

**CITY OF BOULDER  
WATER RESOURCES ADVISORY BOARD  
AGENDA ITEM**

**MEETING DATE: May 20, 2013**

**AGENDA TITLE:** Public hearing and consideration of a recommendation to City Council to adopt the Upper Goose Creek and Twomile Canyon Creek floodplain remapping study

**PRESENTER/S:**

Jeff Arthur, Director of Public Works for Utilities  
Bob Harberg, Principal Engineer - Utilities  
Annie Noble, Greenways Program Coordinator  
Kurt Bauer, Engineering Project Manager

**EXECUTIVE SUMMARY:**

The city has a comprehensive floodplain management program designed to identify flood risks, mitigate the risks of flooding, minimize loss of life and property damage and support recovery following a major flood event. Floodplain mapping provides the basis for the city's floodplain management program by identifying the areas subject to flooding. Changes in land use, updated topographic mapping and upgrades to hydrologic and hydraulic models warrant periodic mapping updates. In addition, the city's Comprehensive Flood and Stormwater Master Plan and the Multi-Hazard Mitigation Plan state the city should work to update floodplain mapping on a ten-year cycle. This memorandum presents a proposed mapping update to the Upper Goose Creek and Twomile Canyon Creek west of Folsom Street. This memorandum also provides a brief summary of the other important components of the city's comprehensive floodplain management program including mitigation master planning and property acquisition, flood insurance, protection land use regulations and flood preparedness.

The existing Upper Goose Creek and Twomile Canyon Creek floodplain maps date back to 1991 and shows one main flow path for the 100-year flood event along each creek. The limited size of the creek system and documentation of past flood events, indicate that Twomile Canyon Creek did, and would again, overtop during even a minor storm event and spill downstream along several flow paths. The updated mapping study used a combination of modeling techniques to identify and define these overflow paths along Twomile Canyon Creek. The resulting proposed updated floodplain mapping therefore differs significantly from the 1991 mapping for Twomile Canyon Creek but remains relatively similar for Upper Goose Creek.

The proposed mapping for both creeks would result in a net increase of 19 structures in the 100-year floodplain, but a net reduction of 43 structures in the conveyance zone and net reduction 35 structures in the high hazard zone. Following input from WRAB, the mapping study will be presented to Planning Board in mid-summer 2013 and City Council in the fall of 2013. WRAB acceptance of the study does not require board members to verify the analysis and calculations, but indicates the overall study process and results are reasonable and acceptable.

**STAFF RECOMMENDATION:**

Staff requests Water Resources Advisory Board consideration of this matter and action in the form of the following motion:

Motion to recommend that City Council adopt the Upper Goose Creek and Twomile Canyon Creek floodplain remapping study

**COUNCIL FILTER IMPACTS:**

- Economic: Flood insurance is required for properties located in the 100-year floodplain if they are financed by a federally-backed mortgage. Flood insurance rates are set by FEMA based on the flood risk. The average annual rate for flood insurance within the city in 2012 was \$733 (3,189 policies). Flood protection land use regulations also create costs for the property owners in the form of permit fees, increased costs of remodeling and restrictions on development. Flood insurance and land use regulations do, however, provide protection from potentially catastrophic losses due to floods.
- Environmental: Flood events can result in damage or destruction to buildings and corresponding release of man-made contaminants. Flood waters can also cause erosion and damage to areas of the natural environment that are not capable of conveying high-velocity stormwater. A flood mitigation study will be developed for Upper Goose Creek and Twomile Canyon Creek following adoption of the revised mapping. The updated mapping will provide a framework for the development of flood mitigation measures designed to reduce environmental damage that can be caused by a large flood event.
- Social: Floodplain mapping provides the basis for flood management by identifying the areas subject to flooding. This information is essential for determining areas where life safety is threatened and property damage is likely. Land use regulations help reduce risks to people and property in these high flood-risk areas. Accurate mapping of flood risks also helps implement effective flood preparedness and response programs, thereby increasing the safety of people living, working or visiting the City of Boulder.

**OTHER IMPACTS:**

- Fiscal: Funding for this study is provided by the Urban Drainage and Flood Control District and the Department of Public Works Utilities Division.
- Staff Time: Time for completing the study is included in existing work plans.

## **BOARD AND COMMISSION FEEDBACK:**

The Upper Goose Creek and Twomile Canyon Creek remapping study has not been brought to any Boards or Commissions prior to WRAB. Following input from WRAB, the mapping study will be presented to Planning Board in mid-summer 2013 and City Council in the fall of 2013.

## **PUBLIC FEEDBACK:**

A public open house was conducted on March 20, 2013. Sixty people attended the open house and the city received 11 written comments (**Attachment A**). Post cards were mailed to owners and residents of every parcel located within the existing and proposed 100-year floodplain notifying them of the proposed changes, specifics of the open house and the WRAB public hearing. In addition, letters were mailed to properties impacted by the high hazard zone, notifying them that the proposed flood mapping identifies their property as being impacted by the high hazard zone and indicating how to get more information to prepare themselves or their family for a flood event.

## **BACKGROUND:**

The risk of flash flooding is an important issue for the City of Boulder primarily due to its location at the mouth of Boulder Canyon and other canyon creeks. Approximately 13 percent of the city is located within the 100-year floodplains of Boulder Creek and its 14 tributaries. Nearly 2,600 individual structures are located within this flood zone.

The city has a comprehensive floodplain management program designed to identify and mitigate the risks of flooding, minimize loss of life and property damage, and support recovery following a major flood event. Major components of the city's floodplain management program include mapping, mitigation master planning and construction, property acquisition and flood protection through land use regulations and flood preparedness. The following provides a brief summary of each of the city's floodplain management program elements along with a summary of the National Flood Insurance Program. Additional information on the city's floodplain management program is presented in **Attachment B**.

### **Floodplain Mapping**

Floodplain mapping provides the basis for the city's floodplain management program by identifying the areas subject to flooding. Changes in land use, updated topographic mapping and upgrades to hydrologic and hydraulic models warrant periodic mapping updates. The city has recently updated or is in the process of updating all of its floodplain mapping. Current mapping studies include Upper Goose Creek and Twomile Canyon Creek, Skunk Creek, Boulder Slough, Kings Gulch and Bluebell Canyon Creek. The city delineates four flood zones:

- 1) 500-year floodplain
- 2) 100-year floodplain
- 3) Conveyance zone
- 4) High hazard zone

The 500-year floodplain delineates the flood limits resulting from a storm that has a 0.2 percent chance of occurring in any given year. The 100-year floodplain delineates the flood limits resulting from a storm that has a one percent chance of occurring in any given year (26 percent chance over a 30-year mortgage). The conveyance zone is defined as the areas in the floodplain that are reserved for the main passage of the entire 100-year flood flow when the 100-year floodplain is artificially narrowed until a maximum six-inch increase in flood water depth is created. This zone is delineated to allow development to occur up to the narrowed floodplain and still provide passage of 100-year storm flows. The high hazard zone defines the area of the floodplain where water depth and velocity pose a threat to life and safety. This area is delineated for areas in the floodplain where water velocity multiplied by water depth equals or exceeds the number four.

### **Flood Mitigation and Property Acquisitions**

Flood mitigation master planning is scheduled to follow each mapping study update. The following presents a schedule of upcoming flood mitigation studies:

- South Boulder Creek (in process)
- Boulder Creek (2014)
- Skunk Creek, Bluebell Canyon Creek and Kings Gulch (2015)
- Upper Goose Creek and Twomile Canyon Creek (2016)
- Boulder Slough (2018)

In addition to funding the planning and construction of flood mitigation projects, the Stormwater and Flood Management Utility Capital Improvement Program allocates \$500,000 each year for property acquisition. This provides funds for the purchase of properties in areas prone to flooding, especially in the city's high hazard regulatory area. The city has purchased 11 properties since 2001 and will continue to purchase properties as opportunities arise.

### **Flood Insurance and Regulations**

The National Flood Insurance Program (NFIP) was established in 1968 to enable property owners in participating communities to purchase flood insurance. Flood insurance through the NFIP provides coverage for loss up to \$250,000 for residential structures and \$500,000 for commercial properties. Flood insurance is required for structures located in the 100-year flood zone that have a federally-backed mortgage. Flood insurance is available for all properties within Boulder, whether or not they are located in the 100-year floodplain. While not mandated by law, a lender may also require a flood insurance policy as a condition of a loan for a property in any zone on a Flood Insurance Rate Map. The city does not require flood insurance but does encourage property owners to consider purchasing a policy. The average annual rate in 2012 for flood insurance within the city was \$733 (3,189 policies). This rate reflects a 20 percent discount based on the city's participation in the National Flood Insurance Program (NFIP) Community Rating System (CRS). The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premium rates are discounted five percent for every CRS class reduction. The city joined the CRS in 1992 as a Class 8 community,

improved to a Class 7 in 2008 and a Class 6 in 2012. The city was awarded a Class 5 in early 2013. As a result, policy holders will now receive a 25 percent discount on flood insurance with anticipated city-wide annual savings of over half a million dollars.

Floodplain regulations are land use regulations intended to reduce risks to people and property in areas along rivers and streams that are prone to flooding. A floodplain development permit is required for all development activities in the 100-year floodplain. Development within the 100-year floodplain is permitted, subject to the provision of flood protection measures to mitigate the risk of property loss or damage. The conveyance zone represents a preservation zone for passing flood flows along the creek corridor without increasing flood depths, redirecting flood waters or adversely impacting land areas. Proposed development must demonstrate that improvements will not result in a rise in the conveyance zone water surface. The high hazard zone is the area of the floodplain where there is the greatest risk of loss of life. Development in the high hazard zone is the most restricted due to life safety concerns. Regulations for the 100-year floodplain also apply in the high hazard zone and conveyance zone. It should be noted that the city does not currently regulate within the 500-year floodplain. A Critical Facilities Ordinance is, however, being drafted for board and Council consideration. The ordinance proposes regulations for critical facilities located in the 100- and 500-year floodplains. The city's current floodplain regulations can be reviewed using the following link: [Boulder Revised Code](#).

### **Flood Preparedness**

Flood preparedness is a critical element in the city's floodplain management program. The more prepared the community can be with pre-flood readiness, ongoing monitoring, effective warning systems, trained response, and post-flood recovery, the better chance the impacts of flooding can be managed. During the peak flood season, the Urban Drainage and Flood Control District (UDFCD) contracts to have 24-hour meteorologist coverage for the Denver metro area. The UDFCD meteorologists forward daily forecasts to the city and the Boulder Office of Emergency Management (Boulder OEM). The UDFCD also operates and maintains a network of stream and rainfall gauges in and around the city. This information provides real-time data that is monitored by city staff and the Boulder OEM during the flood season. Information relating to the city's flood risks and ways to prepare for flooding can be found on the city's website: [Boulder Flood Info](#).

### **ANALYSIS:**

The study area includes Upper Goose Creek and Twomile Canyon Creek west of Folsom Street. The area was last mapped in 1987 and updated in 1989 to include conveyance and high hazard delineations. While the land use has not changed significantly in the 25 years since the original mapping, the hydrologic and hydraulic modeling capabilities have changed dramatically. In addition, the city's topographic mapping has been updated to an increased accuracy that provides one-foot contours. The city hired ICON Engineering in 2011 to conduct an updated study. The study, co-funded by the Urban Drainage and Flood Control District (UFCD), was conducted in the following three phases:

1. Hydrologic analysis
2. Field survey and investigation
3. Hydraulic analysis

The following briefly summarizes each of these project phases along with a description of the peer review for the study. Additional background information for this study can be found on the project web site: [Upper Goose Creek and Twomile Canyon Creek Floodplain Mapping Update](#).

### **Hydrologic Analysis**

A hydrologic analysis was conducted in late 2011 using updated land use, topographic mapping and current modeling software. The updated analysis refined the area of land tributary to the study creeks, resulting in a slightly smaller watershed area (a portion of land located east of Broadway and north of Iris Avenue was determined to be tributary to Elmers Twomile Canyon Creek and therefore excluded from the study area). Results from the updated analysis were compared to the 1987 study results, regional regression equations and comparisons to similar Front Range drainage basins. The average 100-year peak flows from the updated hydrology are approximately two percent lower than those in the 1987 study. The hydrologic analysis was documented in a report that can be reviewed using the following link: [Hydrologic Verification Report](#).

### **Field Survey and Investigation**

ICON Engineering conducted a field survey in late 2011 to document existing conditions within the study area. This information was used to:

- Identify sizes and characteristics of existing culverts and other creek crossings
- Assign hydraulic model parameters (roughness coefficients, debris blockage values and contraction and expansion values)
- Collect select topographic survey information to supplement the one-foot contour mapping

The field investigation was documented in a report that can be reviewed using the following link: [Field Documentation Memorandum](#).

### **Hydraulic Analysis**

The 1987 floodplain maps show one major flow path along Twomile Canyon Creek. Findings from the field survey and documentation of historic flood events, however, indicated that even relatively minor storm events would cause Twomile Canyon Creek to overtop with flood waters flowing downstream along several paths. It was therefore decided early in the study process to develop two hydraulic models for the study area. A separate 2-dimensional model was developed for just Twomile Canyon Creek. This model served as a 'roadmap' for determining the major floodplain flow paths. A traditional 1-dimensional hydraulic model was then developed for the entire creek system (both Twomile Canyon Creek and Upper Goose Creek) with channel alignments mimicking the major flow paths identified by the 2-dimensional model. Floodplains were delineated for the 10-, 25-, 50-, 100-, and 500-year events. The hydraulic analysis was documented in a report that can be reviewed using the following link: [Hydraulic Report](#).

**Peer Review**

Anderson Consulting Engineers was hired to perform a peer review of ICON Engineers work. The peer review was conducted on the model parameters, hydrologic analysis, hydraulic modeling and proposed mapping delineations. Review comments were addressed by ICON Engineering and approved by the city and UDFCD.

**Results**

**Table 1** below presents a summary of the changes between the existing and proposed floodplains. The proposed updated floodplain mapping differs significantly from the previous mapping for Twomile Canyon Creek, but remains relatively similar for Upper Goose Creek. Unlike the original mapping that shows one flow path for Twomile Canyon Creek, the proposed mapping shows several flow paths. This new flow pattern results in shallower flooding and lower velocities. As a result, there are slightly more structures located in the 100-year floodplain, but fewer structures in the conveyance and high hazard zones. In addition, the conveyance zone impacts were reduced by maximizing the use of city-owned right-of-way to define this zone.

**Attachments C, D and E** present figures showing a comparison between existing and proposed 100-year floodplains, conveyance zones and high hazard zones for both creeks.

**Table 1: Summary of Proposed Changes**

Number of Structures	100-Year Floodplain	Conveyance Zone	High Hazard Zone
Existing Floodplain	414	154	66
Proposed Floodplain	433	109	31
Change	+19	-43	-35
No Longer Affected	258	105	62
Newly Affected	277	60	27
No Change	156	49	4

**NEXT STEPS:**

Following input from WRAB, the mapping study will be presented to Planning Board in mid-summer 2013 and City Council in the fall of 2013. If City Council adopts the study, the city will forward the mapping to FEMA for review and begin to regulate to the more restrictive of the existing and new mapping. Following formal adoption by FEMA, the city will regulate solely based on the new mapping. A finding from FEMA is anticipated in mid to late 2014.

**ATTACHMENTS:**

- A. Summary of Public Comments
- B. May 29, 2012 City Council Floodplain Management Study Session Memorandum
- C. Existing and Proposed 100-Year Floodplain
- D. Existing and Proposed Conveyance Zone
- E. Existing and Proposed High Hazard Zone

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

COMMENTS

I'd like <sup>request</sup> to have our  
House looked @ again regarding  
conveyance zone

1600 Alpine Ave

We are on the border and  
we hope to be removed from  
this if possible

Steve Silverman  
1600 Alpine Ave 80304  
bianci1969@gmail.com

see attached email response  
4/12/13

## **Bauer, Kurt**

---

**From:** Bauer, Kurt  
**Sent:** Friday, April 12, 2013 3:07 PM  
**To:** 'bianci1969@gmail.com'  
**Subject:** 1600 Alpine

Dear Mr. Silberman:

Thanks for attending the Upper Goose / Twomile Canyon Creek remapping study open house and providing comments. The structure located on 1600 Alpine was incorrectly shown on the open house graphic as still being located in the conveyance flood zone. The revised mapping indicates that the conveyance zone comes very close to, but does not include the structure. Sorry for the misrepresentation on the graphic.

Sincerely,

Kurt Bauer, P.E. C.F.M.  
Engineering Project Manager  
City of Boulder  
Public Works Department - Utilities Division  
P.O. Box 791  
Boulder, CO 80306  
303-441-4232  
[BauerK@bouldercolorado.gov](mailto:BauerK@bouldercolorado.gov)

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

COMMENTS

Thanks for providing information  
- felt a few of the experts had  
a bit of cavalier attitude  
towards the impact the new  
study has on some homeowners  
- this was disappointing!

Kurt Bauer with city was  
very helpful + informative.  
Thanks

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

**COMMENTS**

Thank you for doing this. Helpful  
to see maps, meet city personnel.

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

**COMMENTS**

Very Informative —

Thanks ;

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

COMMENTS

Nice presentation.

I'm now out of the 100 + 500 year flood plain. The value of my house has risen considerably.

I feel sorry for the home owner now newly in the flood plain.

Whose to say in the future with improved methods and data - who's in + who's out.

Seems not fair somehow.

Must be a better way, but, I'm afraid I don't have any answers.

I do feel that when it's time to collect on a flood claim - no one, the insurance company, Fed Govt, and Boulder will not step up and do the right thing.

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

**COMMENTS**

If mitigation is not the main incentive to remap then why remap?

Are the insurance companies driving the remapping?

It seems Iris Ave needs to have its storm sewer system optimized.

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

**COMMENTS**

1 line at 3135 Reppster St. From the proposal, we will  
be removed from the floodplain, which I totally support!

Thank you!

Robin Kovard

We all need to be notified when we are taken out of  
the floodplain

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

COMMENTS

I have lived across the street from  
Foothill Elem. school 44 years. Only once  
(about 25 yrs ago) - that I can recall,  
has the creek left its banks.

The school land it is a much higher  
elevation, & can't see how creek  
water would reach me.

Thank you

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

**COMMENTS**

Good format to  
display information

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

**COMMENTS**

Very helpful  
thanks!

Upper Goose Creek / Twomile Canyon Creek Remapping Study  
Open House Wednesday March 20, 2013

**COMMENTS**

I am Red-green  
colorblind.

Please put a hatch mark  
or other pattern to allow  
folks like me to see  
the difference between  
the red/green color  
coded items.

**TO:** Mayor and Members of City Council

**FROM:** Jane S. Brautigam, City Manager  
Paul J. Fetherston, Deputy City Manager  
Maureen Rait, Executive Director of Public Works  
Jeff Arthur, Director of Public Works for Utilities  
Bob Harberg, Utilities Engineering Project Management Coordinator  
Annie Noble, Greenways Coordinator  
Kurt Bauer, Engineering Project Manager  
Christie Coleman, Engineering Project Manager  
Katie Knapp, Floodplain & Wetlands Administrator

**DATE:** May 29, 2012

**SUBJECT:** Floodplain Management Study Session

## **I. PURPOSE**

The risk of flash flooding is an important issue for the City of Boulder primarily due to its location at the mouth of Boulder Canyon and other canyon creeks. The city has a comprehensive floodplain management program designed to mitigate the risks of flooding, minimize loss of life and property damage, and support recovery following a major flood event. City Council is regularly asked to take action on measures to support these efforts, including consideration of capital projects, floodplain mapping studies and ordinance changes. Some key projects scheduled for City Council consideration in the next year include updating mapping of the Boulder Creek floodplain, a mitigation plan for the South Boulder Creek floodplain, and additional regulations related to critical facilities. The purpose of this study session is to provide City Council with background on the city's flood risks and upcoming floodplain management agenda items. The study session will also provide an opportunity for council members to ask questions and provide input prior to formal consideration of those items.

## **II. QUESTIONS FOR COUNCIL:**

1. Does City Council have any questions about the city's flood risk or its existing floodplain regulations?
2. Does City Council have any questions about the city's proposed floodplain regulations involving critical facilities and mobile populations?
3. Does City Council have any questions about the Boulder Creek floodplain mapping study, South Boulder Creek mitigation study, or the planning effort for the civic center area?

### **III. BACKGROUND**

#### **Flood Risks**

Approximately 13 percent of the city is located within the 100-year floodplains of the 14 tributaries to Boulder Creek (Attachment A). Nearly 2,600 individual structures are located within this flood zone.

The greatest flash flood risk is generally considered to be between April 15 and Sept. 15, but flooding can occur at any time. Flash floods along the city's creeks can occur very quickly with little or no warning. The greatest threat is from thunderstorms that produce high intensity rainfall in short periods of time.

The city has had several major flood events in the past. In 1894, up to six inches of rain fell west of the city, resulting in 100-year event flows in Boulder Creek, extensive flooding up to one mile wide and the loss of one life. Boulder Creek flooded again in both 1914 and 1929. South Boulder Creek flooded in 1938 and again in 1969, causing extensive damage in Eldorado Springs and within the city limits.

The city has also had minor flood events in recent years. A flash flood event in 2007 along Bear Canyon Creek resulted in roadway overtopping at Table Mesa Drive. Fourmile Canyon Creek overtopped its banks in summer 2011, producing minor flooding within the city and greater flooding upstream in Boulder County.

On Sept. 6, 2010, a wildfire started that eventually burned nearly 6,200 acres of the steep, forested Fourmile Canyon area just west of Boulder. Approximately 60 percent of the area was severely or moderately burned. Approximately 80 percent of the burn area is located on land that is tributary to Fourmile Creek, which is a tributary to Boulder Creek (approximately two miles west of Boulder). Approximately 20 percent of the burn area is located in the Fourmile Canyon Creek watershed. Fourmile Canyon Creek flows through north Boulder and is also tributary to Boulder Creek, with a confluence downstream of the Boulder city limits.

As a result of the burn, there is an increased flood risk for approximately the next eight years along Boulder Creek and Fourmile Canyon Creek as vegetation gradually re-establishes. A hydrologic model has been developed for the burn area and calibrated based on the runoff observed from rainfall events in 2011. Based on this model, rainfall thresholds and inundation maps have been created to help identify flood threats to the city.

#### **Flood Emergency Preparedness**

Flood preparedness is a critical element in the city's floodplain management program. The more prepared the community can be with pre-flood readiness, ongoing monitoring, effective warning systems, trained response, and post-flood recovery, the better chance the impacts of flooding may be managed.

During the peak flood season, the Urban Drainage and Flood Control District (UDFCD) contracts to have 24-hour meteorologist coverage for the Denver metro area. The UDFCD meteorologists forward daily forecasts to the city and the Boulder Office of Emergency Management (Boulder OEM). The UDFCD also operates and maintains a network of stream and rainfall gauges in and around the city. This information provides real-time data that is monitored by city staff and the Boulder OEM during the flood season.

Due to the very short time frame in which flooding can occur, there is often limited time available to provide adequate warning. This is particularly true for some of the city's smaller creek systems, which lack stream gauges. In addition, thunderstorm cells can move and intensify very rapidly and often unpredictably. Flood education, regulations and ordinances are therefore critical components of the city's flood emergency preparedness program.

### **Floodplain Mapping Updates**

Floodplain mapping provides the basis for flood management by identifying the areas subject to flooding. This information is essential for determining areas where life safety is threatened and property damage is likely. The city's floodplain maps need to be periodically updated to reflect changes in the floodplain resulting from land development, flood mitigation improvements, new survey information and new study technologies. Floodplain mapping updates are currently being completed for Boulder Creek (see discussion in analysis section below) Skunk Creek, Boulder Slough, Kings Gulch, Bluebell Canyon Creek, Upper Goose Creek and Twomile Canyon Creek.

### **Flood Mitigation and Property Acquisition**

The city has been working to reduce the flood threat by increasing the conveyance capacity of the creek systems. The most recently-completed flood mitigation project was along Elmer's Twomile Creek. This project increased the capacity of the creek to convey 100-year flows, thereby reducing the flood risk and removing numerous structures from the 100-year floodplain designation. The city is currently designing a flood mitigation project along Wonderland Creek from Foothills Parkway to 30th Street and will begin design of the next upstream reach to 28th Street. The projects are based on a master flood mitigation plan for Fourmile Canyon Creek and Wonderland Creek that was accepted by City Council in 2009. The city has leveraged funding available through the State of Colorado and the UDFCD for these projects. A flood mitigation plan is also being developed for South Boulder Creek, as discussed in the Analysis section below.

In addition to funding the construction of flood mitigation projects, the Stormwater and Flood Management Utility Capital Improvement Program allocates \$500,000 each year for property acquisition. This provides funds for the purchase of properties in areas prone to flooding, especially in the city's high hazard regulatory area. High risk properties have been identified and prioritized for purchase along each of the city's major drainageways. This program has been "opportunity based," working with willing sellers and relying on properties that become available on the real estate market. The table below presents the properties that have been purchased using this fund over the past 11 years.

### Properties Acquired Using Pre-flood Property Acquisition Funds

Property Address	Stream	Year
3115 Iris Ave.	Wonderland Creek	2010
2727 Valmont Road	Elmer's Two-Mile Creek	2007
2400 Topaz St.	Fourmile Canyon Creek	2006
2490 Topaz St.	Fourmile Canyon Creek	2005
2435 Topaz St.	Fourmile Canyon Creek	2004
1228 17th St.	Boulder Creek	2004
1230 17th St.	Boulder Creek	2003
2650 13th St.	Goose Creek	2002
299 Arapahoe Ave.	Boulder Creek	2001

Significant flood mitigation improvements to Boulder Creek were implemented as part of a joint use project with the Boulder Valley School District. Thirteen multi-family structures (169 units) near Boulder High School were purchased. The structures were removed and the overbank area on the north side of the creek south of Arapahoe was excavated and graded to provide for additional flood conveyance and the construction of park and athletic fields. This work was completed in 1993.

#### **Floodplain Regulations**

Floodplain regulations are land use regulations intended to reduce risks to people and property in areas along rivers and streams that are prone to flooding. The City of Boulder adopted its first floodplain regulations in 1969, in response to flooding along the Front Range of Colorado.

The city's "Floodplain Regulations" are contained in Chapter 9-3-2, Boulder Revised Code (B.R.C.) 1981. Regulated flood areas are the: 1) 100-year floodplain 2) conveyance zone and 3) high hazard zone.

**100-year floodplain:** defined as all land areas subject to inundation by flood waters in a storm event having a one percent chance of being equaled or exceed in any given year.

A floodplain development permit is required for all development activities in the 100-year floodplain. Development within the 100-year floodplain is permitted, subject to the provision of flood protection measures to mitigate the risk of property loss or damage. In residential applications, this requires that the lowest floor of any new structure or addition be elevated above the flood protection elevation (which is two feet above the flood elevation). Basements are not permitted for residential structures.

In non-residential applications, the lowest floor of any new structure or addition must be elevated above the flood protection elevation or be flood proofed to ensure that the structure is watertight with walls substantially impermeable to the passage of flood waters below the protection elevation. Floodproofing of structures must be provided in an automatic manner and not require any human intervention to be effective. This is often accomplished through the use of flood gates that will automatically raise during a flooding event, such as the flood gates at the Municipal Building, the St. Julien or Alfalfa's.

New parking lots are not permitted in the 100-year floodplain where flood depths would exceed 18 inches, since automobiles are buoyant and become flood debris at these depths. Hazardous materials may not be stored below the flood protection elevation (except for existing gasoline storage tanks that were in place prior to 1989). Mobile homes placed after July 1, 1989, must be elevated on a permanent foundation, and new structures are to be oriented to minimize flood flow obstruction.

**Conveyance zone:** represents a preservation zone for passing flood flows along the creek corridor without increasing flood depths, redirecting flood waters or adversely impacting land areas. The establishment of a conveyance zone recognizes that development activities are expected to occur in the 100-year floodplain, but places a limit on these activities to prevent adverse impacts to the floodplain.

Development in the conveyance zone typically requires an analysis to ensure that flooding conditions are not worsened. Flood mitigation measures are sometimes required to offset the development and keep the floodplain from expanding or floodwaters from getting deeper. Regulations for the 100-year floodplain also apply to the conveyance zone. If the area is also located in the high hazard zone, then high hazard zone regulations apply.

**High hazard zone:** This area of the floodplain is where there is the greatest risk of loss of life. The area should not be occupied by people during a flooding event. The high hazard zone represents those areas in the 100-year floodplain where an unacceptably high hazard to human safety exists and where there is the potential for flood waters to sweep people off of their feet and wash them downstream.

Research was conducted to determine the flood depths and velocities that were most likely to sweep people off of their feet. As a result of the research, the high hazard zone is defined as all areas in the floodplain where the flood water velocity (feet per second) multiplied by the flood water depth (measured in feet) would equal or exceed four or where flood water depth alone would equal or exceed four feet. An example would be a flood depth of three feet with the water only moving 1½ feet per second, which would result in a product number of 4½, thus placing the area within the high hazard zone.

Development in the high hazard zone is most restricted due to life safety concerns. No new structures or additions to existing structures intended for human occupancy are permitted in the high hazard zone. It is anticipated that most of the structures within the

high hazard zone will require evacuation during a major flooding event due to structural failure or potential issues with fire, sanitation, electric hazards, broken utilities, or debris. Additionally, no new parking lots and no change of use of an existing non-residential structure to a residential use is permitted. Regulations for the 100-year floodplain also apply to the high hazard zone and conveyance zone.

### **Flood Insurance and the Community Rating System (CRS)**

***National Flood Insurance Program:*** The City of Boulder participates in the National Flood Insurance Program (NFIP) by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes Federal government-backed flood insurance available to homeowners, renters and business owners, whether or not their properties are in a floodplain. Flood insurance covers direct losses caused by surface flooding, including a river overflowing its banks, a lake or ocean storm, and local drainage problems. The NFIP insures buildings with two types of coverage: structural and contents. Structural coverage is for the walls, floors, insulation, furnace, and other items permanently attached to the structure.

***Mandatory Purchase Requirement:*** There is a mandatory flood insurance purchase requirement that applies to all forms of federal or federally-related financial assistance (such as mortgages) for buildings located in the 100-year floodplain. This requirement affects loans and grants for the purchase, construction, repair, or improvement of any publicly or privately owned building.

Before a person can receive a loan or other financial assistance from a federally-backed agency or lender, there must be a check to see if the building is in a Special Flood Hazard Area (SFHA). The SFHA is the base (100-year) floodplain mapped on a Flood Insurance Rate Map (FIRM).

If the building is in a SFHA, the agency or lender is required by law to require the recipient to purchase a flood insurance policy on the building. The requirement is for structural coverage equal to the amount of the loan (or other financial assistance) or the maximum amount available, whichever is less. The maximum amount available for a single-family house is \$250,000. While not mandated by law, a lender may also require a flood insurance policy as a condition of a loan for a property in any zone on a Flood Insurance Rate Map.

***The Community Rating System:*** The NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements.

As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from community actions that meet the three goals of the CRS:

1. Reduce flood losses;
2. Facilitate accurate insurance rating; and
3. Promote the awareness of flood insurance.

For CRS participating communities, flood insurance premium rates are discounted in increments of five percent; i.e., a Class 9 community would receive a five percent premium discount, while a Class 8 community would receive a 10 percent discount.

The CRS classes for local communities are based on 18 creditable activities, organized under four categories:

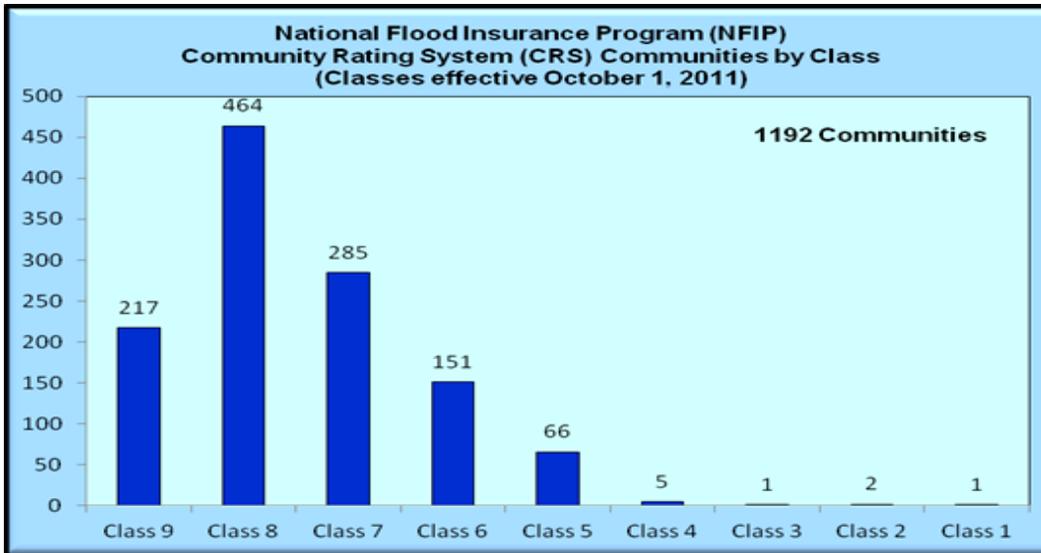
1. Public Information,
2. Mapping and Regulations,
3. Flood Damage Reduction, and
4. Flood Preparedness.

The City of Boulder joined the CRS in 1992 as a Class 8 community and improved to a Class 7 in 2008. In 2011, the city applied for additional CRS credit for the Multi-Hazard Mitigation Plan, floodplain mapping studies, community outreach, the flood warning program, stormwater management and other efforts. The city was notified in March 2012 that it had achieved enough credit to become a Class 6 rating, which provides a 20 percent discount on flood insurance premiums. This new rating is currently being processed through the NFIP. The NFIP also informed the city that it is close to becoming a Class 5 community. Public Works staff is currently pursuing different options to achieve enough CRS credit to become a Class 5 community.

The total annual savings on flood insurance premiums available through the CRS for property owners within the City of Boulder are shown below:

<b>Class</b>	<b>Discount</b>	<b>Total Annual Savings</b>
9	5%	\$117,953
8	10%	\$219,179
7	15%	\$320,407
<b>6</b>	<b>20%</b>	<b>\$438,359</b>
5	25%	\$539,585
4	30%	\$640,811
3	35%	\$742,038
2	40%	\$843,264
1	45%	\$944,490

Nationally, there are 1192 communities that currently participate in the CRS program. In Colorado, the City of Fort Collins (a Class 4 community) has the best CRS rating due to their floodplain management efforts. The graph below illustrates the ratings of the participating communities:



This year, FEMA is adopting a new CRS manual, which will change the way that communities are scored. Public Works staff is reviewing the program to determine how to achieve the best rating within the new system.

#### IV. ANALYSIS

##### **Proposed Critical Facilities and Mobile Populations Ordinance**

Recent and historical flood events have demonstrated that flood damage to certain critical facilities can significantly delay and increase the costs of flood recovery. By requiring protection of critical facilities, local governments can help support economic and social recovery and decrease the risk of deaths or injuries from flooding.

During a flood event, it will be critical for “essential services” like fire stations, police stations and hospitals to remain operational. The Hurricane Katrina disaster highlighted the threat to “at-risk populations” like child day care facilities, schools and nursing homes located in flood prone areas. In addition, appropriate flood response information should be available to people at hotels, theaters, restaurants and other “mobile population” facilities to help them understand what to do while an event is occurring. Finally, large stockpiles of hazardous materials should be contained in order to minimize environmental damage during a flood event. Protecting at-risk populations, essential services, hazardous materials and mobile populations increases the community’s ability to recover from flooding.

To begin addressing this issue, City Council endorsed the development of a critical facilities and mobile populations ordinance as part of its April 28, 2009, study session. The city’s 2004 Comprehensive Flood and Stormwater Master Plan and 2011 Multi-Hazard Mitigation Plan also call for identification and protection of critical facilities located in the city’s 500-year floodplain.

## **Public Engagement**

An open house was held on Aug. 24, 2010, to inform the public of the proposed ordinance and input was received on three initial proposed management strategies. Since then, staff has continued to engage stakeholders through a variety of methods, including the development of a project website, postcard invitations to public hearings, newspaper articles in the *Daily Camera*, emails to listserv subscribers, two meetings with the Local Emergency Planning Committee, a presentation to the Boulder Chamber's Community Affairs Council in October 2010, a February 2011 spot on "Controversy and Consensus" that aired on Channel 8, and phone calls to hazardous materials facility managers. Community feedback has been collected and is being considered as the city continues to refine the ordinance.

The Water Resources Advisory Board (WRAB) reviewed and provided input on the draft ordinance at its Jan. 20, 2011, and March 28, 2011, meetings. The WRAB voted 5-0 to recommend approval of the ordinance. The Planning Board reviewed the draft ordinance at its Aug. 4, 2011, meeting and voted to recommend approval of the ordinance in a 6-0 vote.

## **Proposed Ordinance Requirements**

The draft ordinance currently proposes requiring new flood protection measures for some facilities in the 500-year floodplain. It would also require some facility and business owners in the 500- and 100-year floodplains to develop emergency management plans.

The concept of protecting critical facilities and mobile populations is based on direction from the NFIP's Community Rating System (CRS). The CRS recommends the protection of critical facilities in the 500-year floodplain to reduce damage to those facilities that, in turn, will improve a local government's ability to respond to the needs of the community during a disaster. Other Front Range communities have implemented this concept. In 1995, the City of Fort Collins implemented regulations to protect critical facilities in the 500-year floodplain of the Poudre River.

### Proposed Structural Flood Protection Requirements:

Structural flood protection measures either elevate a building above flood levels or protect the structure from the impacts of flood waters.

- New and existing at-risk populations and essential service sites in the 500-year floodplain would be required to floodproof or elevate the building above floodwaters when building new structures or making significant increases in the building's value or size.
- New and existing hazardous materials facilities in the 500-year floodplain would be required to contain the hazardous materials, floodproof or elevate the buildings within 10 years of building a new structure, proposing improvements leading to a significant increase in the building's value, or completing floodplain related improvements.
- In the 100-year floodplain, no new structural flood protection measures are currently proposed.

Proposed Emergency Management Plan Requirements:

Emergency management plans would need to include either a shelter-in-place plan or an evacuation plan for employees, patrons and residents. Evacuation routes or sheltering locations would have to be posted in the buildings (similar to a fire exit route map in hotels).

New and existing at-risk populations, essential services, mobile populations, and hazardous materials sites in the 100 or 500-year floodplain would be required to develop an emergency plan within 10 years of building a new structure, increasing the size of a building, completing a floodplain related improvement, or proposing improvements leading to a significant increase in the building’s value.

A summary of the proposed ordinance requirements is presented below:

**Proposed Ordinance Requirements**

	<b>100-Year Floodplain</b>	<b>500-Year Floodplain</b>
<b>Essential Service Facilities</b>	Emergency Management Plan	Structural Flood Protection & Emergency Management Plan
<i>Examples: Police and Fire Stations, Hospitals, Utilities, Emergency Shelters</i>		
<i>Number of Facilities</i>		
<b>At-Risk Populations Facilities</b>	Emergency Management Plan	Structural Flood Protection & Emergency Management Plan
<i>Examples: Schools, Childcare Centers, Nursing Homes</i>		
<i>Number of Facilities</i>		
<b>Hazardous Materials Facilities</b>	Emergency Management Plan	Contain Hazardous Materials & Emergency Management Plan
<i>Examples: Large pharmaceutical Plants, Utilities</i>		
<i>Number of Facilities</i>		
<b>Mobile Populations Facilities</b>	Emergency Management Plan	Emergency Management Plan
<i>Examples: Hotels, Theaters, Restaurants</i>		
<i>Number of Facilities</i>		

Staff is continuing to work with affected property owners and other community stakeholders to incorporate additional feedback into the proposed ordinance provisions. This is expected to come to City Council for further consideration in the fourth quarter of 2012.

## **Boulder Creek Floodplain Mapping Update**

An engineering evaluation for the Boulder Creek floodplain mapping update has been completed and the proposed floodplain mapping is being presented through a series of public meetings. The Boulder Creek study area extends from approximately three-quarters of a mile east of 61<sup>st</sup> Street upstream to the mouth of Boulder Canyon, west of Boulder's city limits.

In a comparison of the proposed mapping to the existing floodplain mapping, 107 buildings will no longer be identified as in the 100-year floodplain; 72 buildings will be newly identified as being in the floodplain; and there will be no change in the status of 574 buildings already identified as in the floodplain. The draft study results can be viewed in the [Study Results - Impacts to Structures](#) section of the [Boulder Creek Floodplain Mapping Study](#) webpage.

The new study represents the best available information and is superior to the existing information used for regulatory and insurance purposes. The study results were formally considered by the Water Resources Advisory Board (WRAB), which voted 4-0 to recommend approval on Feb. 27, 2012 (one member absent), and Planning Board, which voted 4-0 (3 members absent) to recommend approval on March 15, 2012.

Staff is currently working with Boulder County staff and property owners located outside of the city limits to evaluate information regarding the proposed flood hazard zone designations. Staff will work to determine if alternative flood hazard zone designations are appropriate. If agreement cannot be reached, then staff would recommend that the flood mapping be truncated at or near the city limits, allowing Boulder County to contend with flood mapping issues within their jurisdiction and providing for the timely processing of the updated mapping within the city's jurisdiction. This approach was supported by the Planning Board as part of their March 15, 2012, motion to recommend approval of the study.

The mapping update is expected to be presented to City Council in June or July 2012. If City Council adopts the new floodplain study results, the updated maps would then be submitted to the Federal Emergency Management Agency (FEMA) for review and adoption. During the FEMA review period, the city would use the more restrictive of the existing and proposed mapping in the regulation of all annexations and development proposals. If approved, the new floodplain maps would form the basis of the Flood Insurance Rate Map (FIRM) along Boulder Creek. The proposed flood maps would also provide the basis for land use permit applications and flood insurance requirements for properties impacted by the 100-year flood. Study results may also provide the basis for land use and building permits in the 500-year floodplain if City Council adopts a critical facilities ordinance.

### **South Boulder Creek Flood Mitigation Plan**

A flood mitigation plan is currently being prepared for South Boulder Creek. South Boulder Creek overtops U.S. 36 near Table Mesa Drive during major storm events. A risk assessment estimates over \$200 million in damages would result should a 100-year event occur along South Boulder Creek. The study has identified five alternatives through an extensive evaluation and public process. These five alternatives have been refined and a recommendation will be developed. It is anticipated the recommendation will be presented to the public and to the Water Resources Advisory Board later this year prior to City Council consideration in late 2012 or early 2013.

### **Civic Center Plan**

The Civic Center Plan project will develop a comprehensive vision for the area from 9<sup>th</sup> to 17<sup>th</sup> streets and Canyon Boulevard to Arapahoe Avenue. The plan will guide future land use decisions and develop an urban design vision for public and private property. A [Civic Center Plan Study Session](#) packet was recently presented to the council on April 10, 2012.

The planning area is located in the Boulder Creek 100-year floodplain. Additionally, most of the study area west of Broadway is also located in the Conveyance and High Hazard Zones. As part of the Civic Center Plan process, an engineering analysis was undertaken to develop and evaluate potential mitigation measures, which could reduce the extent of the flood hazard areas. Flood hazard mitigation scenarios are available in Attachment 1 of Attachment A of the April 10, 2012, study session packet.

The analysis assumes that large scale excavation or channelization of Boulder Creek and the surrounding riparian environment would not be used to reduce flood hazards in the Civic Center area and that no new structures intended for human occupancy and parking would be located in the high hazard zone. New development would be considered within the conveyance zone and 100-year floodplain, provided it meets existing flood regulatory requirements.

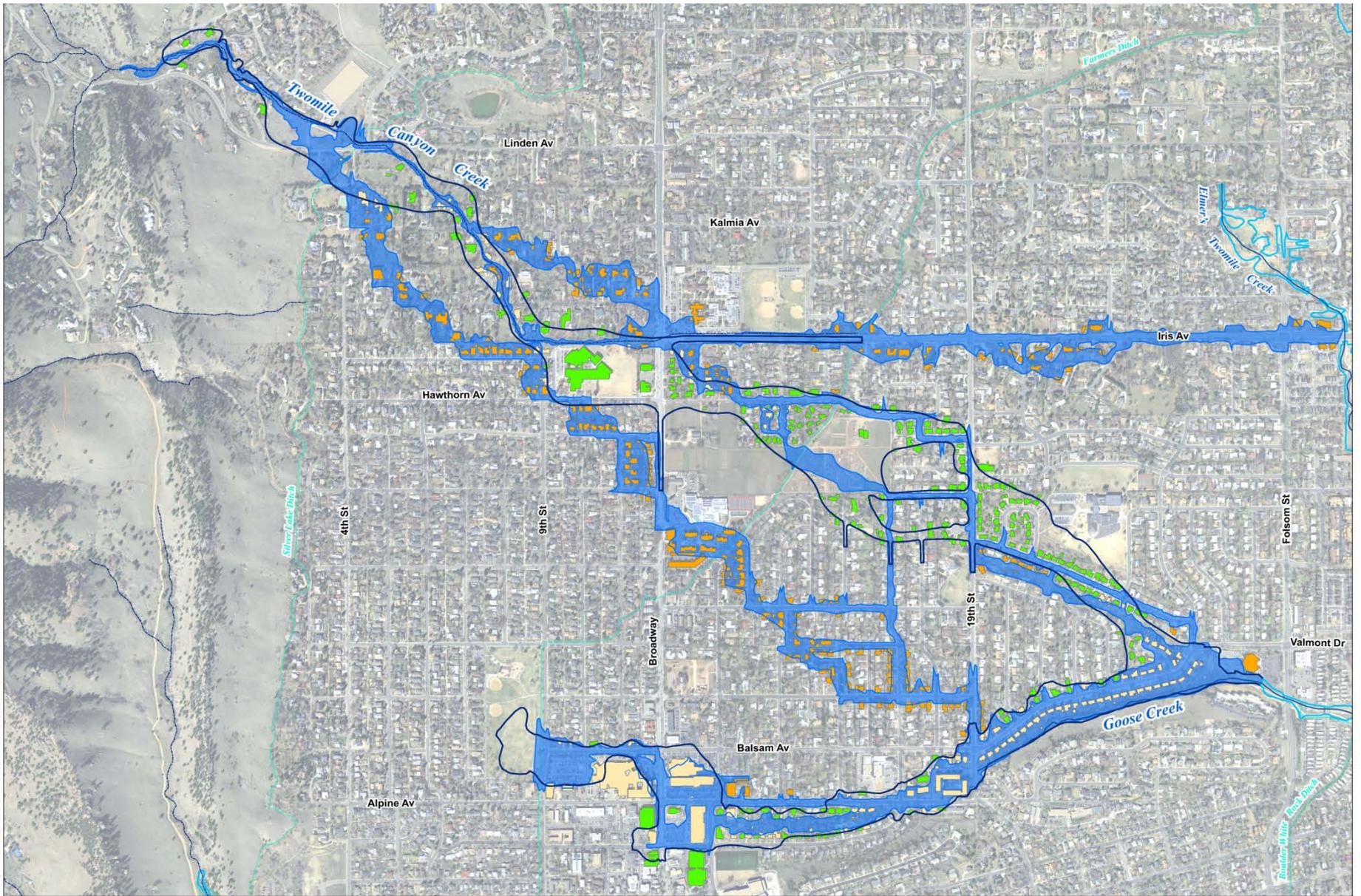
The analysis also considers existing critical facilities located within the flood hazard areas mentioned above. The proposed critical facilities and mobile populations ordinance will not have a dramatic affect on the Civic Center planning since the area is located within flood hazard areas (100-year floodplain, conveyance and high hazard zones) already regulated by the city. The only affect of the proposed ordinance requirements in this area would be that critical facilities and mobile populations facilities would be required to develop emergency management plans that include either a shelter-in-place plan or an evacuation plan for employees, patrons and residents.

Additional discussion of Civic Center flood hazard issues may occur at the June 12, 2012 study session.

## **V. NEXT STEPS**

Depending on feedback provided by City Council during the study session, possible next steps include the scheduling of public hearings and City Council consideration of the following:

1. Floodplain regulation amendments addressing flood hazard issues related to critical facilities and mobile populations; (3<sup>rd</sup> quarter 2012)
2. Updated information regarding Boulder Creek flood mapping; (3<sup>rd</sup> quarter 2012)
3. South Boulder Creek flood mitigation planning and alternatives analysis (4<sup>th</sup> quarter 2012 or 2013)
4. Additional analysis of Civic Center flood hazard issues and potential mitigation measures for plan options (late 2012 or 2013).



**Legend**

Proposed Twomile Canyon & Upper Goose Creek 100 Year Floodplain	Buildings Added to the 100 Year Floodplain (277)	Creek
Effective Twomile Canyon & Upper Goose Creek 100 Year Floodplain	Buildings Remaining in the 100 Year Floodplain (156)	Intermittent Creek
Other Effective 100 Year Floodplain	Buildings Removed from the 100 Year Floodplain (258)	Ditch

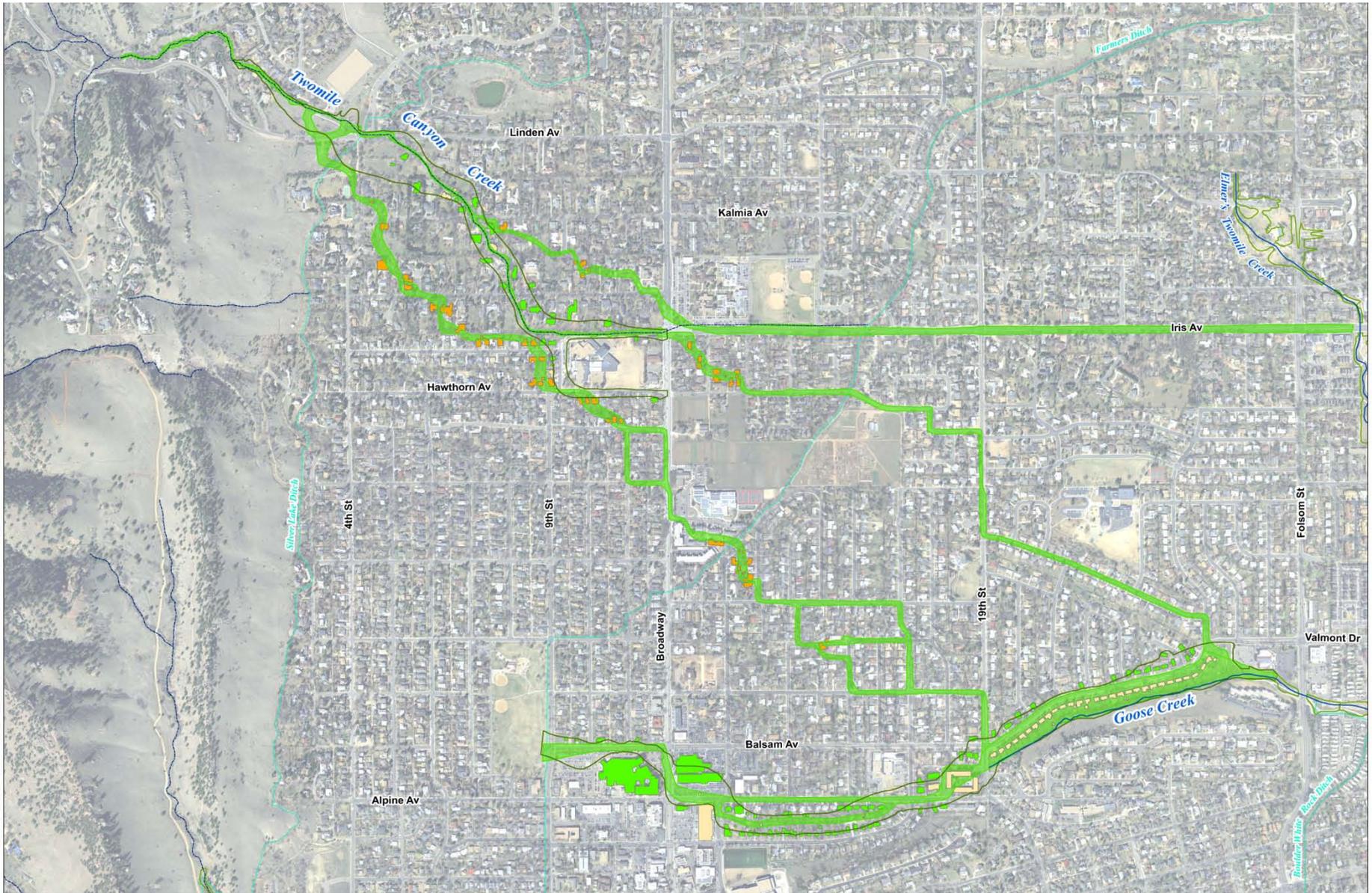
0 250 500 1,000 1,500 2,000 2,500 Feet

1:3,200

The information depicted on this map 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 herein.

**Twomile Canyon & Upper Goose Creek**  
*Structures Affected by Proposed 100 Year Floodplain*

# Attachment D: Existing and Proposed Conveyance Zone



<b>Legend</b>	 Proposed Twomile Canyon & Upper Goose Creek Conveyance Flood Zone	 Buildings Added to the Conveyance Flood Zone (60)	 Creek
	 Effective Twomile Canyon & Upper Goose Creek Conveyance Flood Zone	 Buildings Remaining in the Conveyance Flood Zone (49)	 Intermittent Creek
	 Other Effective Twomile Canyon & Upper Goose Creek Conveyance Flood Zone	 Buildings Removed from the Conveyance Flood Zone (105)	 Ditch





0 250 500 1,000 1,500 2,000 2,500 Feet

1:3,200

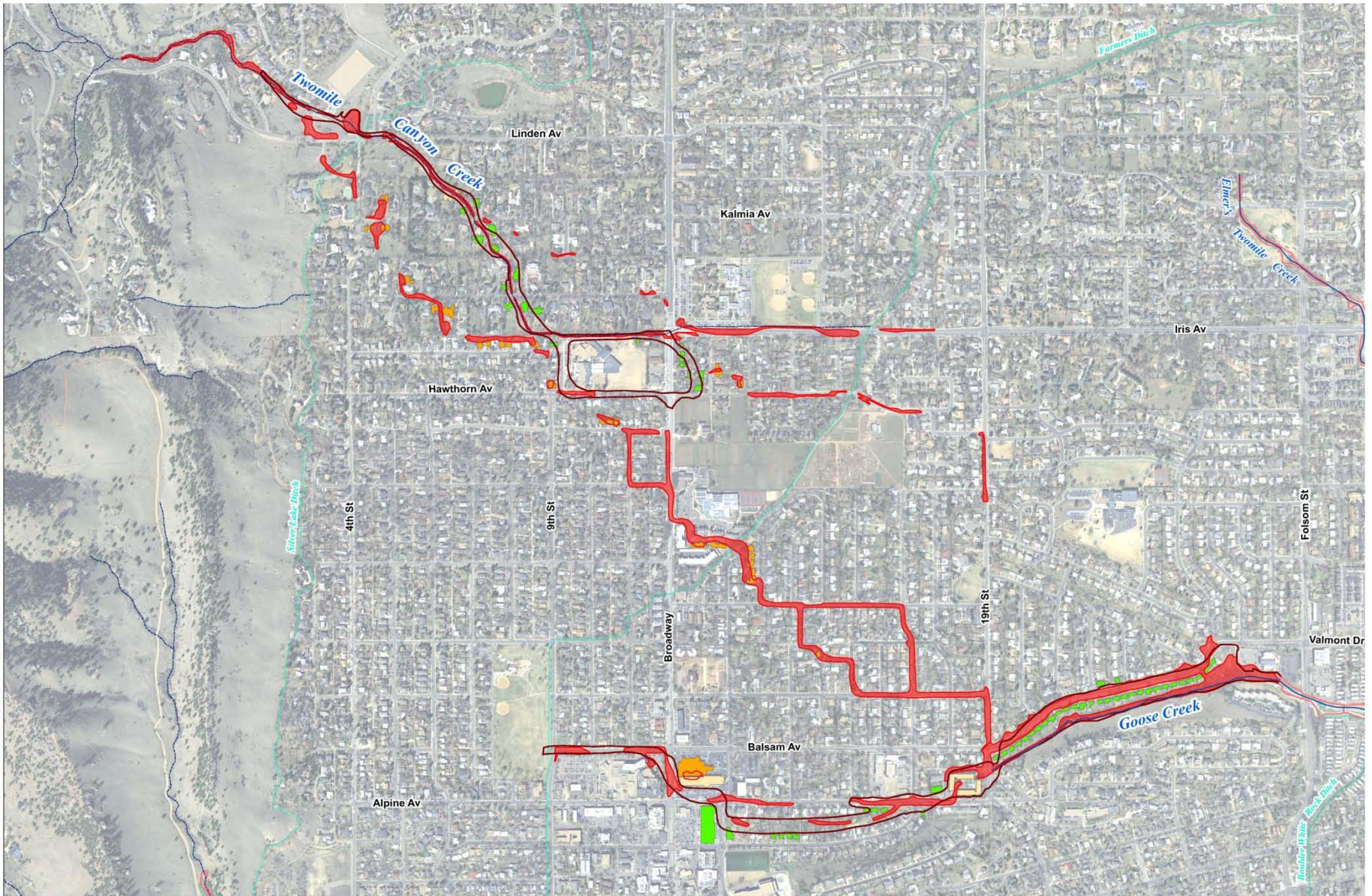


The information depicted on this map is provided as graphical representation only. The City of Boulder provides no warranty, expressed or implied, as to the accuracy and/or completeness of the information contained herein.

## Twomile Canyon & Upper Goose Creek

### Structures Affected by Proposed Conveyance Flood Zone

# Attachment E: Existing and Proposed High Hazard Zone



<b>Legend</b>	 Proposed Twomile Canyon & Upper Goose Creek High Hazard Flood Zone	 Buildings Added to the High Hazard Flood Zone (27)	 Creek
	 Effective Twomile Canyon & Upper Goose Creek High Hazard Flood Zone	 Buildings Remaining in the High Hazard Flood Zone (4)	 Intermittent Creek
	 Other Effective High Hazard Flood Zone	 Buildings Removed from the High Hazard Flood Zone (62)	 Ditch





0 250 500 1,000 1,500 2,000 2,500 Feet

1:3,200



The information depicted on this map 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 herein.

## Twomile Canyon & Upper Goose Creek Structures Affected by Proposed High Hazard Flood Zone