofing of developments already in the floodplain.

The City Council asked the U.S. Army Corps of Engineers to design a wide, flat channel for Boulder Creek, starting at the mouth of Boulder Canyon and extending to a location past the 17th Street bridge. Then, after the 6th Street bridge was replaced, the City proceeded with plans for a low-income housing project for the elderly, on Canyon Boulevard near 7th Street. In order to ensure the safety of the project, they constructed a 900-foot berm, completed in 1978, along Canyon Boulevard.

This area northeast of Canyon Boulevard and 6th Street was raised in 1978 to create a berm in order to protect a housing project from flooding. *Author's photo, 2015*

The governmental agency that showed the most interest in disaster planning and mobilization was the Boulder County Sheriff's Department (now Boulder County Sheriff's Office). Its concern was urgent, as deputies were required to respond to any emergency, e*ven though* their vehicles were parked in the most flood-prone location of all — in an underground garage, beneath the Boulder County Justice Center. (Boulder County, *Boulder County Sheriff's Department Disaster Planning and Mobilization, Flood Plans, 1977,* p.1-2)

Sheriff officials were to follow these steps in the event that weather conditions posed an imminent danger to Boulder residents:

- Move auxiliary fuel to roof (by Communications).
- Move vehicles and other critical resources out of the garage, including generators, batteries, fuel, crime scene van (by Patrol).
- Call in building maintenance personnel (by Communications).
- Consider position of prisoners (by Corrections). [Note: At the time, both the Boulder County Sheriff's Department and the Boulder County Jail were housed in the Boulder County Justice Center.]
- Ensure adequate staffing (by first staff officer to arrive).
- Establish command post (by first staff officer to arrive).
- Ensure adequate food supplies (by Corrections).

(Boulder County, *Boulder County Sheriff's Department Disaster Planning and Mobilization, Flood Plans, 1977,* p.2)

As part of an early warning communications system, radio-controlled gauges to measure stream levels and rainfall were installed in May 1978. Instead of the 15-minute warning provided by the previous, and primitive, rain gauge near Orodell (at the junction of Boulder and Fourmile creeks), the new system gave up to 45 minutes warning of a slowly rising creek, and at least 15 minutes of a flash flood. The gauges (3 in Boulder Creek and 6 in Boulder and Fourmile canyons) were developed by Leonard Rice and Associates, Denver consulting engineers, and were financed jointly by the City of Boulder, Boulder County, and the regional Urban Drainage and Flood Control District **(UDFCD)**.

Supplementing this flood warning system were 80 volunteers (including Sheriff deputies and county road personnel), all with their own rain gauges and portable radios. Radio-controlled equipment also sent information from the gauges to the Regional Communications Center at the Boulder County Justice Center, which was capable of handling flood warnings and evacuation of residents by voice receivers (similar to pagers) in Boulder's floodway and floodplain. A newspaper reporter, at the time, reiterated that "adequate warning followed by evacuation are the keys to preventing loss of life in a major flood." (*Daily Camera*, "Flood Warning System Readied," December 30, 1977)

When a flash flood warning was issued for Boulder Creek, in August 1979, Boulder County Sheriff Brad Leach had buses ready to transport his 75 prisoners, if necessary, to other jail facilities. (*Daily Camera*, August 17, 1979)

FLOODWAY AND FLOODPLAIN DECISIONS

Ever since 1945 (in response to the federal Flood Control Act of 1939), the U.S. Army Corps of Engineers has studied and reported on flood control of the South Platte River and its tributaries. The section on Boulder Creek was based on a peak discharge of 12,000 cfs for a 1-per cent flood. In 1969, the Corps of Engineers revised its estimate to 7,400 cfs, but the Corps raised it, again, in 1977, to 12,000 cfs. (U.S. Army Corps of Engineers, *"Boulder's Flood Decision — A Choice to Live With,"* p.7)

Boulder's first floodplain zoning regulations — the ones adopted in 1969 using the 7,400 cfs peak discharge estimate — provided for a regulatory **FLOODWAY** along the creek that was defined as that portion of the 1 per cent/100-year floodplain where velocities exceeded 2 feet per second, or, as previously noted, depths exceeded two feet. The regulation permitted new buildings in the floodway, provided that their development did not increase flood stages.

The regulations also stated that the 1 per cent/100-year flood depth could not be increased by more than a half-foot as a result of development in the **FLOODPLAIN,** outside of the floodway. Buildings in the floodplain were allowed provided that they were flood-proofed to two feet or more above the 1 per cent/100-year flood level. At the time, there was no protection for existing floodplain development. (U.S. Army Corps of Engineers, *"Boulder's Flood Decision — A Choice to Live With,"* p.7-8)

In 1978, Randall H. Philipsborn (one of Gilbert White's students) wrote a master's thesis on the construction of new buildings in the floodway. Again echoing Frederick Law Olmsted, Jr.'s (and others') recommendations that no buildings be built in the floodway, Philipsborn wrote, "Its purpose lies in the hope that by being able to describe how these decisions are made, there is the possibility of improving the decision-making process, or of becoming capable of adjusting to it, and the hope that more consideration will be given to these concerns in future choices." (Philipsborn, Randall H., *Decisions to Construct New Buildings Within the Regulatory Floodway of Boulder Creek: 1959-1978,* p. 1)

Philipsborn's study indicated that the decisions to build new structures were "economic decisions made under conditions of limited knowledge." Apparently, the values of the locations were more important to developers than risk of flooding. For instance, in 1959, Boulder architect James Hunter appeared before the Boulder Planning Board and explained that his designs of both the Municipal Building and the main building of the Boulder Public Library placed the first floor one foot above the level of the flood of record (flood of 1894). There was no serious consideration of any other location.

Nor was there any concern in 1974, when the Boulder Public Library expanded to the south side of Boulder Creek. Apparently, there was no discussion of alternate locations for the Boulder County Justice Center, either. (Philipsborn, Randall H., *Decisions to Construct New Buildings Within the Regulatory Floodway of Boulder Creek: 1959-1978,* p. 1, 25, 28)

Changes in floodplain management began in 1978, when the City adopted a "non-containment" policy for Boulder Creek as part of the **Boulder Valley Comprehensive Plan.** This policy promoted ongoing city efforts to protect public safety by restricting development within the floodplain associated with Boulder Creek and its tributaries. (City of Boulder, Greenways Masterplan, 2011)

INTEGRATION OF THE FLOODWAYS AND GREENWAYS PROGRAMS (1980s)

After the Big Thompson Flood, Boulder officials began planning for a major flood in Boulder County, specifically in Boulder Canyon. By 1983, Lon Callen, director of **Boulder County's Emergency Preparedness Office**, announced during an annual report to the County Commissioners that in setting up its early warning system, it had placed 17 rain gauges and 7 stream gauges to automatically transmit data to the Sheriff's Department (now Sheriff's Office) in the Boulder County Justice Center. Additional data came from a network of volunteer rain and stream observers. Callen also stated that when completed, the system would consist of 36 rain gauges and 12 stream gauges.

In the event of a major flood, police vehicles (still from the flood-prone underground lot!) would be dispatched to residents in the floodplain areas to advise them to evacuate. Don Van Wie, director of emergency services for the Sheriff's Department (now Sheriff's Office) stated that dependence on a good warning system could be a vice if people didn't act rationally on their own when they saw a stream rapidly rising.

Mike Serlet (Boulder County water resources engineer, at the time, and designer of the "Climb to Safety" signs"), agreed that the public's reaction was crucial to any flood warning system, adding that 139 victims of the Big Thompson Flood "attempted to outrun the flood and did not heed warnings to climb the canyon walls." He also stated, "Floods, especially flash floods — the kind we have in Colorado — kill people and cause millions of dollars in property damage each year. Awareness of this will help save lives." (Gillen, Sharon. "County Ready for Major Flood" *Daily Camera*, May 17, 1983)

In 1984, the City Council adopted the **Boulder Creek Corridor Plan**, revitalizing one of Frederick Law Olmsted, Jr.'s recommendations, i.e. to enhance Boulder Creek and its floodway by making it into a recreational area. Today, walkways and bike paths stretch between Eben G. Fine Park to 55th Street.

The **Boulder Creek Corridor Plan** was multi-objective. It recommended development of a continuous path along the entire length of Boulder Creek to serve both as a flood hazard mitigation measure and a linear urban park for recreational and transportation use. It also provided for restoration and enhancement of wetlands, as well as fish and wildlife habitat. As a result, aquatic habitat, which was severely affected by diminished stream flows and efforts to channel the creek, was enhanced, and a self-sustaining creek channel and healthy aquatic habitat were established with the implementation of minimum stream flow agreements for Boulder Creek.

A year later, in 1985, a panel appointed by the Boulder City Council completed a **Master Plan For Boulder Creek Tributaries** on methods to reduce flood hazards on 11 streams that flow through the City and into Boulder Creek. Top priorities were given to areas where lives would be threatened or the flood hazard was determined severe. Recommended areas for immediate action included creating a detention pond for Goose Creek, creating a detention pond behind K-Mart (now Safeway) for Elmer's Two Mile Creek, and enlarging the crossing of Bear Canyon Creek at Broadway. (Cornett, Linda. "$50 Million Recommended to Prevent Flood Damages," *Daily Camera*, April 6, 1985)

As an outcome of the significant floodplain boundary changes, Greenhorne & O'Mara, Inc. prepared an updated **Major Drainageway Planning for Boulder Creek Tributaries** document, in 1986, which replaced the Wright-McLaughlin master plans.

In May 1985, the *Daily Camera* reported that the City Council was inundated with public comments on the proposed flood hazard measures. Representatives from PLAN-Boulder and the local Sierra Club criticized the recommendations as too costly and too reliant on structural solutions that included culverts and flood walls. The President of the League of Women Voters, however, endorsed the panel's recommendations, and a representative of the Board of Realtors praised them as "achievable and very realistic." (Cornett, Linda. "Issue Gets Flood of Comments," *Daily Camera,* May 8, 1985)

When the **Boulder Creek Corridor Plan** was completed in 1987, the corridor also functioned as a buffer zone between the stream channel and nearby development. The buffer was designed to retain stormwater which might otherwise have caused more damage in the event of a severe flood. In addition, lands were purchased by the city to provide additional storm water retention and/or to remove structures from the **High Hazard Zone**. The Boulder Creek project also preserved and/or enhanced the riparian environment, which was considerably damaged. Natural vegetation was planted, and corridor use was redirected to the Boulder Creek path to reduce on-going damage.

Meanwhile, the City denied building permits in the floodway and initiated flood-proofing on buildings in the floodplain. One of these projects included the January 1986 installation of a $500,000 flood wall at the Boulder County Justice Center. Also, the City began to replace older bridges over Boulder Creek that had low spans and were deemed to be debris-catchers.

With the Rapid City and Big Thompson floods in the recent past, flood preparation discussions continued and, in particular, resurfaced every year. In May 1989, Environmental Design Professor and Boulder City Councilman Spenser Havlick wrote an editorial, published in the *Daily Camera*, titled "Boulder Hasn't Done All It Should to Protect Against the Flood." He reiterated the "not-if-but-when" theme, and he urged residents to heed the advice of a Rapid City, South Dakota official who spoke to other government officials of his city's 1972 flood and (as quoted in the *Daily Camera*) stated:

> We should never have been foolish enough to violate that floodplain. That was a stupid place for residential property. The people that suffered the most and died the quickest were people who lived in temporary mobile home courts. Hundreds were made homeless. Those homes were tossed around like toothpicks in a breeze. There are some mobile homes that were never found. There were many automobiles that were torn beyond description because of the force and fury of mother nature... There is something I hope you take to your governments. I hope your governments respond before you needlessly kill 238 people the way we did in South Dakota.

Havlick explained that, as in South Dakota, Boulder should emphasize protecting life before property. He even participated in a simulation to determine at what depth and at what velocity an average individual would be toppled in a rushing stream. Several dozen volunteers, including Havlick, were strapped into harnesses in a flume at Colorado State University in Fort Collins, Colorado. Even though Havlick was in reasonably warm-waist-deep water, he described the flooding stream simulation as "terrifying" and "the most helpless feeling I ever had."

When asked why he was apprehensive of the flood warning procedures already in place, Havlick said that post-disaster records showed that the vast majority of people paid little attention to flood warnings. Additionally, for those who did, and if Boulder Creek were flooding, they would have, at the most, 30 minutes notice. "What if it came at 2 a.m. on a cold rainy night?" Spenser asked. (Havlick, Spenser. "Boulder Hasn't Done All It Should to Protect Against the Flood," *Daily Camera*, May 21, 1989)

GREENWAYS PROGRAM

A **Master Plan for the Greenways Program**, including Boulder Creek and, initially, six additional tributaries, was adopted by the City Council in January, 1989. (The plan was updated several times, most recently in 2011, and expanded to include fourteen tributaries.)

The six additional tributaries were described as follows in the **Master Plan (of 1985) for Boulder Creek Tributaries**, as submitted to the 1993 City Council Study Session:

- **Fourmile Canyon Creek** — The headwaters of Fourmile Canyon Creek are at Bighorn Mountain approximately five miles west of Boulder. The creek flows generally in an east-southeasterly direction, through the northern corner of the City, to its confluence with Boulder Creek approximately 3,000 feet north of Valmont Butte. The creek is mostly unobstructed and confined in the upper basin with wider floodplains inundating some residential units in the lower basin. The creek is well defined and has no major tributaries contributing flood flows.
- **Wonderland Creek** originates in the basin along the western foothills of the City above Wonderland Lake and south of Fourmile Canyon Creek. Wonderland Creek flows in an easterly direction for much of its length but turns southward to its confluence with Boulder Creek near Pearl Street.

- **Goose Creek** originates in North Boulder Park. Its upper drainage basin reaches into the western foothills of the City, and its middle and lower basins encompass large urbanized areas through the center of Boulder. Goose Creek flows generally east to its confluence with Boulder Creek.
- **Skunk Creek** originates on the eastern slopes of Green Mountain and flows northeasterly into the city proper. The creek crosses U.S. 36 at Baseline Road and eventually reaches its confluence with Bear Canyon Creek south of Arapahoe Road near the Foothills Parkway.
- **Bear Canyon Creek** originates in a mountain basin near Kossler Lake and has the second-largest basin of any of the tributary drainageways in Boulder after Fourmile Canyon Creek. The channel divides Table Mesa Drive, between Lehigh Avenue and Broadway.
- **South Boulder Creek** (description not included in 1985 Master Plan)

The following basic objectives guided the Master Plan's development:
1. Frederick Law Olmsted, Jr.'s advice, from 1910, to keep land along Boulder Creek "open for public use."
2. The Boulder Valley Comprehensive Plan's adoption, in 1978, of a "non-containment" policy to restrict development within the floodplain.
3. The Boulder Creek Corridor Plan, that recommended a continuous path along Boulder Creek.

As an outgrowth of the **Boulder Creek Corridor Project**, the Greenways Program was created on the basis of recognition that stream corridors are a vital link in the larger environmental system, and that each stream is a natural and cultural resource. The Program's objectives were designed to:
- protect and restore riparian, floodplain and wetland habitat.
- enhance water quality.
- mitigate storm drainage and floods.
- provide alternative modes of transportation routes or trails for pedestrians and bicyclists.
- provide recreation opportunities.
- protect cultural resources.

COMPREHENSIVE DRAINAGE UTILITY MASTER PLAN (CDUMP)

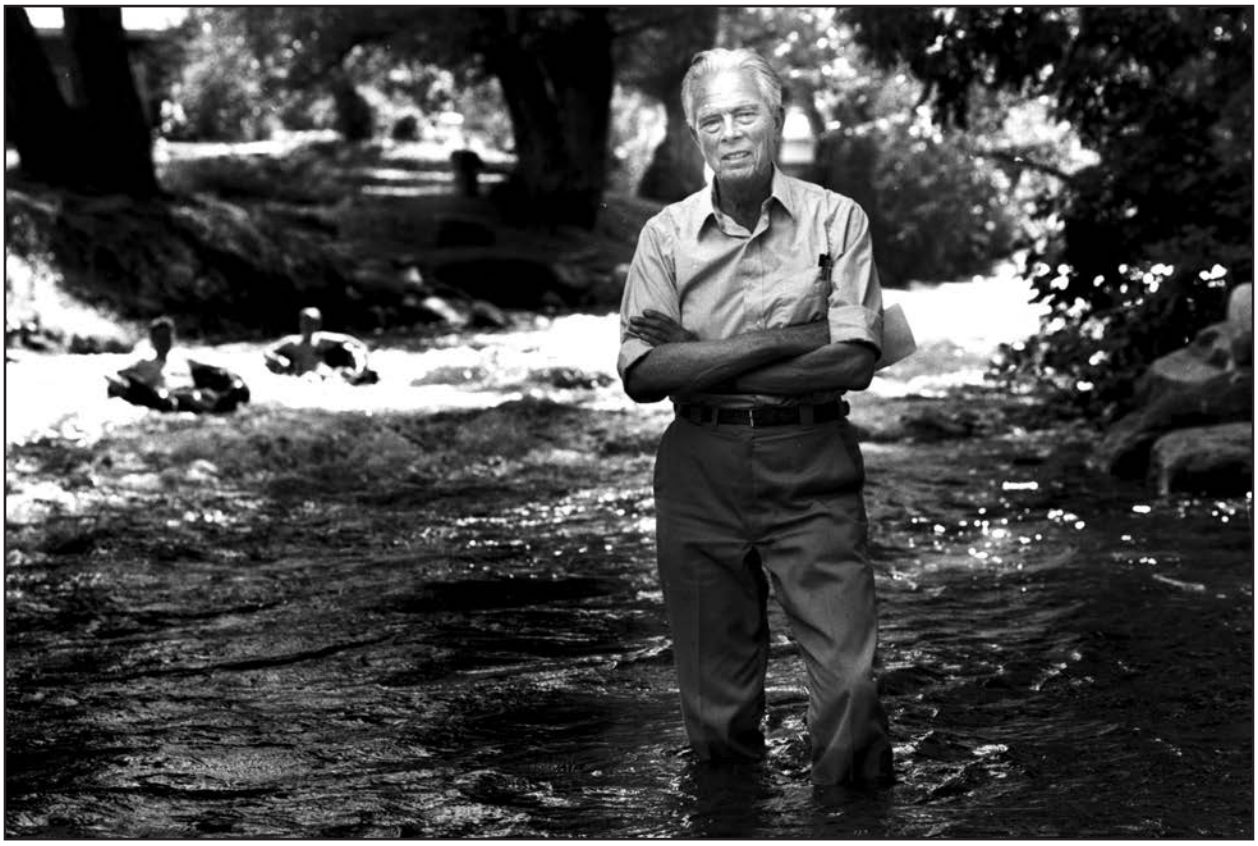
During the late 1980s, Boulder was nearing a population of 83,000 and continued to grow. Up to this time, Boulder Creek had been the focus of floodplain regulations But, in 1989, the focus expanded with the adoption of new floodplain regulations — as outlined in the **Comprehensive Drainage Utility Master Plan (CDUMP)**. These new regulations were designed to address the separate issues of life safety, floodwater conveyance, property protection, and compliance with the minimum standards established by the Federal Emergency Management Agency (FEMA) for inclusion in the **National Flood Insurance Program** (NFIP).

Consultants involved with the project included Arthur Young, Muller Engineering, Kistner & Associates, and Brown & Caldwell, with Water Resources Associates, Inc. participating in the earlier stages of plan development. A component of CDUMP (to be renamed the **Comprehensive Flood and Stormwater Master Plan**, in 2004) was the **Stormwater Quality Program**, which addressed runoff and storm-related water quality problems and preparation for future stormwater regulations.

These regulations, adopted in 1989, identified three portions of the floodplain where an unacceptably high safety risk existed for Boulder citizens and visitors, included:

- The **Floodplain** - defined as all land areas subject to inundation by flood waters. The adopted regulatory floodplain was based on a predicted flood which has a one-percent (1%) chance of being equaled or exceeded in any given year. The area predicted to be flooded by a 1% base flood is commonly called the 100-year floodplain.
- The **Conveyance Zone** - defined as all areas in the floodplain (contained in a narrowed corridor) which would be required for the passage or conveyance of the entire flood flow (measured in cubic feet per second) resulting from the encroachment (or blocking out) of the floodplain from the edges, allowing no greater than a maximum six-inch (0.5 foot) increase in flood water depths. The conveyance zone represents a preservation corridor for passing flood flows along the creek corridor, without redirecting flood waters onto or adversely impacting land areas located outside of the adopted floodplain. The conveyance zone is based on the FEMA "floodway" regulation (which allows for a maximum one-foot increase in flood water depths), but uses the more restrictive 0.5-foot flood water depth increase criterion.
- The **High Hazard Zone (HHZ)** - defined as all areas in the floodplain where the resultant product number of the flood water velocity (measured in feet per second) multiplied by the flood water depth (measured in feet) would equal or exceed four, or where flood water depth would equal or exceed four feet. The high hazard zone addressed life safety concerns where there was a potential for flood waters dislodging people from their feet. (Boulder City Council, *Study Session on Floodplain Management*, 1993, pp. 8-9)

The "high hazard zone" — that Councilman Spenser Havlick endured in the simulation— was identified as the location where an average person would likely lose his/her balance and be swept downstream. In Havlick's case, it was determined as where the stream ran at a velocity of 2 cubic feet per second in water that was 2 feet deep.



In 1988, Gilbert White posed for a *Daily Camera* photographer while standing in Boulder Creek. *Carnegie Branch Library for Local History, Daily Camera collection*

STUDY SESSION ON FLOODPLAIN MANAGEMENT, 1993

In September 1993, the Boulder City Council and a panel of technical experts held a study session to discuss potential refinements to floodplain management and the proposed Civic Park Master Plan. There was general support for the current regulations and locating the Tea House in the Civic Park. The Council also supported moving forward with the implementation of the **Comprehensive Drainage Utility Master Plan (CDUMP)**, adopted in 1989, but identified other concerns with the Civic Park Project and the following floodplain management issues:

1. More emphasis on public education efforts
2. Desire to improve Boulder's Class 9 rating under the **National Flood Insurance Program (NFIP)** Community Rating System
3. Strategy for purchasing substantially damaged properties
4. Implementation of post-flood recovery plans
5. More restrictive standards for public buildings, other critical structures and places of assembly

NATIONAL FLOOD INSURANCE PROGRAM (NFIP) COMMUNITY RATING SYSTEM

In 1968, the U.S. Congress had created the **National Flood Insurance Program (NFIP)** in response to the rising cost of taxpayer-funded disaster relief for flood victims and the increasing amount of damage caused by floods. The NFIP makes federally backed flood insurance available in communities that agree to adopt and enforce floodplain management ordinances to reduce future flood damage. According to the City's "Stormwater and Flood Management Utility Background Information," from February 7, 2003, the NFIP, through partnerships with communities, the insurance industry, and the lending industry, helps reduce flood damage by nearly $800 million per year.

Further, buildings constructed in compliance with NFIP building standards suffer 77 per cent less damage annually than those not built in compliance with the standards. Every $3 paid in flood insurance claims saves $1 in disaster assistance payments. The NFIP is self-supporting for the average historical loss year, which means that operating expenses and flood insurance claims are not paid for by the taxpayer, but through premiums collected for flood insurance policies. (City of Boulder, "Stormwater and Flood Management Utility Background Information," February 7, 2003, p. 62)

In 1990, the Federal Insurance Administration (FIA) developed the **Community Rating System (CRS)** that encourages activities to reduce potential flood damages within various communities. The incentive for participation is a reduction in flood insurance premiums paid by individual property owners within the jurisdiction of the community. In order to obtain these reduced rates, each community is required to submit an application to the **Federal Emergency Management Agency (FEMA)** and receive a classification based on the amount of floodplain management activities the community implements.

The City of Boulder first submitted this application in 1991. A verification visit by FEMA was conducted in the summer of 1992 to ensure that the City implemented the activities claimed in the application. The City received a Class 9 rating in October 1992, which resulted in a 5 per cent reduction in flood insurance premiums paid by all flood insurance policy holders in the City.

According to FloodSmart.gov, the official site of the NFIP, each CRS-participating community is assigned a Class number ranging from CRS Class 1 to 10, based on credit points that are earned for implementing various floodplain management practices. A CRS Class 1 is the most favorable classification, and CRS Class 9 is an introductory Class. A community with a CRS Class 10 designation no longer participates in the CRS. Since 1992, the City worked to improve its rating and, at the time of this writing, has brought it up to a Class 5, giving policy holders a 25 per cent reduction in flood insurance premiums.

GOOSE CREEK DRAINAGEWAY (PHASES I - III)

The **Goose Creek Drainageway** improvements required the bulk of the City's flood mitigation expenditures during the 1980s, 1990s and early 2000s. The project was split into various phases, I-IV. The first drainage improvements (PHASE I) — east of the Foothills Parkway to the creek's confluence with Boulder Creek — were completed in 1987. Trail connections between the Foothills Parkway and Pearl Parkway were completed in 1995. (Greenways Master Plan Update, 2011)

Historically, Pearl Street's orientation extended in a straight line northeast out of downtown Boulder. Pearl Street ended at the (former) East Pearl Wastewater Treatment Plant (now City Yards) and paralleled the (since-removed) Union Pacific Railway tracks that connected Boulder and Brighton.

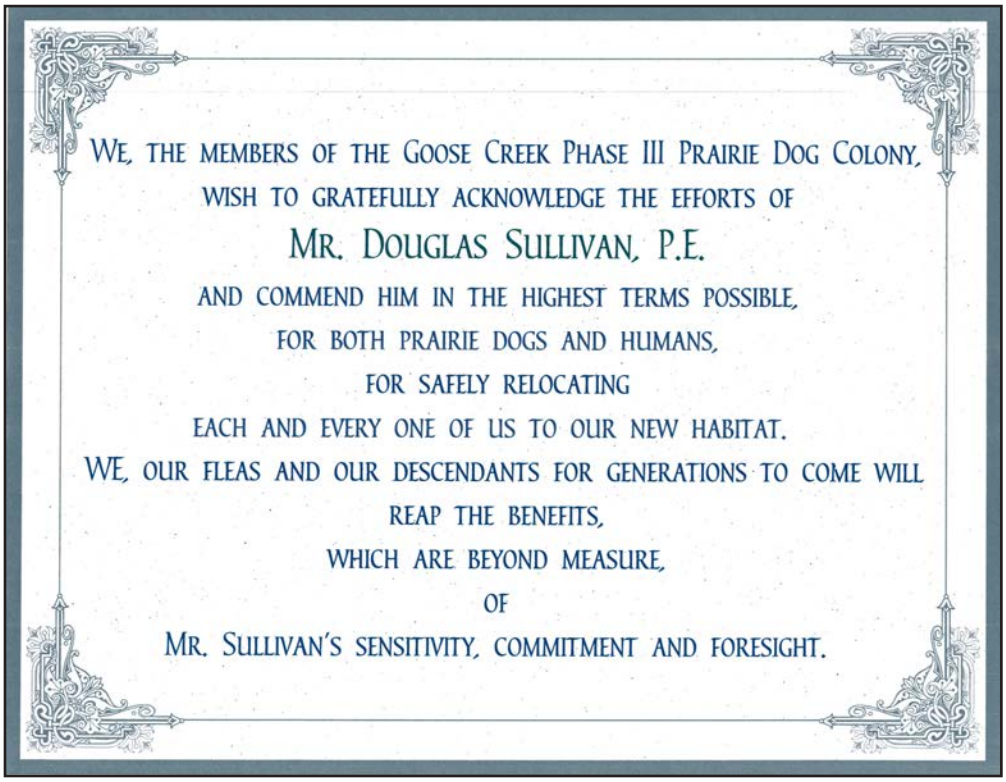
When the Foothills Parkway (Colorado State Highway 157) was built in the early 1980s, "Old Pearl," east of the Burlington Northern Santa Fe Railway tracks, was cut in two. The portion between the tracks and the Foothills Parkway then was accessed only by Frontier Avenue, while the portion east of the Parkway was only accessed by 47th and 49th streets. A new street — Pearl Parkway — was constructed east from 30th Street, extending under the Foothills Parkway, to 55th Street.

Phase I of the Goose Creek Greenway included Goose Creek's north and south tributaries, which split in the vicinity of today's Foothills Parkway and then merge before flowing into Boulder Creek. As shown in the Google map, above, North Goose Creek parallels "Old Pearl Street," while South Goose Creek parallels, crosses under, and then again parallels Pearl Parkway.

PHASE II of the Goose Creek flood-mitigation improvements and greenway was completed in 1995, extending the drainage west of the Foothills Parkway to 30th Street. This phase included box culverts and separated grade crossings at the Burlington and Santa Fe Railway crossing and at 30th Street.

Meanwhile, beginning in 1986, the City had entered into negotiations for property it planned to condemn for PHASE III mitigation improvements. At the time, Boulder offered Jack Fowler, founder of Fowler Real Estate, $675,000 for three acres along Goose Creek (north of Mapleton Avenue, between 28th and 30th streets), stating that it was in a high-hazard zone. Fowler refused, contending that his property was worth $2.1 million. In 2002, Boulder City Attorney Joe de Raismes said the high-hazard designation on Fowler`s property resulted from a 1986 routine re-mapping of the floodplain, not from the Goose Creek flood control project. Fowler`s attorney, however, determined that the City came up with the plan to divert the creek through Fowler's undeveloped land first, and then the floodplain map fit the project. (*Daily Camera*, February 16, 2002)

Other major land acquisitions were made to set the stage for future drainageway improvements including portions of the Branding Iron Mobile Home Park and the Mapleton Mobile Home Park in its entirety, the later being acquired in cooperation with the city's affordable housing goals in mind. Court action, however, did not stop the City from condemning Fowler's land and building an open channel sufficient to convey the estimated 100-year flood flows along with wetland improvements to improve water quality and wildlife habitat, part of the Goose Creek Phase III project. Still undecided, at the time, was the amount of money the City would have to pay.



City employees are not without a sense of humor. *Courtesy City of Boulder*

Today the Goose Creek Greenway goes through the former Fowler property. *Author photo, 2015*

100th ANNIVERSARY (of 1894 flood) & PLANNING FOR THE FUTURE

In May 1994, the *Daily Camera* published several articles to commemorate the 100th anniversary of Boulder's flood of record. In addition to presenting historical accounts, the authors used the more recent example of the Big Thompson Flood to tell Boulder residents what *not* to do. "Not one of the 139 people who died in the canyon west of Loveland drowned," the *Daily Camera* stated. " Rather, the victims, their clothes torn off, were crushed by the force of the water or debris carried by it. Many thought they could outrace the flood in their cars. Instead, they found themselves trapped inside cars and trucks carried away by the waters. Others climbed to the tops of motels, which were tumbled and also swept away."

"Still others simply didn't heed the warning of the sheriff's deputies in the canyon. They couldn't believe the danger was so great. One deputy warned diners in a restaurant of the impending flood. The customers kept right on eating — until they were misinformed 20 minutes later that the Estes Park Dam had broken. Only then did they climb to safety, their lives saved by a rumor." (Hoover, C. Rusnock and Carol Chorey. "The Flood of '94,' " *Daily Camera*, May 29, 1994)

The 100th anniversary of Boulder's "100-year flood" also was the impetus for Sharon Gabel (under the direction of Gilbert F. White) to prepare an on-line plan for studying the next major flood to strike Boulder. Titled the **Boulder Creek Flood Notebook**, it was published by the **Natural Hazards Research and Applications Information Center (NHRAIC)** and became a guide to be filled out and followed in the event of another major flood on Boulder Creek that would rival or even exceed that of May 1894.

The author of the Flood Notebook provided suggestions to problems and suitable field methods, while acknowledging that the ideas could be "on the mark" or turn out to be greatly deficient. Gabel noted, "It is expected that whoever serves as coordinator will exercise her/his best judgment as to what then seems suitable. The goal is simple: to promptly inform the citizens of Boulder appropriately." There was no doubt in either White's or Gabel's minds that preparedness was (and is) the key to surviving a flood.

In the Flood Notebook, Gabel stated: "The causes of flood loss are to be found primarily in the decisions of individuals and public groups to expose themselves or others to the ravages of flood water. These were decisions to build or not build in floodplains, to prepare or not prepare to cope with high water when it comes, and to share knowledge with other people of how to mitigate losses."

As stated over and over, building in the floodway and floodplain was the major contributing factor to flood damages. Included in the notebook was a review of the key decision processes leading to this increased public exposure:

- 1910-1912
  The report by Olmsted on public and recreational land use recommends that the floodplain not be used for buildings. A similar recommendation was made by engineers Metcalf and Eddy. Neither was accepted by the City Council.
- 1945-1951
  Under authority of the Flood Control Act of 1936, the U.S. Army Corps of Engineers recommended channel and levee construction to protect areas in the floodplain with federal-municipal cost sharing. This was rejected by the City Council that, in 1951, decided to build its new Municipal Building on Broadway between the channel and proposed levee line, with the floor level one foot above 9,000 cfs flow. (A later Corps report estimates the 1894 flood was 8 feet deep at that site.)
- 1966-1970
  Following a consultant's study of floodplain use, and after the Platte River Flood of 1969, the Council enacted floodplain regulations that prohibited building in the floodway and guided development in other parts of the floodplain. The City then qualified for participation in the National Flood Insurance Program.
- 1973
  The Public Library was built in the floodplain.
- 1977
  Following the disastrous Big Thompson Flood, in 1976, the City and County of Boul-

der, along with NOAA, joined in the design and establishment of a flood prediction and flood warning system to facilitate emergency action.

- 1989
  Revised flood hazard maps were issued by the City of Boulder, and public acquisition began of selected buildings that obstructed the floodway below Broadway.
- 1991-1993
  The City Council authorized and built a library addition slightly above the 13,000 cfs flood level but constricted the creek with a new foot bridge. The Council first authorized and then withdrew a plan for new Civic Center construction at Canyon and 13th streets.
- 1994
  The City used the centennial of the 1894 flood to focus public attention on flood vulnerability and on possible mitigation measures.

In the "Boulder Creek Flood Notebook," Gabel then looked back at 100 years of decisions (and lack of, as well) and made the following observations:

- The uncertainty about the measurements and estimates of the frequency and volumes of flood flows made it difficult to accept precise numbers on which to base plans.
- There was no clear public policy as to the degree of risk for which individuals or agencies found it acceptable to prepare.
- Many decision makers found it difficult to contemplate a very rare event occurring during their expected term of life or office.
- It was far less difficult to value a direct economic cost or profit as opposed to a loss of human well-being or life.
- Federal agencies that offered increasing proportions of loans and grants to assist private and public flood sufferers tended to reduce the incentive to insure, to take mitigating actions, or to avoid hazardous locations.

Another section of the Flood Notebook contained a description of the flood warning systems in place in 1994. By then, the City and County of Boulder had established a **Multiple-Agency Coordinating System (MACS)** that provided a framework for response to a potential flood in Boulder County. Participating agencies included the **Emergency Preparedness Office of the Boulder County Sheriff's Department**, the University of Colorado Police Department, the Urban Drainage & Flood Control District, Colorado State Office of Emergency Management, the Colorado State Patrol, the Boulder County Health Department, the Louisville Police Department, and the regional Red Cross.

These agencies worked together to develop the early warning system from data recorded by the stream and rain gauges placed throughout the Upper Boulder Creek watershed, as well as technical information from the National Weather Service. This data was transmitted to both the Urban Drainage and Flood Control District (in Denver) and to the Boulder City and County emergency management operations center. The ALERT

system software interpreted the data, using parameters defined by local emergency officials, and generated automated warnings of varying degrees of severity according to these parameters. Within the City of Boulder, warning systems were in effect for residents in the Boulder Creek floodplain, but the eleven remaining tributaries within the City had no warning system in place.

Two levels of warning were used to indicate the severity of potential conditions: a **flash flood watch** meant, and still means, heavy rains may result in flooding, while a **flash flood warning** meant, and still means, that a flood is imminent or is already occurring. These warnings were made public by radio and television announcements on local stations, by outdoor warning sirens and public address messages, and by police, fire and university officials (including student residence managers).

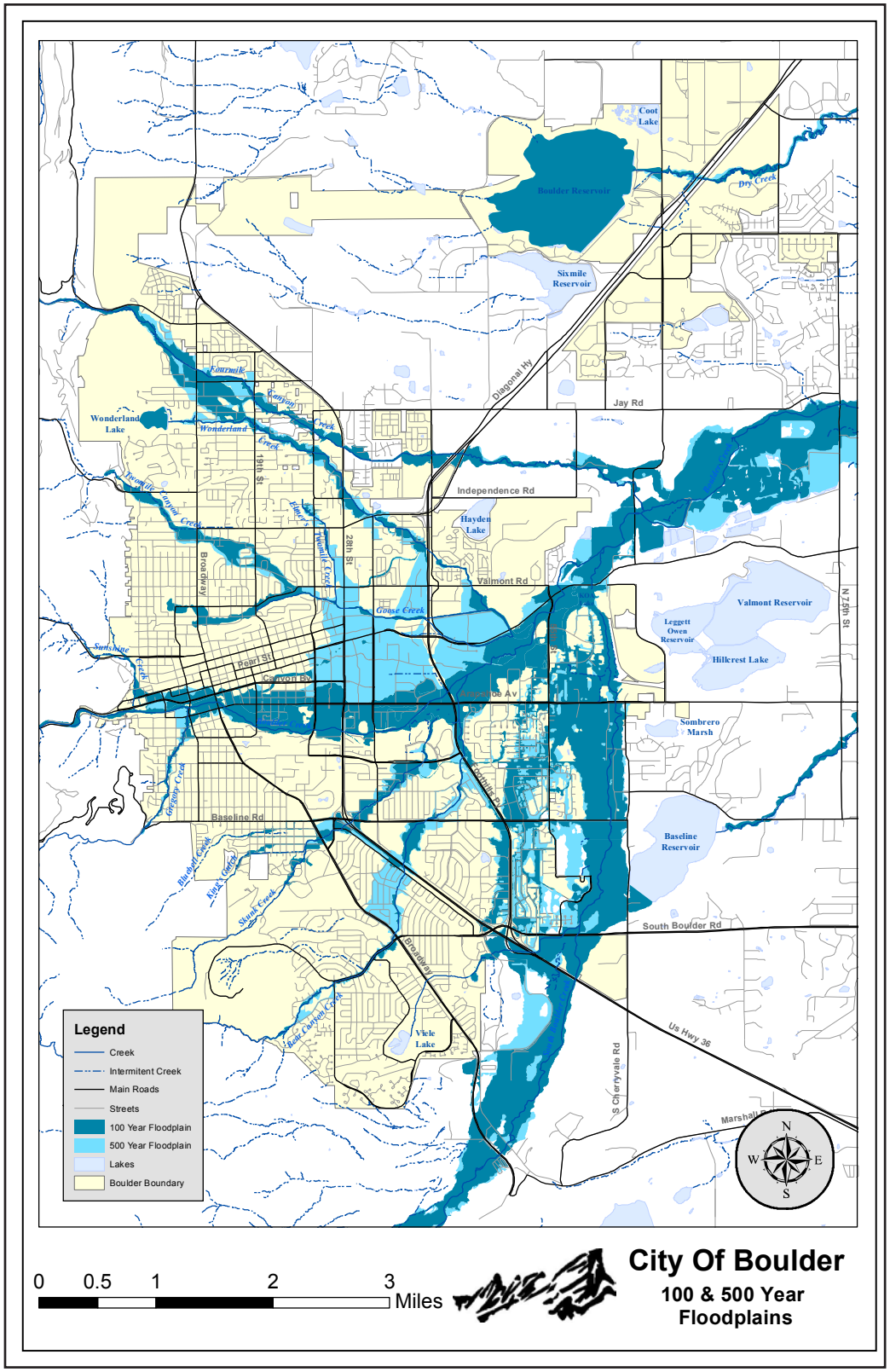
Challenges faced by local emergency managers included:

- the need to mobilize public safety personnel before the severity of the flood potential was determined (if public response is to be timely).
- obstacles to the dissemination of warnings (such as siren audibility).
- the ability of affected residents to understand the warning message (broadcast clarity, non-English-speaking residents).
- public awareness of how to respond after the warning is received.

FLASH FLOOD DANGER

Bear Canyon Creek had been prone to flash flooding for many years. It seemed that this tributary to Boulder Creek was more "flashy" than other tributary drainageways within the City. As a result, flood mitigation improvements along this drainageway were prioritized during the 1990s along with a multiuse trail that extended from Foothills Parkway to west of Broadway. The improvements resulted in the 100-year floodplain being decreased by approximately 49 acres. Overall, 68 structures were removed from the 100-year floodplain, 8 from the conveyance zone, and 77 structures were removed from the high hazard zone. Gary Lacy, who helped create Boulder's Greenway Program was the City's project manager for many of these improvements. The Urban Drainage and Flood Control District (UDFCD) provided significant matching funds for these improvements.

By the end of the twentieth century, Boulder's flood-management history had spanned three decades — without any major floods. Would residents again become complacent? City and County leaders hoped not, and they were eager to keep the topic in the public eye.



Map of 100-Year and 500-Year Floodplains - Boulder City Council agenda item, August 20, 2013, *Courtesy City of Boulder*

Flood management: into the 21st century

In 2001, Gilbert F. White donated his research library and personal papers to the U.S. Army Corps of Engineers. The collection, considered one of the largest in the world on water resources planning, is housed in the Arthur Maass - Gilbert F. White Reference Room at the Corps' Institute for Water Resources in Alexandria, Virginia.

By then, the integration of Boulder's floodways with the City's Greenways Program was firmly in place. This multi-objective approach (originally developed in the mid-1980s) continued to influence Boulder's flood control plans as its residents entered the twenty-first century.

SOUTH BOULDER CREEK

According to U.S. Census records, the population of Boulder in 2000 was 94, 598 — ten times its size in 1910, when Frederick Law Olmsted, Jr. advised against building in the floodplain. In Olmsted's time, his primary concern was Boulder Creek. But, as Boulder grew, and flood impacts were anticipated in newly developed portions of the City, the floodplain expanded to include additional tributaries. The most significant of these tributaries was South Boulder Creek.

As noted in earlier chapters, previous flooding along South Boulder Creek occurred in 1894, 1938 and 1969. During the flood of May 29 to June 2, 1894, the South Boulder Creek basin received up to 6.0 inches of precipitation, washing out bridges, buildings, roads and railroads. This event occurred at the same time as the largest recorded flood on Boulder Creek. From August 31 to September 4, 1938, more than 6.0 inches of rainfall was recorded west of Eldorado Springs causing the largest recorded South Boulder Creek flood of 7,390 cubic feet per second (cfs). Floodwaters passed through Eldorado Springs causing heavy damage and destroying numerous buildings (including the resort), leaving a path of destruction in the valley downstream.

The flooding of South Boulder Creek from May 4 to May 8, 1969, like the flood of 1894, was caused by a combination of rainfall and snowmelt. Precipitation of 8.11 inches at Eldorado Springs and 10.05 inches at Gross Reservoir caused a peak discharge of 1,690 cfs at Eldorado Springs, and inundated many areas downstream including U.S. 36 at

South Boulder Road. Of note during this event was the fact that Gross Reservoir captured the entire runoff generated above the dam averting what would have been much greater flooding in the South Boulder Creek valley.

In 1996, The University of Colorado (CU) contracted with **Love and Associates, Inc. (Love)**, to study South Boulder Creek floodplain impacts at the Flatiron's property (now CU-Boulder South Campus), located south of U.S. 36 and Table Mesa Drive. The engineering study was intended to assist in the "due diligence" review of the Flatiron's property as part of CU's purchase of the land.

Love determined that significant flood spills would be expected west of the creek and north of U.S. 36. These spills had not been identified in the currently adopted floodplain regulatory mapping for South Boulder Creek and gave rise to serious concerns about flooding into developed neighborhoods inside the eastern city limits. Following the release of this information, both the city and county of Boulder, as well as the **Urban Drainage and Flood Control District (UDFCD)** agreed to jointly fund an independent engineering analysis comparing the Love study with the adopted **Greenhorne and O'Mara (G&O)** regulatory floodplain mapping. **Taggart Engineering Associates, Inc. (TEA)**, was retained to perform this analysis.

TEA agreed with the Love findings and indicated that the G&O floodplain mapping should be updated to include the flood spill into what is now known as the "west valley overflow." The results of TEA and Love demonstrated that approximately 2,600 cfs of the overall 100-year flood hydrology of 6,200 cfs at U.S. 36 spills into the west valley. This finding identified significant increases in 100-year flooding and described flood waters spilling into developed city neighborhoods that had not been indicated in the adopted G&O floodplain maps.

The west valley overflow area in east Boulder had been considered to be outside of a flood hazard area since the introduction of the 1978 and 1979 Flood Insurance Rate Maps. Since that time, a great deal of development had been permitted without any requirements for flood restrictions and protection measures because the City relied on the adopted regulatory floodplain mapping. This resulted in an increased risk in several built-out neighborhoods.

This overflow area crosses U.S. 36 primarily at the South Boulder Road interchange. Neighborhoods most affected include Pawnee Meadows, Thunderbird Court, Keewaydin Meadows, Frasier Meadows Manor, Chateau Village, Country Club Park, Wagner Manor, Park East First, Arapahoe Ridge, and Meadow Glen. In addition, the Meadows on the Parkway Commercial Center, Friends School, and Burbank Middle School are also affected by South Boulder Creek flooding. (City of Boulder, "Project Management, Utilities," 2000, p. C-33)

In 1999, the City Council authorized participation in the multi-agency funding agreement between the City, Boulder County, CU, and UDFCD to study and identify solu-

tions to South Boulder Creek flooding impacts on city neighborhoods. The resulting study identified the potential need for significant and costly flood mitigation measures. Recommendations of the study for these vast measures immediately met with opposition from the community and were scrutinized by the City's Open Space Board of Trustees, Planning Board, Water Resources Advisory Board, Boulder City Council, and Boulder Board of County Commissioners in a series of meetings held during 2000 and 2001. (Taggart Engineering Associates, Inc., *South Boulder Creek Major Drainage Planning, Phase A Report,* February 5, 2001.)

The South Boulder Creek Major Drainage Planning, Phase A Report, developed by Taggart Engineering Associates, Inc. (TEA), was released February 5, 2001. The sponsors have since been involved in reviewing the South Boulder Creek floodplain and Phase A Report to determine if acceptable alternatives for floodplain management and mitigation have been presented. A detailed background and overview of floodplain issues and the Phase A Report was presented to the City Council at the April 10, 2001, study session. (Boulder City Council Agenda Item, meeting July 17, 2001)

To help with its decision making, the City Council asked the Independent Review Panel (IRP), previously convened at the request of Boulder citizens in 1999 in response to concerns about the proposed floodplain master planning process for Fourmile Canyon Creek, to review the South Boulder Creek study results. The IRP consisted of notable experts including: Gilbert White - Gustavson Distinguished Professor Emeritus of Geography at the University of Colorado, Boulder; Mary Fran Myers - Co-Director of the Natural Hazards Research and Applications Information Center at the University of Colorado, Boulder; Rich Madole - Scientist Emeritus with the Earth Surface Processes Team of the U. S. Geological Survey; Brian Hyde - employee of the Colorado Water Conservation Board in Denver; and Jonathan Friedman – employee of the Stream and Riparian Ecology Section of the United States Geological Survey's Midcontinent Ecological Science Center.

In sum, the IRP recommended, "that an integrative approach should guide the City and other sponsors' watershed management activities in regard to South Boulder Creek. All entities should coordinate and cooperate fully and should use a wide variety of floodplain management tools to deal with flood hazards including the following: floodplain regulations, zoning, subdivision regulations, building codes, housing codes, sanitary and well codes, disclosures to property buyers, design and location of utility services, land acquisition and open space, redevelopment, permanent evacuation, disaster preparedness, disaster assistance, land treatment, on-site detention, tax adjustments, and emergency measures." (South Boulder Creek Independent Review Panel Report, July 10, 2001)

The Boulder City Council and Board of County Commissioners discussed the South Boulder Creek Master Plan, as the study was called, and reached similar conclusions. In Commissioner Ron Stewart's motion, he rejected alternatives that had been presented by Taggart Engineering Associates (i.e. relocations and dam structures), then stated, in

part: "... that we indicate our support for looking at flood warning systems, additional mapping with the potential for additional insurance there, and that we seek other partners to look at what other alternatives, including the maximum use of the CU site for flood storage, might be. Further, [we suggest] that potential upstream enhancement measures and cost and environmentally sensitive solutions be sought."

As a result of the lack of support for the Taggart Engineering Associates (TEA) plan, the City embarked on a new study that called for the evaluation of flood mapping, risk analysis, flood preparedness, flood mitigation, study process and the recommendations of the IRP, Open Space Board of Trustees, Water Resources Advisory Board, and the City Planning Board. Alan Taylor, the City's Floodplain and Wetland Coordinator, coordinated work activities associated with the study, and with the public process and sponsor interaction and cooperation.

By 2003, the South Boulder Creek flood mapping study was underway, with HDR Engineering as lead consultant. The study was an advanced "state-of-the-art" effort that employed modern GIS technology and online capabilities that completed the following elements: resource atlas, climatology, hydrology, floodplain hydraulics, risk assessment, and public process. (City of Boulder, 2003 Annual Report, Utilities Division)

FOURMILE CANYON AND WONDERLAND CREEKS

A plan for resolving the potential flood hazards in North Boulder extended into the late 2000's. An initial study identified the spill flow from Fourmile Canyon Creek to Wonderland Creek to the south, with the potential to cause significant property damage in developed areas of the City. Then, a more detailed study was commissioned and eventually expanded to include consideration of additional areas affected by the spill flows from Fourmile Canyon Creek. Not only did the spill flows have the potential to affect developed property between Fourmile Canyon Creek and Wonderland Creek west of 19th Street, but it also affected the area along Wonderland Creek east of 19th Street and between Wonderland Creek and Goose Creek. Wonderland Creek did not have the capacity to convey these additional spill flows.

The issues were finally resolved and the revised flood mapping study (using high resolution mapping commissioned in 2003) was submitted to and approved by the FEMA in 2006. The master plan for flood improvements was completed in 2011. Improvements included a combination of property acquisition, new underpasses at major roadway crossings, and drainageway capacity improvements focused on mitigating high (life safety) hazards. One of the first of these improvement projects was along Wonderland Creek between Foothills Parkway and 28th Street.

STORMWATER PERMITTING PROGRAM

Also in 2001, in response to Federal Clean Water Act requirements, the **Colorado Department of Public Health and Environment (CDPHE)** expanded its regulations to include those for discharges from municipal storm sewer systems for cities with populations between 10,000 and 100,000, which included Boulder. The intent of this **Stormwater Permitting Program** was, and is, to reduce the amount of pollutants entering streams, lakes, and rivers as a result of runoff from residential, commercial, municipal, and industrial areas, including construction sites. Stormwater permit compliance was, and is, based on implementation of stormwater management intended to reduce pollutant loading from urbanized areas.

The Stormwater Permitting Program came under the purview of Boulder's **Stormwater and Flood Management Utility,** which was initially named the **Storm Drainage and Flood Control Utility** at its creation in 1973. The City's stormwater collection system consists of a variety of storm sewers and open drainage ditches that collect water and divert the water to major drainageways. Irrigation ditches also collect stormwater in many places in the City. Depending upon the amount of rainfall, stormwater flows may exceed the capacity of the ditch. The program's main components included public education, water quality monitoring, regulatory compliance, and source control. (City of Boulder, "Comprehensive Flood and Stormwater Utility Master Plan," October 2004, p. 4-1 and 5-1)

FLOOD PROTECTION HANDBOOK

Unlike the **Boulder Creek Flood Notebook**, published in 1994 for local governmental agencies by the **Natural Hazards Research and Applications Information Center (NHRAIC)** , the Boulder County Transportation Department published a **Flood Protection Handbook** for the general public, in 2002. The 48-page guide was designed to educate residents in flood-prone areas about the dangers they could face. In the introduction, the Boulder County Board of Commissioners wrote, "Regardless of what you have seen, the next flood could be worse. We cannot ignore our flood risk. Floods take lives and damage property. They can be emotionally devastating to you and your family, both while they are happening and later when you have to deal with their aftermath."

The Handbook described what to do in case of a flash flood warning, told how residents could prepare flood response plans, and explained how to flood-proof a home or business. According to the *Daily Camera*, Boulder City Councilman Spenser Havlick said he liked the idea of a manual, but he thought it was too long and difficult to understand. "People are not going to read this until there is a moment of crisis," he said at the time. "Unfortunately, this document may find its way to the recycling bin or a dusty shelf somewhere." (*Daily Camera*, February 2, 2002)

A section on local causes of flooding pointed out the fact that, in recent years, in addition to pollutants entering the waterways (as mentioned above), development had

changed the natural environment. An increased amount of paved areas and rooftops was interfering with rainwater soaking into the ground. As a result, gutters and storm sewers sped the runoff to stream channels. Even the pattern of streets and buildings has interrupted some of the natural drainageways and reduced the width of some of the channels. With the increase in development, it was noted that water ran off more quickly, and the drainage system more frequently became overloaded.

The Handbook also explained that the combination of heavy precipitation and an overloaded drainage system could result in three types of flooding: over-bank flooding, irrigation ditch/canal flooding, and street flooding, and each produced different hazards. (Boulder County Transportation Department, *Boulder County Flood Protection Handbook,* January 2002, p. 1)

The book also made the following major points:

KNOW YOUR FLOOD HAZARD
Ask the Floodplain Manager the following questions:
- How high would the 100-year flood be in my neighborhood?
- Can I expect fast-moving water, or water filled with debris?
- How much warning time can I expect?
- How will I get the flood warning?
- What streets are likely to be flooded or barricaded near my neighborhood?

FLASH FLOOD SAFETY
- Flash floods can happen without warning. Have a plan!
- Know your flood hazard: If you are at home, at work, or in your car, know whether you could be affected by a flash flood.
- If it is raining and you are near a mountain stream, keep listening to a local radio or television station. If you hear a "flash flood watch" for your area, play it safe and move to high ground.
- If you hear a flash flood warning or a loud noise - Climb to higher ground immediately!
- Leave your car and other belongings. You may have only moments to escape.
- Never try to drive or run downhill to outrace a flash flood. Avoid flooded areas and fast-flowing water. Do not try to cross flooded streams on foot or in your car. Roadbeds can wash away and 18 inches of water can carry away an automobile. Be especially cautious at night when it is harder to recognize flood dangers.

(Boulder County Transportation Department, *Boulder County Flood Protection Handbook*, January 2002, p. 9, 27)

BROADWAY BRIDGE

When the concrete bridge on 12th Street (now Broadway) was built over Boulder Creek in 1921, Boulder's City Engineer described it as "a thing of beauty and a joy forever." He expected it to last more than 250 years. But, it needed to be replaced in 2002. The Broadway project, which stretched between University Avenue and Pine Street, combined flood control with paving, improving transit stops, bicycle access, and landscaping.

Specifically important to flood management, the new bridge spanned a much longer distance than earlier bridges, thus eliminating the need for a former concrete pier in the middle of the stream. Finally, as a century of report writers had requested, debris in a flood would be able to pass more easily under the bridge.

Even though the historic bridge was structurally unsound, its design was long-lasting. Alex May, transportation project manager for the City of Boulder, factored several historic features into the new bridge's design. "The new bridge railing is somewhat patterned after the old Roman Cross pattern on the previous bridge," he said. "In addition, the four tall pylons, which originally marked the bridge corners, will be reset on site as gateway monuments."

Compare this recent photo of the 2002 Broadway Bridge with the two previous bridges, on the same site, as shown on page 43. *Author's photo, 2015*

GOOSE CREEK PHASES III-IV

Construction had been completed in 2002 for PHASE III of the Goose Creek mitigation improvements, but the City still owed Realtor Jack Fowler payment for his land. He filed a lawsuit and took it all the way to the Colorado Supreme Court. "They just have to pay what the land is worth," Fowler told a newspaper reporter at the time. "It may be expensive, but that`s the way it should be."

In *City of Boulder v. Fowler Irrevocable Trust*, No. 01CA0224, the City pointed out that the location of the land was a product of its topography, and that the direction that the water flowed was not within the City's control. Therefore, the City argued that limitations on construction on the site did not arise from the Goose Creek project for which the property was being acquired. (City of Boulder, "Memo Regarding Implications of Fowler Decision," October 21, 2003)

Fowler, however, argued that the "high hazard" and "floodway" designations *were* the result of the flood control project for which the property was being taken. Specifically, he stated that the City:

- decided to deal with potential flooding on Goose Creek.
- imposed flood designations and building restrictions to help carry out the project, adding that the regulations adversely affected the value of the land.
- declared that it would purchase the land at the lowered value caused by the imposition of its regulations.

Fowler used a legal theory called the Project Influence Rule to argue that the project itself could not be used to affect the value of land taken. Both the trial court and the appellate court ruled in favor of Fowler and against the City.

In 2002, the Colorado Supreme Court accepted an argument that affected the valuation of floodplain land, stressing the importance for the City of Boulder to separate regulatory activities (i.e., designating limitations on building sites due to flood danger) from City flood mitigation construction projects.

Douglas Sullivan, Engineering Project Manager, worked to complete the Goose Creek drainageway improvements, up to 28th Street. McLaughlin Water Engineers (later WH Pacific) was the City's consulting engineer on both Phase II and IV. These improvements had taken more than 15 years and required more than $20 million. Construction for PHASE IV of the Goose Creek drainageway began in 2003 and was completed in 2004. This Phase extended the Goose Creek mitigation improvements from 28th Street, through the Mapleton Mobile Home Park, to the west side of Folsom Street, including the separation of the creek from the Boulder and White Rock Ditch.

Numerous trailers in the Mobile Home Park needed to be removed, and the process became controversial because of affordable housing issues. The City purchased the park in

1997 and found other areas within the park to site mobile homes, but it couldn't replace all 10-12 that had to be removed. The property was eventually sold to the affordable housing non-profit organization – Thistle Communities.

Phase IV of the Goose Creek drainageway runs through the Mapleton Mobile Home Park. This view, above, is from Folsom Avenue, looking east. Below, is part of Elmer's Two-Mile Park, between Iris and Glenwood avenues. *Author's photos 2015*

Goose Creek *west* of Folsom Avenue is visible in the foreground of the above photograph, from 1972. The undeveloped land bounded by Balsam Avenue and Folsom Street is now the location of Unity Church. Barely visible on the left is the Kline fish hatchery. *Carnegie Branch Library for Local History, 750-9-10 #7.* Below, the same area (but looking west from Folsom Street) was photographed in 2015 along the Goose Creek drainageway and bike path. *Author's photo*

FLOOD MANAGEMENT & THE WEATHER, 2002-2005

Flood management projects in 2002, a drought year, included the completion of the construction of the Wonderland Creek channel and trail in Valmont Park, Elmer's Twomile trail and channel improvements in Elmer's Twomile Park, and the design of improvements to Skunk Creek between Broadway and Moorhead Avenue. Design efforts also were initiated for the Iris Avenue Underpass along Elmer's Twomile Creek, as well as the habitat improvements along the levee at Bear Canyon Creek along Harrison Avenue.

Weather conditions changed quickly in March 2003, when western Boulder County received a massive snowstorm that dumped eight feet of snow. By the end of May — as had happened during the floods of 1894 and 1969 — the snow quickly began to melt. In late May 2003, water spilled over the top of Barker Dam, below Nederland. Overnight, the stream flow of Boulder Creek increased from 120 cfs to 518 cfs. The Sheriff's Office closed the creek to tubing, the first time it had been necessary to do that since similar conditions of high water in 1995. (*Daily Camera,* May 29, 2003)

The following October (2003), a 3,500-acre wildfire scorched the steep hillsides north and east of the mountain town of Jamestown. Afterwards, the slopes lacked vegetation to stabilize the soil. When heavy rains came in June 2004, mud, water, and rocks slid down a natural drainage and inundated the western Boulder County community with debris. Although there was minor flooding in Boulder, most creeks stayed within their banks.

Meanwhile, in Boulder, projects were continuously underway in the Greenways Program. Those in 2003 included:

- updating and coordinating the Greenways Design Guidelines and projects in the Greenways work plan.
- completion of the construction of the improvements to Skunk Creek between Broadway and Moorhead.
- a path connection from Goose Creek to 29th and Bluff, along with drainage improvements on Bluff Street.
- construction of the levee at Bear Canyon Creek along Harrison Avenue, as well as habitat improvements along Bear Canyon Creek.
- continuation of construction efforts on the path connection between Wonderland Creek and Fourmile Canyon Creek south of the Elks Club.
- continuation of design efforts on the Iris Avenue Underpass along Elmer's Twomile Creek.
- Community and Environmental Assessment Process (CEAP) report initiated for Elmer's Twomile Creek from Goose Creek to Glenwood Drive.
- continuation of work between the Greenways staff and the U.S. Army Corps of Engineers in obtaining grant funding for a restoration project along Goose Creek between Foothills Highway and the confluence with Boulder Creek. (City of Boulder, "Project Management, Utilities," 2003, p. C-42)

As previously noted, the Big Thompson Flood, in 1976, was a wake-up call for Boulder residents. In 1997 , another major storm had dumped 14.5 inches of rain in the city of Fort Collins, Colorado, causing a flood that resulted in $200 million in damage and the loss of five lives. In 2005, Hurricane Katrina hit New Orleans. The major flooding in its aftermath was a wake-up call for a whole new generation of people all over the country. When Boulder *Daily Camera* editorial writers speculated on the next big flood to hit Boulder, they began to speak about "when, not if." And, they pleaded with residents to better educate themselves for the time when the next big flood would happen.

COMPREHENSIVE FLOOD AND STORMWATER UTILITY MASTER PLAN (CFS)

The **Comprehensive Drainage Utility Master Plan (CDUMP)**, originally adopted in 1989, was updated and renamed the **Comprehensive Flood and Stormwater Utility Master Plan (CFS)** in 2004. Its name change (in addition to its acronym that ties in with the words "cubic feet per second") was made to address:

- flood Management (flash flood hazards).
- stormwater quality.
- stormwater drainage.
- program integration and implementation.
- financial considerations.

The Stormwater and Flood Management profession had matured considerably since CDUMP, and CFS was a reflection of this involving a multidisciplinary team led by Bob Harberg – Principal Engineer for Utilities. Other key staff included Alan Taylor – Flood Program Manager, Donna Scott – Stormwater Quality Specialist; Douglas Sullivan – Engineering Project Manager; Annie Noble – Greenways Coordinator; and Jeff Arthur who was then the City's Engineering Review Manager. URS Corporation was engaged to consult on the project and the previously seated IRP, a Community Review Group, and the Water Resources Advisory Board also contributed to the project.

The purpose of the CFS Master Plan was for the City to use it as a tool for reviewing, integrating, and setting direction for the City's Stormwater and Flood Management Utility work program. Boulder was, and still is, considered the number-one flood risk city in Colorado where flash flooding can occur with less than thirty minutes of warning.

The Boulder of 2004 (and at the time of this writing), however, was vastly different from the Boulder of 1894, when the City was inundated by the "100-year-flood." Urbanization has drastically impacted the landscape/cityscape by increasing the amount of impervious areas. In 1894, Boulder didn't have any paved streets (a few blocks of Pearl Street were paved, for the first time, in 1917), and the city barely stretched from Mapleton Hill to University Hill. Now, much of the city consists of paved streets, sidewalks, and rooftops. Without storm sewers, the melting snow and rain water has no place to go.

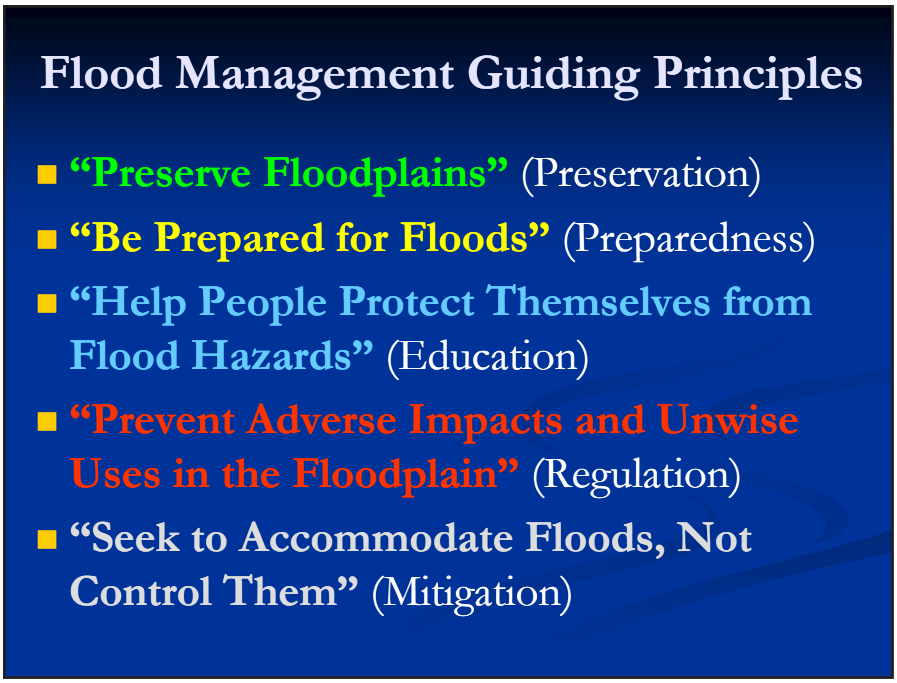
Impervious surfaces can cause groundwater reserves to be depleted, but, in Boulder, the likelihood of flash floods is the major concern. According to author Lance Frazer's "Paving Paradise: The Peril of Impervious Surfaces" (*Environmental Health Perspectives,* July 2005), runoff from an acre of pavement is about 10–20 times greater than the runoff from an acre of grass, and that runoff can trigger devastating floods.

To minimize the flood danger, the City combined major drainageway improvements (that narrowed the floodplain) with the removal of high hazard structures from the regulated high-hazard flood zone. Between the years 1989 and 2004, 134 (out of 279) of these structures were removed. One project involved the acquisition and physical removal of thirteen multi-family structures (169 units) near Boulder High School, as well as the excavation of the area north of Boulder Creek (now recreational/sports fields) to improve flood conveyance (City of Boulder, "Project Management, Utilities," 2004, p. C-33).

Still, there were thousands of people and approximately 3,600 structures with an assessed valuation of almost $1 billion within the City of Boulder's 100-year floodplain. Flood management program elements designed to mitigate these hazards included:

- regulating the 100-year floodplain.
- participating in the National Flood Insurance Program (NFIP) and Community Rating System (CRS).
- maintaining and updating floodplain mapping studies and mitigation master plans.
- acquiring high hazard flood properties and preserving these lands for flooding.
- designing and constructing flood mitigation capital improvements.
- physically maintaining major drainageways and structures (such as bridges, culverts and erosion control features) to ensure flood water conveyance.
- participating with the Boulder County Office of Emergency Management (OEM) to provide flood monitoring, prediction, warning, and response.
- providing flood information to the public.
- managing post-flood property acquisition funds to address the aftermath of a flood emergency ("Comprehensive Flood and Stormwater Utility Master Plan," City of Boulder, October 2004, p. 3-1)

Meanwhile, Boulder's **Flood Management Guiding Principles**, developed by Alan Taylor, the City's Floodplain and Wetland Coordinator, can best be explained within the categories of Preservation, Preparedness, Education, Regulation, and Mitigation, as illustrated in the following slide that was part of a 2004 presentation to the City Council.



Flood Management Guiding Principles, Boulder City Council Presentation, November 16, 2004, *Courtesy City of Boulder*

The Principles are self-explanatory, but "Seek to Accommodate Floods, Not Control Them" deserves to be explained here as it was stated in the Boulder City Council's 2007 Study Session on Floodplain Regulations and Management:

"This approach entails assessing and implementing planned and monitored system maintenance, nonstructural flood proofing, opening non-containment corridors, overbank land shaping to train flood waters, and limited structural (channelization) measures at constrained locations. Recommended implementation tools include updating mitigation master plans, re-evaluating priorities for mitigation efforts to focus on high hazard mitigation, and carefully considering the need for structural improvements. This includes developing updated mitigation master plans that emphasize nonstructural measures, increase opportunities to realize beneficial functions in floodplains and seek cost-effective solutions that minimize major construction efforts and re-evaluating of priorities for mitigation efforts." ("Study Session on Floodplain Regulations and Management," Boulder City Council, 2007)

One of the flood management action items recommended in the **Comprehensive Flood and Stormwater Utility Master Plan (CFS)** was to proceed to develop 500-year protection standards for critical facilities in line with federal guidance. This would ensure access to, use of, and uninterrupted service for critical facilities that included fire and police stations; water and sewer treatment plants; utility infrastructure for water, sewer, gas, electric and communications; schools; day care and senior care facilities; hospitals; major roads and bridges; and hazardous material storage. ("Project Management, Utilities," City of Boulder, 2004, p. C-34).

Stormwater quality action items included an expanded Greenways program, minimiz-

ing paved surfaces, and creating landscaped buffers and filters. Stormwater drainage issues were addressed by recommending on-site detention facilities and groundwater collection and discharge.

REASSESSMENT OF SOUTH BOULDER CREEK MAPPING PROJECT

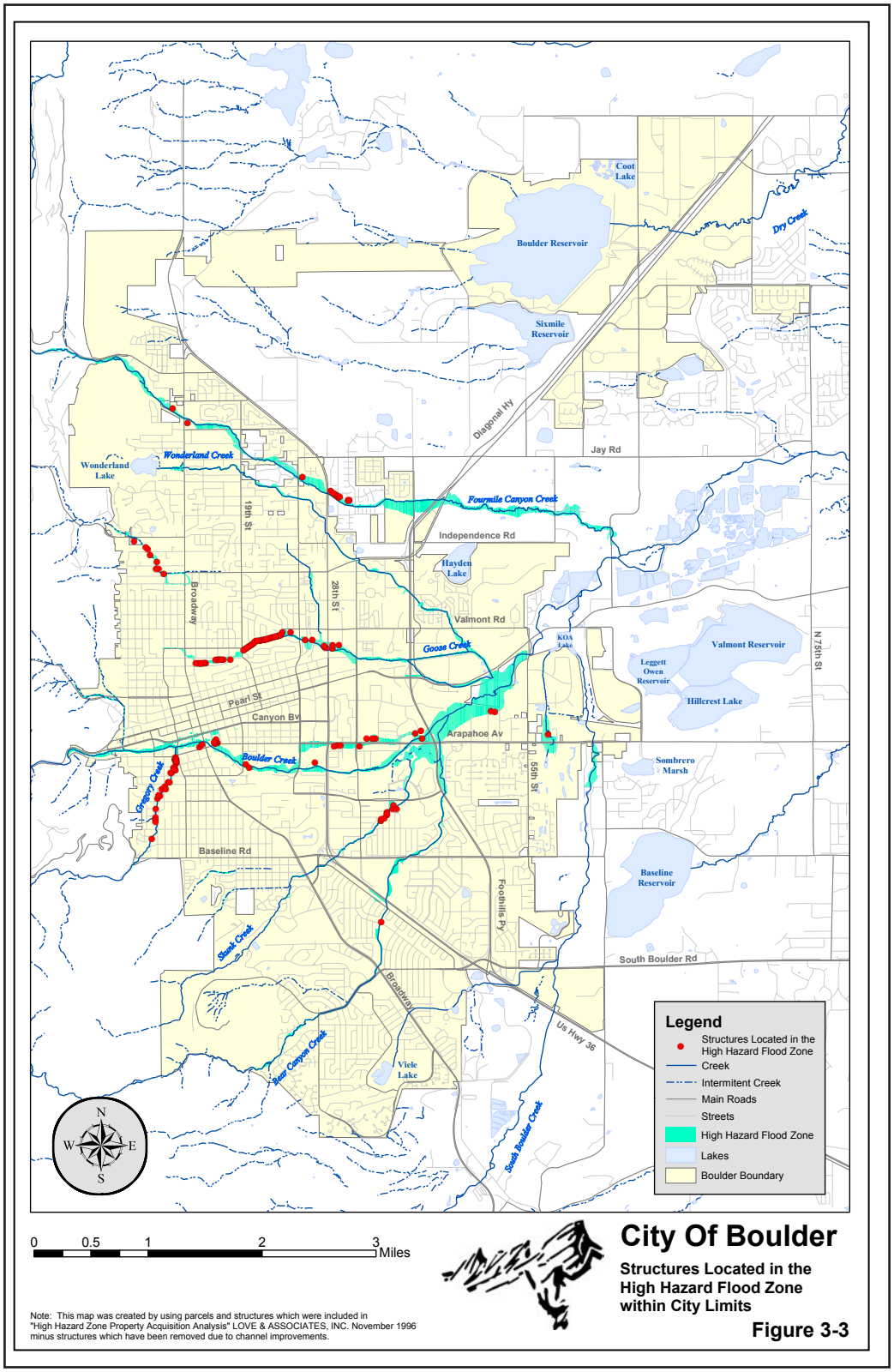
The South Boulder Creek mapping project that began in 2003 was formally assessed in 2005. This project evaluated the climatology/hydrology portion of the South Boulder Creek floodplain mapping project by applying additional scientific research and analysis. Further study was done on the size and intensity of historical thunderstorms that are the most likely cause of flooding along the creek. The most significant assessment involved the development of detailed characteristics for an additional 37 thunderstorms, made possible by the introduction of new Geographic Information System (GIS)-based Doppler weather radar analytical techniques for storms observed from 1997 to 2004.

The initial study had used only 13 thunderstorms and required manual analyses. The new storm sample improved the quality of the study results by including a total of 50 thunderstorms. The new analysis determined that the size and distribution of regional thunderstorms were larger than initially determined and that thunderstorms in the South Boulder Creek basin would produce greater flooding conditions than during general storms. (City Council Agenda Item, April 17, 2007)

In 2007, a motion was brought to the City Council to authorize the Boulder City manager to submit the new South Boulder Creek Flood Mapping Study results to the **Federal Emergency Management Agency (FEMA)**. The intention of the study, then completed, was "to define the flood problem, not solve it."

Mitigation planning effort for the South Boulder Creek drainageway was initiated in 2009. First, the City completed a risk assessment designed to identify and quantify life and safety issues associated with South Boulder Creek flooding. Property damage assessments, as well, involved depth of flooding by rainfall event recurrence interval and the corresponding value of associated damages. Environmental risks were identified based on the consideration of erosion and sediment transport, loss of vegetation, and likely changes in creek alignment. The risk assessment estimated that there would be more than $200 million in damages should a 100-year event occur along South Boulder Creek. (City of Boulder, 2010 Utilities Annual Report, p. C-39)

In December 2012, **FEMA** officially adopted new **Digital Flood Insurance Rate Maps (DFIRMs)** for Boulder County, including the City of Boulder. Although the new DFIRMs were generally consistent with the existing DFIRMs, the new maps incorporated the South Boulder Creek Floodplain Mapping Study and also de-certified three levees within the city. (https://bouldercolorado.gov/flood/south-boulder-creek-floodplain-mapping-study)



CFS Utility Master Plan, October 2004, *Courtesy City of Boulder*

Changes in a new era

FOURMILE CANYON FIRE, 2010

In 2010, high spring temperatures and a large snow pack resulted in early season high flows in Boulder Creek, but it would be fire, not flood, that would severely test the resources of the Boulder community in the months to come. The Fourmile Canyon fire —which began on September 6, 2010, and lasted for days — was named the most destructive fire in terms of damage and dollar loss in Colorado's history, destroying 169 homes and burning more than 6,000 acres of steep, heavily forested land in western Boulder County. Despite mulching, seeding, weed management, and other flood-control measures, this sudden removal of vegetation resulted in an increased flood risk along Boulder and Fourmile Canyon creeks that was estimated to last for the next ten years.

In 2011, Boulder's Utilities staff began coordinating with state and federal agencies, as well as Boulder's **Office of Emergency Management (OEM)** and the **Urban Drainage and Flood Control District (UDFCD),** to determine the flood risks during the 2011 flood season. The agencies also developed rainfall thresholds for Alert levels for Boulder Creek and Fourmile Canyon Creek. (City of Boulder, 2010 Annual Report, Utilities Division, C-34-35)

Several rainfall events were tracked. Storms on July 13, 2011 resulted in severe flooding within the burn area, high flows along Boulder Creek, and minor flooding along Fourmile Canyon Creek. As a result, the city received grant money to have Wright Water Engineers update the hydrologic model of the burn area based on the 2011 flood season gage (gauge) data, and extend the flood routing through the City to 29th Street. (2011 Annual Report, Utilities Division, p. C-32) It has since been determined that the watershed has recovered substantially and the increased flood risk is minimal.

GILBERT WHITE MEMORIAL

Gilbert White died, in 2006, at the age of 94. After his death, the Boulder City Council and Boulder City Manager established a Gilbert F. White Memorial Committee to design and implement a monument honoring the man who had spent much of his life preparing Boulder residents for the City's next major flood. He didn't live to see it, but his memorial surely will.

GILBERT WHITE MEMORIAL, erected in 2011

Markers show four major flood levels:

- Big Thompson Level (Projected water level *if* a flood the size of the Big Thompson Flood — Loveland 1976 — were to occur in Boulder Creek)
- 500 Year Level (none in Boulder's known flood history)
- 100 Year Level (Boulder's "Flood of Record," 1894)
- 50 Year Level

Author's photo, 2015

White's lifelong work was based on the belief that people can live in harmony with their environment — including inevitable extremes such as floods.

A committee of friends, family, colleagues, and City staff, as well as White's students, agreed that Gilbert would not have wanted a memorial, but, that if one was deemed necessary, he would have wanted it to serve some practical, educational function. So, the committee decided on a memorial promoting flood hazard education in Boulder — a sculptural flood-height marker with accompanying signage and information about both White and Boulder's flood hazard.

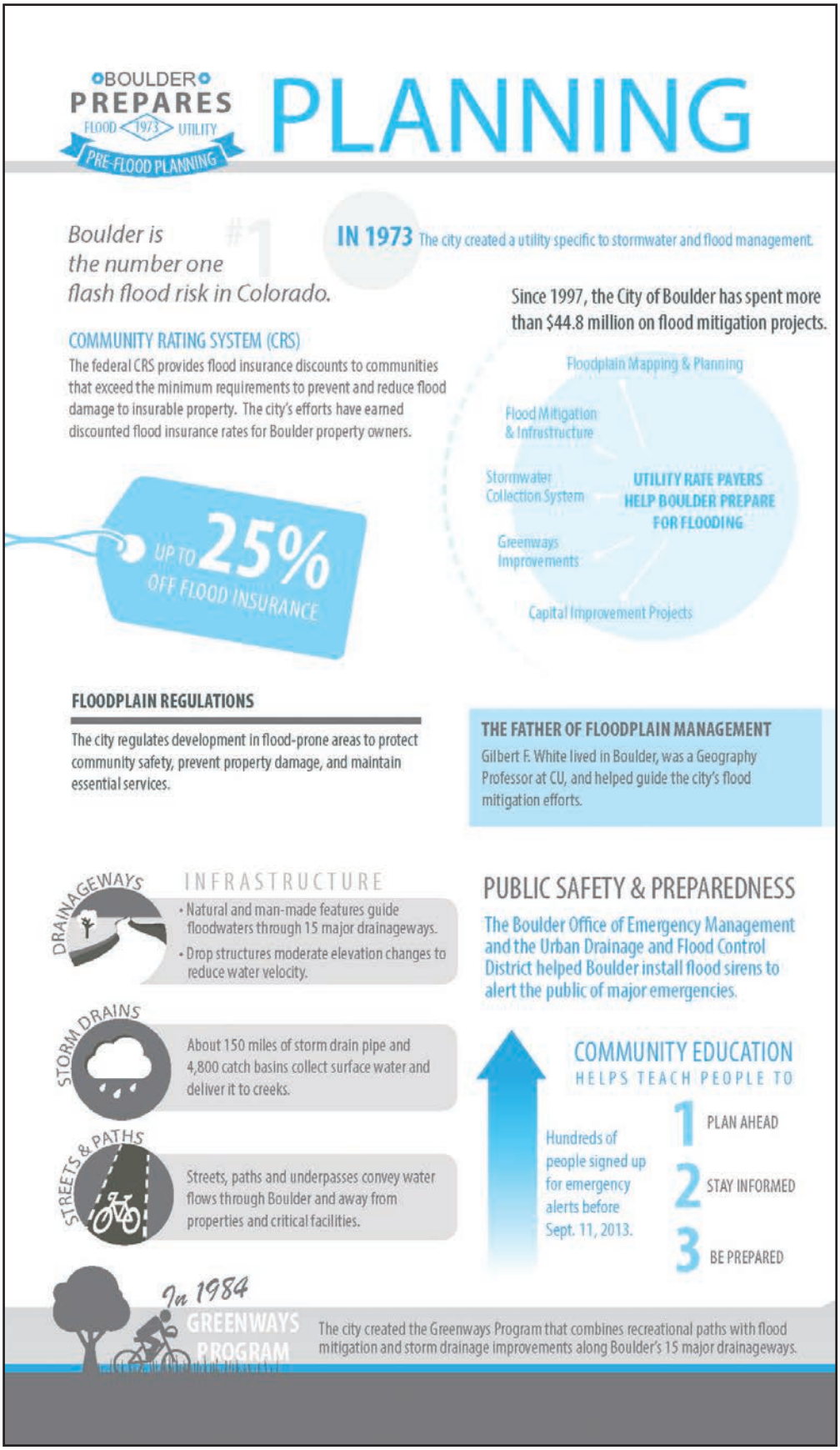
The 18-foot-tall glass column was designed by White's daughter, Mary Bayard White, along with Christian Muller, the designer and builder of Boulder's Sister City Plaza. Raising funds and permitting with the City took six years. Internal LED lights are powered by solar panels on a nearby building. The Flood Marker dedication finally was held in July 2011. The flood-height marker is located alongside the Boulder Creek Path, between Arapahoe Avenue and Canyon Boulevard, just east of Broadway. (Natural Hazards Center, http://www.colorado.edu/hazards/gfw/GFW_memorial.html)

Above, interpretive signs explain the meaning and purpose behind the Gilbert F. White memorial, set in place next to Boulder Creek in 2011.

Right, the memorial is east of the Broadway Bridge.
Author's photos, 2015

Boulder Flood Infographic, Flood Recovery and Resilience-City of Boulder

Courtesy City of Boulder



GREENWAYS PROGRAM MASTER PLAN UPDATE, 2011

In 1989, when the City Council adopted the original Greenways Program, it consisted of Boulder Creek and the following six tributaries:

- Fourmile Canyon Creek
- Wonderland Creek
- Goose Creek
- Skunk Creek
- Bear Canyon Creek
- South Boulder Creek

Although the purpose and objectives of the Greenways Program have not changed since its implementation, the Program has undergone several updates. In 2011, the following components included:

- an expansion to all of the fourteen major tributaries to Boulder Creek within the City of Boulder (The additions to the tributaries were: Bluebell Canyon Creek, Dry Creek No. 2, Elmer's Two Mile Creek, Gregory Canyon Creek, Kings Gulch, Sunshine Creek, Two Mile Canyon Creek, and the Viele Canal.)
- bringing the plan up to date on the progress made since 2001 reflecting on current adopted policies and plans. (These plans included the Boulder Valley Comprehensive Plan, the Comprehensive Flood and Stormwater Utility Master Plan, the Transportation Master Plan, Parks and Recreation Master Plan, the Water Quality Strategic Plan, sub-community plans, and stream specific flood mitigation plans. In addition, the Boulder Revised Code required securing a floodplain development permit, as well as wetlands permits for most Greenways improvement projects.)

(City of Boulder, "Greenways Master Plan Update," 2011, p.1-1)

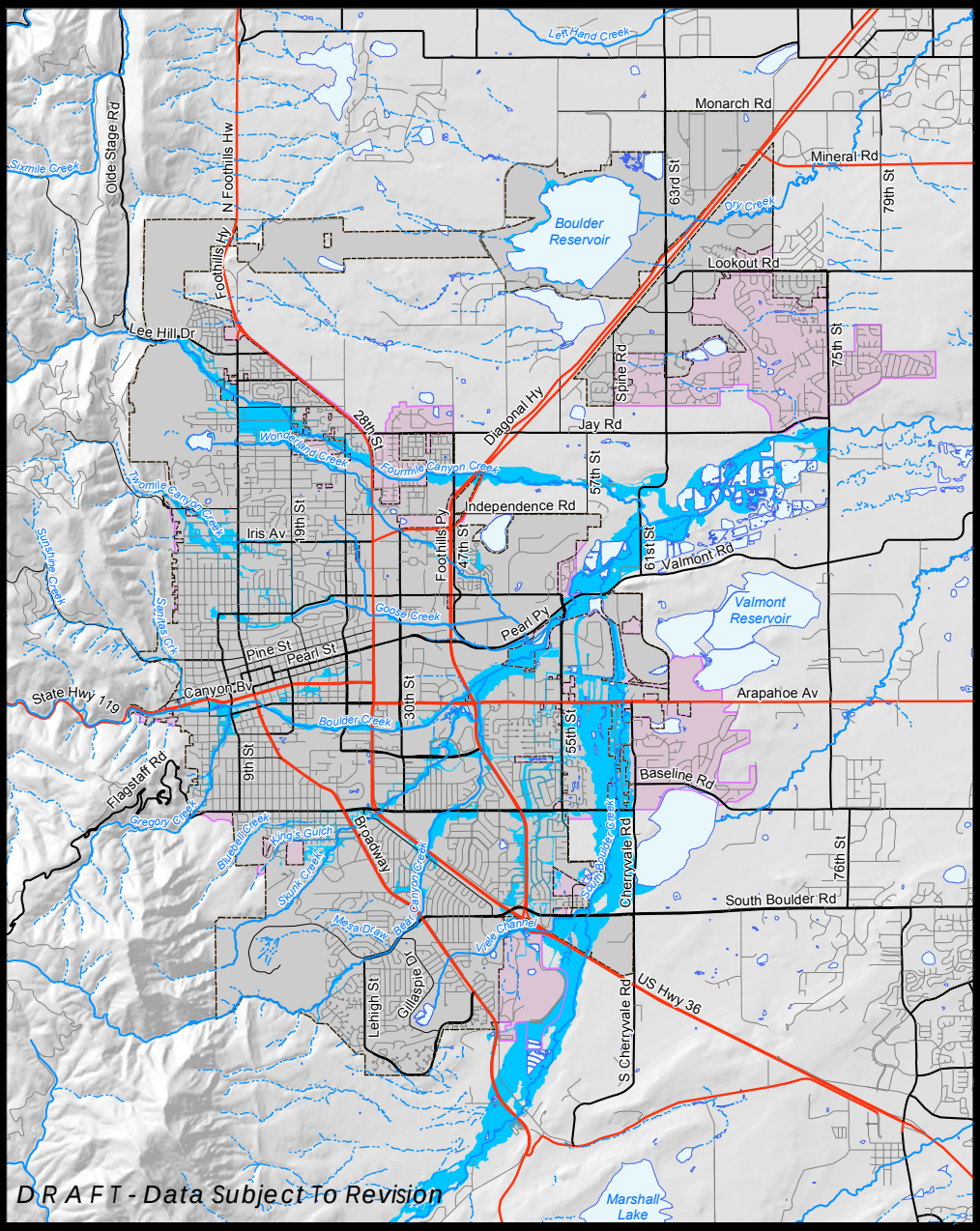
BOULDER'S PLANNING IN PLACE

Boulder has a long history of flood preparedness. First, the City recognized its vulnerability for flash flood risks. Then, City administrators brought in experts, beginning with Frederick Law Olmsted, Jr. who advocated for parks, rather than buildings, along Boulder Creek. More studies and more flood management advice followed, including the wisdom and philosophy of Gilbert F. White who proclaimed that flood mitigation should follow the natural environment.

With infrastructure and pre-flood planning in place by 2013, Boulder was better prepared than in the past. Experts are saying that another "100-year flood" (as was the flood of 1894) lies ahead in the future. But, it hasn't arrived yet, and Mother Nature is full of surprises. The weather event that hit Boulder in September 2013 dumped more rain in one storm than the City gets in a year, and it was unusual, unexpected, and unprecedented.

Urban Flooding Extents

Map 1 — *September 2013 Flood - City of Boulder, Colorado*



Urban Flooding Extents

Urban Flooding Extents, September 2013 (revised 2014), *Courtesy City of Boulder*

City Limits · BVCP Area 2 · Highway · Major Road · Minor Road · Local Street · Creek · Intermitent Creek · Lakes

Map Revision Date: 03/28/14 - © 2014 City of Boulder, CO Subject to Revision

NOTE: The 2013 urban flood extent data was developed using field surveys completed by City of Boulder staff and consultants, Digital Glood Worldview-2 satellite imagery (9/13/13), Boulder County October 2013 Pictometry imagery, public input from the Boulder Crowd Sourcing online map, public input in community meetings, online flood survey data, and input from discussions with affected property owners. Only drainages with a FEMA mapped floodplain were surveyed. Other areas of Open Space and Mountain parks land without a regulatory floodplain were not included. The City of Boulder will continue to make additional updates to this data to incorporate relevant information.

The 2013 urban flood extent data does not supersede the Special Flood Hazard Area Designation (SFHA), or 100 yr floodplain, used by FEMA for Digial Flood Insurance Rate Maps or the proposed floodplain delineations from ongoing flood studies.This data is provided as graphical representation only. The City of Boulder provides no warranty, expressed or implied, as to the accuracy and/or completeness of the information contained hereon.

The preliminary urban flood extent data does not supersede the Special Flood Hazard Area Designation (SFHA), or 100 year floodplain, used by FEMA for Digital

N · 0 · 1 Miles

Rain / flood of 2013

Even before the Fourmile Fire in September 2010, Boulder and Boulder County officials no longer questioned "what if?" (a flood were to happen). Instead, they asked "when?" Their answer came in 2013 — from September 9 to September 13 —when 14.71 inches of rain fell in Boulder County. Instead of Boulder and Fourmile Canyon creeks absorbing the brunt of the precipitation, as had been considered, *all* 15 major creeks (and 23 irrigation ditches) in Boulder became rushing torrents.

Earlier in 2013, the Utilities staff attended pre-flood-season training meetings, participated in hand-held-radio-training sessions, and took refresher courses on new flood protocols resulting from an analysis of the Fourmile Fire flood risk. Even with all of this planning, the September 2013 rain/flood event became a true test of the City's flood preparedness.

WHAT HAPPENED?

The four-day rainfall in September 2013 was off the charts. Only 12. 96 inches of precipitation had fallen in Boulder since the beginning of the 2013 calendar year, which was easily surpassed in September's perfect storm. Breadth, duration, and timing all played a role. On the website of the University Corporation for Atmospheric Research, senior science writer Bob Henson described the rain event by stating: "[The] deluge followed a week-plus of record heat across much of the West that felt more like midsummer than September. Then, the hot dome of upper-level high pressure shifted north and east, while a large but weak upper low set up shop across the western United States. With the main jet stream located well north into Canada, this pattern stayed in place for most of the week.

"The immense amount of water that fell arrived at upper levels via a plume of deep moisture that surged northward from the tropics," Henson continued. "At lower levels, the pattern drove moist air from the Great Plains toward the foothills, where it was forced upslope. Together, these features blanketed the Front Range with the soggiest air mass ever recorded at Denver in September, as measured by radiosondes (weather balloons launched twice daily that sense the amount of water vapor through the depth of the atmosphere)."

This transition — from intense heat to heavy rain — stated Henson, was similar to conditions more typical in July and August when Boulder experiences the North American Monsoon weather pattern. During the September 2013 event, Boulder Creek—as measured just west of Broadway by a U.S. Geological Survey gauge—crested at an impressive 7.78 feet on the evening of Thursday September 12, with an estimated flow of about 5,000 cubic feet per second (cfs).

That water level was the highest since the record flood of May/June 1894, when flows were estimated at more than 11,000 cfs. It's interesting to note that the 1894 event produced lower precipitation amounts than were observed in much of Boulder County in 2013. The 1894 rains, however, had come in May and had been accompanied by major runoff from snowmelt. In contrast, the rains in the September 2013 event fell on a parched, snow-free landscape.

Boulder Creek, west of Broadway, looked like this on September 12, 2013.
Courtesy Bob Henson, UCAR

Flood waters engulfed a bike/pedestrian path along Bear Creek, in South Boulder, uncannily similar to a flash flood in the Bear Canyon Creek watershed on August 15, 2007. That flood occurred very quickly — during a period of only 30 minutes. *Courtesy Bob Henson*

UNFOLDING EVENTS

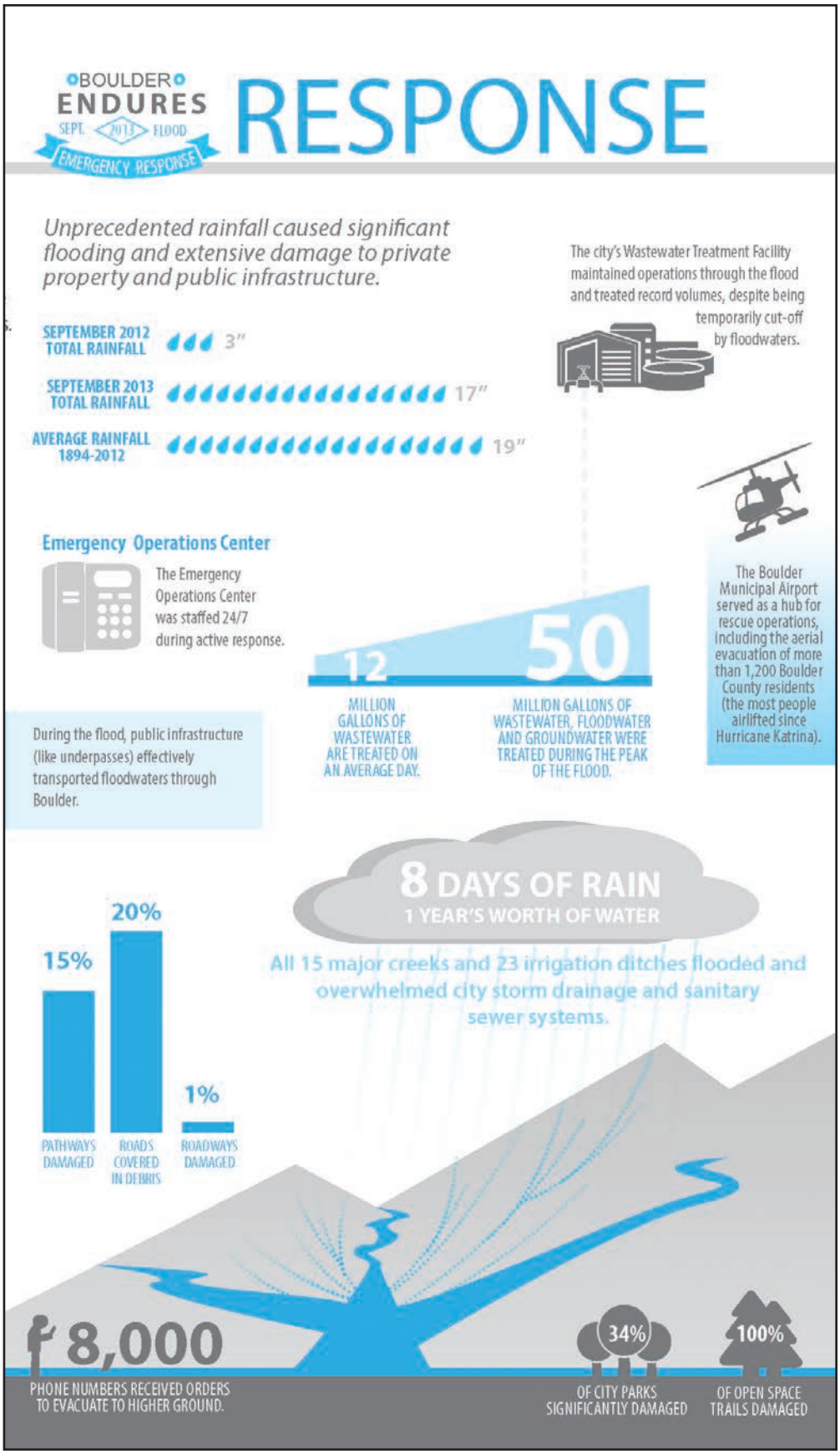
Wednesday September 11, 2013 had started out as just another rainy day in Boulder. Then came reports of street flooding, followed by a 9:20 pm flash-flood warning for all of Boulder and Boulder County. At 10:01 pm, the City activated flood sirens near Boulder Creek, urging anyone near the waterway to immediately seek higher ground.

At 11 pm, Wesley Quinlan and Wiyanna Nelson, a teenage couple, were on their way home from a friend's house on Linden Drive. Two other friends were with them when their Subaru was struck by a mudslide near the intersection of Linden Drive and South Cedar Brook Road, along Two Mile Creek. When three of the teens tried to leave their car, only one survived. Quinlan and Nelson were swept away. Their bodies were found the following day. (*Denver Post*, September 13, 2013)

Eerily, the mudslide responsible for the deaths of Quinlan and Nelson occurred in the same drainage where a woman and a girl lost their lives, on a picnic, during a flash flood in Two Mile Creek in 1909. (*Daily Camera*, July 24, 1909) That same night, Lyons resident Gerald Boland and Jamestown resident Joey Howlett lost their lives.

Boulder Flood Infographic, Flood Recovery and Resilience-City of Boulder

Courtesy City of Boulder



On Thursday September 12, 2013, the flood situation turned from bad to worse. The National Weather Service's forecast, issued for Denver/Boulder at 9:41 a.m. read, in part:

"NATIONAL WEATHER SERVICE DENVER/BOULDER CO ... 941 AM MDT THU SEP 12 2013/ UPDATE/MAJOR FLOODING/FLASH FLOODING EVENT UNDERWAY AT THIS TIME WITH BIBLICAL RAINFALL AMOUNTS REPORTED IN MANY AREAS IN/NEAR THE FOOTHILLS -- THINGS ARE NOT LOOKING GOOD." *(Daily Camera,* September 21, 2013)

At the Boulder Police Department, calls sky-rocketed. The department on a typical day receives 546 phone calls. On Thursday, there were 2,955. Service calls increased, too, from an average of 318 per day to 532. *(Daily Camera,* September 21, 2013) Although Boulder's storm drains and sanitary sewer were overwhelmed, the Betasso Water Treatment Facility and 75th Street Wastewater Facility remained operational throughout the event. The Boulder Reservoir Water Treatment Facility was forced offline for an extended period due to flood impacts to its water sources – Boulder Reservoir and Boulder Feeder Canal. As a testament to the City of Boulder's flood preparedness, public infrastructure (such as underpasses) effectively transported the floodwaters through Boulder.

Spring Valley Road was only one of Boulder's many flooded and debris-covered streets. *Courtesy Katie Knapp, City of Boulder*

The rain/flood event provided the City with concrete data to help it prioritize its efforts. Statistics (for the City of Boulder) included:

- The rains/flood affected 14 per cent of Boulder households.
- Property damage totaled $300 million.
- Destruction impacted 15 per cent of the City's paved paths, 34 per cent of the City's parks, and 100 per cent of its Open Space trails.
- Thousands of feet of drain pipe and 720 tons of creek debris were cleared.
- 1,700 volunteers worked more than 7,000 hours to help.

Meanwhile, in the mountains, many residents lost their homes, while others (including the author) had their road access cut off for days or weeks. According to the Boulder County Office of Emergency Management, more than a thousand people (including a group of school children at Cal-Wood, west of Jamestown) were evacuated by air.

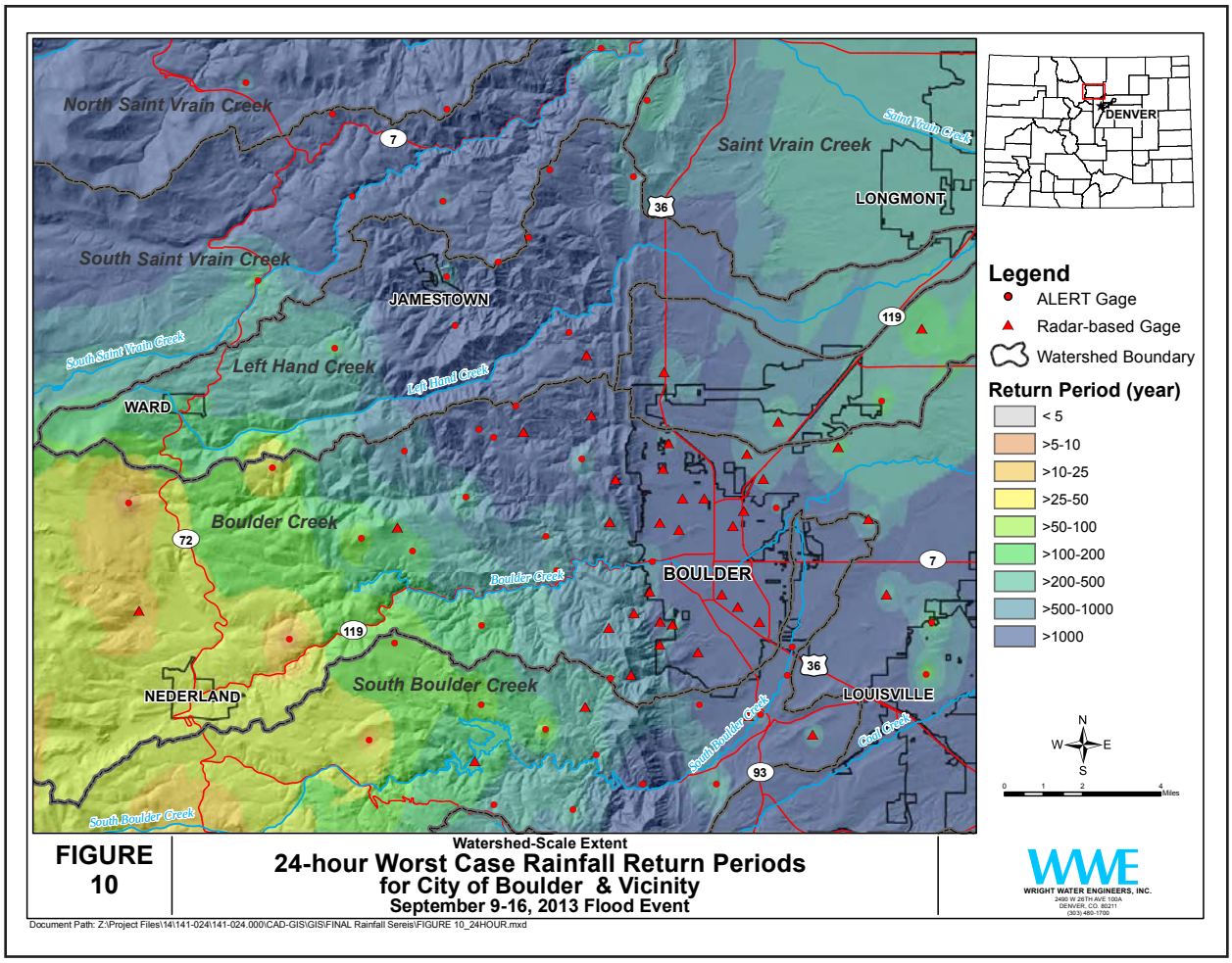
On September 13, 2013, Colorado Army National Guard units used Chinook helicopters to evacuate stranded mountain residents. These residents are shown arriving at the Boulder Airport.
National Guard photo

HOW BIG WAS IT?

Subsequent reports of the National Weather Service began to refer to the four-day "rain/flood event" as a "1,000-year rain," meaning that in the most significant areas of rainfall, there was only one chance in one-thousand of having an event of this magnitude and duration in any given year. But, that didn't mean that Boulder experienced a "1,000-year flood." In reality, the levels were not even close to the "flood of record," on Boulder Creek, in 1894.

As to how big it was, there is no simple answer, as measurements varied in different locations. According to Wright Water Engineers (WWE), "The runoff response typically was between a 25- and 50-year event for many watersheds; however, some watersheds including lower portions of South Boulder Creek, Upper Twomile Canyon Creek and the lower portion of Fourmile Canyon Creek experienced flows on the order of a 100-year event or greater." *(Rainfall-Runoff Analysis for September 2013 Flood in the City of Boulder, Colorado*, Wright Water Engineers, Inc., October 2014)

The reason for the variable levels was because the storm event unfolded in such a way that the majority of the rainfall was centered over the lower elevations of the watershed, including those areas affecting the tributary drainageways within the City of Boulder. In addition, "1,000-year rainfall" did not occur over the entire Boulder Creek watershed and there were many areas with lesser rainfall totals and lower peak rainfall intensity than assumed in design storms. Boulder dodged a bullet, so to speak, from the perspective that the flood disaster could have been much worse for Boulder if the more intense rainfall had occurred more directly over the upper Boulder Creek watershed which would have produced more flooding along the main stem of Boulder Creek.



As shown above, a band of heavy rainfall moved over higher elevations in the Left Hand Creek and Saint Vrain Creek watersheds. "24-hour Worst Case Rainfall Return Periods for the City of Boulder & Vicinity," Wright Water Engineers, Inc. Report of October 2014, *Courtesy Wright Water Engineers*

Looking toward the future

Historians are fond of saying that we need to learn from the past to plan for the future, but it appears that the more flood studies that have been done, the more questions we have. Why, for instance, were so many of Boulder's early flood-planning studies ignored? Would property damages have been less if the Greenways Program had been started back in Frederick Law Olmsted, Jr.'s time? Will residents a century from now ignore the plans being implemented today?

And why was the 2013 rain/flood event so difficult to define, with different understandings of what actually happened? The National Weather Service described the storm as a 1,000-year rain, but the interpretation on the Gilbert White Memorial references a 50-year flood, and the Wright Water Engineers report highlights varying recurrence intervals across different drainage-ways. As Jeff Arthur, Boulder's Director of Public Works for Utilities, states, "Climate science seems to point to the past being a poor predictor of the future, i.e. warmer temps and more extreme weather. It seems like the bottom line is that preparing for the last flood may not be the best strategy to prepare for the next one." (Email correspondence with Jeff Arthur, February 29, 2016)

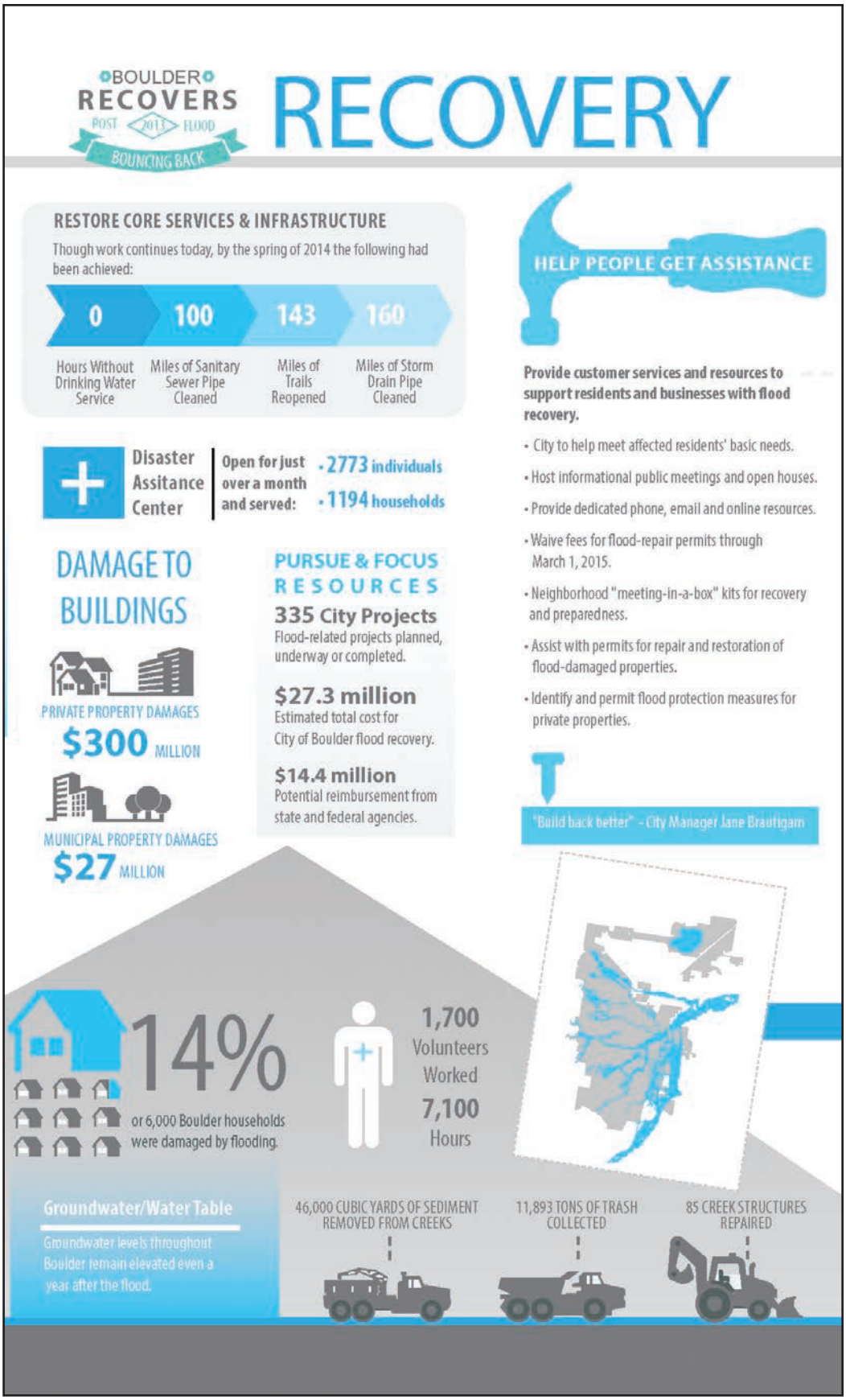
In whatever way the September 2013 event is defined, it was unprecedented, but it wasn't the "big" flood on Boulder Creek that Gilbert White and others had predicted. We don't know if Boulder's next flood of record will happen next year, next decade, or beyond. We do know that we need to be prepared. Immediately after September 2013, Boulder focused simultaneously on both recovery and planning for the future. As noted in the City's After-Action Report, "The flood caused harm, but also created an opportunity — to think critically about our future and to work together in support of long-term community sustainability and resiliency."

Critical issues

As soon as the rain stopped, City contractors began to remove debris and sediment from public property along Boulder's 15 major drainageways, with priority given to sites that posed the biggest threat to public safety and infrastructure. The City's flood recovery work also included repairs to damaged creek infrastructure (culverts and drop structures) and the restoration of waterways to pre-flood conditions.

Boulder Flood Infographic, Flood Recovery and Resilience-City of Boulder

Courtesy City of Boulder



The wastewater treatment facility maintained operations, but the collection system surcharged creating backups in some parts of Boulder which caused many private property owners and residents to experience basement flooding and sewer backups. Private property damages within the 100-year floodplain added up to $38 million. Outside the floodplain, damages were $162 million for a total of $200 million.

The primary causes of private property damages included major drainageway (22 per cent) and local drainage (43 per cent) flooding, groundwater infiltration (56 per cent), floor drain damage (19 per cent), and sanitary sewer backups (17 per cent). (These numbers are the result of a public survey. The total exceeds 100 per cent, as respondents could select more than one option.) The largest amount of damage occurred within the South Boulder Creek floodplain area, mostly in the West Valley overflow area. (City of Boulder, "Flood Impact Survey," 2014)

A few days after the September 2013 event, the Boulder City Council included the Critical Facilities and Lodging Facilities Ordinance in its agenda. This was not a hurried action, however, as this flood management measure had been in the planning stages for several years. The purpose of the ordinance was to amend floodplain regulations in both the 100-year and 500-year floodplains in order to enact more restrictive standards for public buildings and other places of assembly. Once passed, it provided additional protection to critical infrastructure and the people most vulnerable to flood hazards, including the elderly, children, and visitors unaware of local flood risks.

As explained by a *Daily Camera* reporter, "Critical facilities are those that provide essential services, serve at-risk populations, or contain hazardous materials." As a result of the ordinance, these facilities now are required to develop emergency plans and implement flood protection measures when undergoing new construction or significant renovations in the 500-year flood plain. Emergency plans include either evacuation or shelter-in-place plans. Structures are required either to be elevated above the predicted flood levels or to use flood-proofing measures.

Lodging facilities, as defined in the ordinance, include hotels, motels, dormitories, bed-and-breakfasts and overnight shelters. Lodging and mixed-use buildings that include housing were required to be elevated or have other flood-proofing in the 100-year floodplain. In the 500-year floodplain, they were required to develop emergency plans. ("Boulder City Council turns focus to flood issues Tuesday night," Daily Camera, September 16, 2013)

RECOVERY AND RESILIENCY

As the September 2013 rain/flood event receded, Boulder's key objectives focused on both near-term recovery and long-term resiliency. The City, in its "After-Actions Report," defined flood recovery as "the process of establishing a community-based,

post-disaster vision to focus on plans and projects to address damages sustained from the flood and to aid in the community's recovery from the disaster." The City's sustainability framework and resilience principles were applied to maximize long-term recovery efforts and enable the community to effectively respond and adapt to future challenges. Briefly, these objectives included:

- helping people get assistance.
- restoring and enhancing infrastructure.
- assisting business recovery.
- pursuing and focusing resources to support recovery efforts.
- learning together and planning for the future.

Under best practices, some of the common themes that emerged in the report were the following:

- Staff came together with the common mindset to be supportive and understanding for the community during this time of need.
- Establishing the flood recovery team was essential to the success of the community.
- Water and wastewater service remained operational.

Under lessons learned, some of the common themes were to:

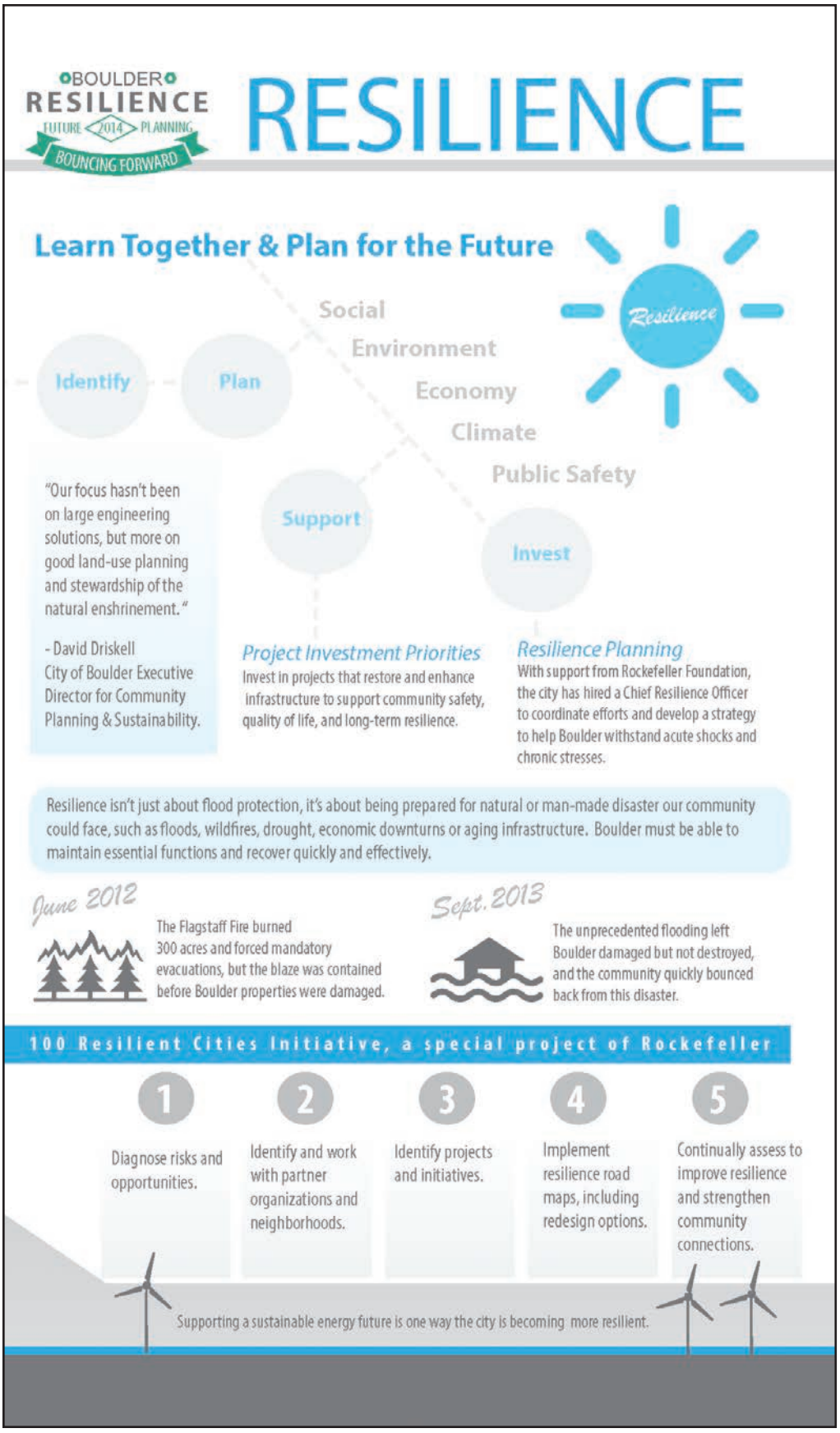
- prepare a pre-disaster recovery plan to quickly meet the changing needs of the community following a disaster.
- set clear expectations for residents.
- provide additional mental health support and referral assistance for staff and on-site mental health professionals.

(City of Boulder, "After-Action Report," September 9, 2015)

ACCURATE FLOOD MAPPING

The importance of accurate floodplain mapping studies cannot be overlooked, as these studies are the first steps in implementing flood mitigation projects. After mapping has been completed, affected property owners are subject to floodplain regulations and may need to purchase flood insurance if required by their mortgage or desired to lessen the financial risk of damages. Once a mapping study has been approved by FEMA, the City develops a mitigation plan to evaluate the feasibility of reducing the flood risk. Construction alternatives are evaluated based on estimated cost and from the perspective of keeping environmental and community impacts to the minimum.

Prior to the September 2013 rain/flood event, the City of Boulder spent a decade updating flood maps for Boulder Creek and many of its tributaries including Bear Canyon Creek, South Boulder Creek, Fourmile Canyon Creek, Wonderland Creek, Goose Creek, Skunk Creek and Twomile Canyon Creek. Fortunately, the information from these studies was released to the public prior to the 2013 flood event, even if the revised flood mapping had not been officially adopted by FEMA.



Boulder Flood Infographic, Flood Recovery and Resilience- City of Boulder

Courtesy City of Boulder

In particular, draft flood mapping along Upper Goose Creek and Twomile Canyon Creek turned out to be much more accurate than the flood mapping that was developed in the 1980s. (As noted earlier in this book, two people lost their lives in the Two-mile Canyon Creek drainage in 1909. Two more lost their lives in this same drainage during the 2013 event.)

Similarly, the 2013 event confirmed the flood hazard predictions of the South Boulder Creek Flood Mapping Study (completed in 2008) that covered the West Valley area where private property owners incurred many of their damages. This most recent South Boulder Creek study had identified approximately 240 structures (700 total dwelling units) at risk of a 100-year flood in an area bounded by US-36 on the south, Mohawk Drive on the west, 55th Street on the east, and Arapahoe Avenue on the North. The structures had been developed with few flood protection measures since the area was not previously thought to have been at risk of major flooding.

Building on the South Boulder Creek Flood Mapping Study is the Final South Boulder Creek Major Drainageway Plan – Alternatives Analysis Report, to address the problems in the West Valley that are located within the incorporated limits of the City of Boulder. The Engineer's recommended plan outlines the following elements:

- US-36 stormwater detention facility
- Arapahoe Avenue detention
- Improvements in the West Valley (includes small detention facilities used to capture and attenuate flows or improvements to existing conveyance infrastructure)

(Final South Boulder Creek Major Drainageway Plan – Alternatives Analysis Report, August 2015)

WONDERLAND CREEK PROJECT

The 2013 rain/flood event also highlighted the vulnerability of properties along Wonderland Creek east of 30th Street, between Winding Trail Drive and Foothills Parkway. Property owners were adamant that the City do something and, fortunately, flood mitigation planning that occurred in 2009 put the City in the position to respond to the outcry.

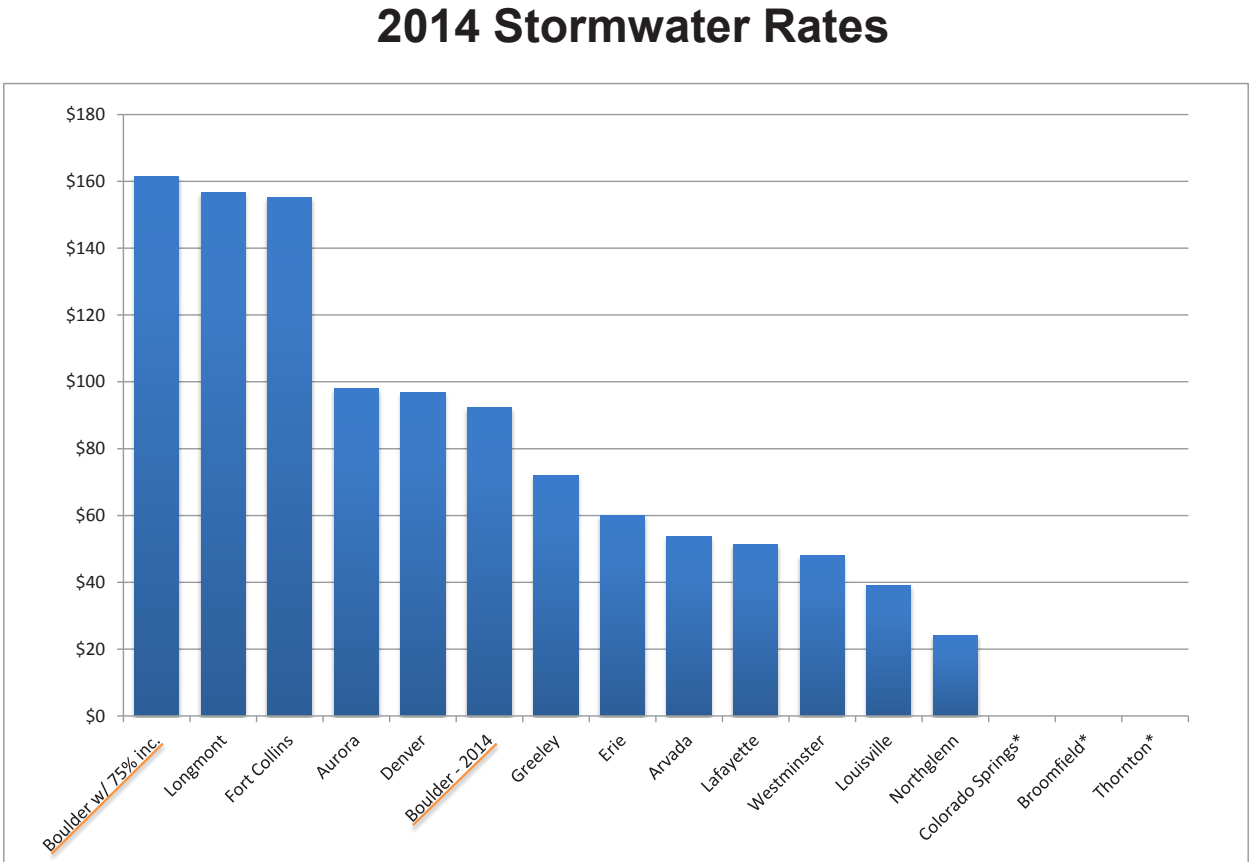
Construction began on the $30-million project in January 2016. Completion of the project is expected in two years, providing 100-year channel improvements for Wonderland Creek. This will reduce flood risk for 583 dwelling units and 130 structures which are currently located within the 100-year floodplain. The project also includes three new underpasses for pedestrians and cyclists — at the BNSF Railroad tracks, at Kalmia Avenue, and at 28th Street. Approximately 450 trees will need to be removed, but once construction is complete, 1,884 new trees and shrubs will be replanted.

The Wonderland Creek project was well underway when these photos were taken in Aapril 2016. *Courtesy Bob Harberg*

2015 INCREASE IN STORM/FLOOD FEES

After the 2013 rain/flood event, the City bore a significant portion of the flood response and clean-up costs, resulting in a review of the City's Stormwater and Flood Management Utility rates. A study of flood insurance policies in Colorado determined that Boulder has, by far, the largest number of these policies — along with the largest insured property values — of any municipality in the state. As of January 2014, there were more than 3,800 policies held by City of Boulder residents, with a total insured coverage of over $857 million at a total yearly premium cost of nearly $3 million. (City Council study session presentation on Flood Management, September 30, 2014.)

In light of this information, utility rates in the City of Boulder were proposed to increase by 75 per cent to cover community investment in flood mitigation, reducing the associated risks and related insurance costs. Meanwhile, utility fees were compared to those of other area communities. The proposed rate increase, however, was only slightly higher annually than the 2014 rate charged in Fort Collins and Longmont. (Water Resources Advisory Board, May 19, 2014.) The increased rates were ultimately deemed acceptable and appropriate by the City Council and were included as part of the 2015 City budget.



Rate comparison fee chart. *Courtesy City of Boulder*

INTO THE FUTURE

Throughout the many decades of Boulder's development, there remained a relatively poor understanding of existing flood hazards. Both public and private structures were built (and still are being built) in floodplain areas, contrary to the recommendations in several of the early flood management studies. Because of today's high property values and scarcity of land, there's simply no other place to build.

The Big Thompson flood in Larimer County became Boulder County's wake-up call, but that was not until 1976. Afterwards, some — but not all — of Boulder's residents heeded the City's distinction as the number-one flood risk city in Colorado where flash flooding can occur with less than thirty minutes of warning. In recent years, significant technological advances in the mapping and modeling of floods and flood hazards have been implemented, but there still are many uncertainties which the public and its decision-makers will need to consider in the years to come.

The September 2013 rain/flood event provided an excellent opportunity for the City to refocus its floodplain management and preparedness efforts. Since then, it has become obvious that previous planning and flood mitigation work reduced flood damages, even though more work remains to be done. Memories of the recent event, however, are apt to be short-lived, so it is important to prioritize flood mitigation work while there is the political will to do so.

In the recent past, Boulder's leaders have been progressive in their attempts to deal with the City's flood hazards, and Boulder's Stormwater and Flood Management Utility has become a model for the country. Time will tell how well prepared the City of Boulder and its residents are as they head into the future. Let all of us remember, however, to take the collective knowledge of the past as reflected by Roman philosopher Marcus Cicero. His words are inscribed over the west entrance of Norlin Library at the University of Colorado and state, "Who knows only his own generation remains always a child." May future Boulder residents and readers add to this document on Boulder's history of floods and flood management and learn from the many who contributed to the Boulder we know today.

Appendix

Recent Wastewater Utilities Work Program Staff

Executive Director of Public Works
Dave Rhodes and Mo Rait

Director of Public Works for Utilities
Ned Williams and Jeff Arthur

Finance and Analysis Manager
Carol Linn and Ken Baird

Principal Engineer—Utilities
Bob Harberg

Water Quality and Environmental Services Manager
Chris Rudkin and Bret Linenfelser

Utilities Maintenance Manager
Don Vetterling, Felix Gallo and Peter Rosato

Floodplain Manager
Alan Taylor

Water Resources Advisory Board (WRAB)

The Water Resources Advisory Board (WRAB) was first seated in 1993 and advises the City Council, Planning Board and city staff on community utilities issues. The board also:

- reviews Capital Improvement Programs for the three city-provided utilities (water, wastewater, and stormwater/flood);
- reviews utilities community and environmental assessment processes (CEAPs),
- reviews utilities master plans; and may provide recommendations concerning policy issues on operating programs.

Throughout the years, the following people have served as the board's chairs:

1993 – Peter Gowen
1994 – Peter Gowen
1995 – Peter Gowen
1996 – Peter Gowen
1997 – Peter Gowen
1998 – Robert Fiehweg
1999 – Robert Fiehweg
2000 – Robert Fiehweg
2001 – Robert Fiehweg
2002 – Robert Fiehweg
2003 – Robert Fiehweg
2004 – Jeannette Hillary
2005 – Ken Wilson
2006 – Ken Wilson
2007 – Jim Knopf
2008 – Bart Miller
2009 – Robin Beyers
2010 – Bill DeOreo
2011 – Bill DeOreo
2012 – Susan Iott
2013 – Chuck Howe
2014 – Vicki Scharnhorst
2015 – Vicki Scharnhorst

Selected References

BOOKS AND REPORTS:

Bixby, Amos, *History of Clear Creek and Boulder Valleys, Colorado,* Chicago: 1880

Boulder County Sheriff's Department, *Boulder County Sheriff's Department Disaster Planning and Mobilization, Flood Plans, 1977*

Boulder County Transportation Department, *Boulder County Flood Protection Handbook,* January 2002

Burns and McDonnell, *Preliminary Report: Water, Creek & Sewer Improvements, Boulder, Colorado, 1921*, Kansas City: 1921

DeBoer, S. R., *Preliminary City Plan for the City of Boulder,* Boulder: 1944

Leonard Rice Consulting Engineers, *Early Flood Warning Planning: Boulder Creek,* Boulder: 1977

Metcalf and Eddy, *Report to the Boulder City Improvement Association Upon the Improvement of Boulder Creek and the Sewerage, Drainage, and Disposal of the Sewage of Boulder, Colorado,* Boston: 1912

Oaks, Sherry D., *Floods in Boulder County, Colorado, A Historical Investigation,* Boulder County Public Works, Boulder: 1982

Olmsted, Jr., Frederick Law, *The Improvement of Boulder, Colorado,* Boulder: 1910

Perrigo, Lynn I., *A Municipal History of Boulder 1871-1946,* Boulder: 1946

Philipsborn, Randall H., *Decisions to Construct New Buildings Within the Regulatory Floodway of Boulder Creek:* 1959-1978, Master of Arts thesis, University of Colorado, Boulder: 1978

Smith, Phyllis, *History of Floods and Flood Control in Boulder, Colorado,* City of Boulder, Boulder: 1987

South Boulder Creek Independent Review Panel Report, Boulder: July 10, 2001

Taggart Engineering Associates, Inc., *South Boulder Creek Major Drainage Planning, Phase A Report,* February 5, 2001

U.S. Army Corps of Engineers, *Boulder's Flood Protection Decision: A Choice to Live With*, Omaha: 1977

U.S. Army Corps of Engineers, S*urvey Report on Flood Control: South Platte River and Tributaries: Colorado, Wyoming, and Nebraska,* Omaha: 1945

UDFCD, *Special Flood Hazard Information Report, Boulder Creek*, City of Boulder, Colorado, May 1972

Wright Water Engineers, Inc., *Rainfall-Runoff Analysis for September 2013 Flood in the City of Boulder, Colorado,* October 2014

ARTICLES:
Frazer, Lance, "Paving Paradise: The Peril of Impervious Surfaces," *Environmental Health Perspectives*, July 2005
Gruntfest, Eve; Thomas Downing, and Gilbert White, "Big Thompson flood damage was severe, but some could have been prevented," *Civil Engineering-ASCE,* February 1978
NOAA National Climatic Data Center, This Month in Climate History, June 3, 1921, Colorado Flooding

NEWSPAPERS:
Boulder Daily Camera
Colorado Banner
Daily Mining Journal
Denver Post
Greeley Sun
Rocky Mountain News
The Mining Journal
Weekly Commonwealth

SELECTED CITY OF BOULDER PUBLICATIONS USED IN THIS MANUSCRIPT:
City of Boulder, 1993, City Council, Study Session on Floodplain Management
City of Boulder, 2000, Project Management, Utilities
City of Boulder, 2001, July 17, City Council Agenda Item
City of Boulder, 2002, City Council Study Session
City of Boulder, 2003, Memo Regarding Implications of Fowler Decision
City of Boulder, 2003, Project Management, Utilities
City of Boulder, 2003, Annual Report, Utilities Division
City of Boulder, 2003, Stormwater and Flood Management Background Information
City of Boulder, 2004, Comprehensive Flood and Stormwater Utility Master Plan
City of Boulder, 2004, Project Management, Utilities
City of Boulder, 2004, CFS Utility Master Plan
City of Boulder, 2007, April 17, City Council Agenda Item
City of Boulder, 2010, Annual Report, Utilities Division
City of Boulder, 2010, Utilities Annual Report
City of Boulder, 2011, Greenways Master Plan Update
City of Boulder, 2011, Greenways Masterplan
City of Boulder, 2013, City Council Agenda item
City of Boulder, 2014, Flood Impact Survey
City of Boulder, 2014, May 19, Water Resources Advisory Board
City Council study session presentation, September 30, 2014, Flood Management
City of Boulder, 2015, After-Action Report
City of Boulder, 2015, Final South Boulder Creek Major Drainageway Plan – Alternatives Analysis Report

BOULDER'S FLOODS AND FLOOD MANAGEMENT: PAST & PRESENT was published by the City of Boulder in 2016. For other publications in this series, see —

BOULDER'S WASTEWATER: PAST & PRESENT (2015)
BOULDER'S WATERWORKS: PAST & PRESENT (2014)