C I T Y OF B O U L D E R
WATER RESOURCES ADVISORY BOARD
AGENDA ITEM

MEETING DATE: November 21, 2016

AGENDA TITLE: Information Item - Skunk Creek, Bluebell Creek and King's Gulch Floodplain Mapping Update

PRESENTER/S:
Jeff Arthur, Director of Public Works for Utilities
Annie Noble, Acting Principal Engineer for Flood and Greenways
Katie Knapp, Engineering Project Manager

EXECUTIVE SUMMARY

The purpose of this memorandum is to provide a general summary of the history and preliminary results of the Skunk Creek Floodplain Mapping Update.

The Skunk Creek Floodplain Mapping Update includes the King's Gulch, Skunk and Bluebell Canyon Creek floodplains between the western city limits to east of Foothills Parkway where Skunk Creek confluences into Bear Canyon Creek as shown below.

Engineering consultants provided hydrologic and hydraulic modeling to update the floodplain mapping and predicted water surface elevations. The existing and proposed floodplain mapping is illustrated in **Attachment A**.

Flood mapping provides the basis for FEMA's National Flood Insurance Program (NFIP) flood insurance requirements and is also used to regulate development. Flooding areas with less than 1-foot depths (shallow, 100-year floodplain areas) are generally mapped as

500-year floodplain areas, which have limited regulatory restrictions and no flood insurance requirements. The City has the option of mapping these areas as a 100-year floodplain for regulatory purposes, but maintaining the Zone X (shaded) designation on FEMA's map therefore not triggering the requirement for flood insurance. WRAB feedback is requested on this option.

Following input from the public and the WRAB, the mapping study will be finalized and presented at a future WRAB meeting with a request for a motion. The WRAB review of the floodplain mapping update does not require board members to verify the analysis and calculations, but accepts the overall mapping study process and that results are reasonable and acceptable.

BOARD AND COMMISSION FEEDBACK

The Skunk Creek, Bluebell Canyon Creek and King's Gulch floodplain mapping study was first presented to the WRAB as an information item on August 18, 2014. The board requested that staff continue to work with the public to inform them about the proposed floodplain mapping and address comments and concerns. It was also requested that information about FEMA's Letter of Map Amendment (LOMA) process be made available on the city's website. Staff continued to work with the public and will continue to send out notification letters and postcards for the mapping update. Information about FEMA's LOMA process was also included on the project website and on the city's general website about floodplain mapping.

Revised floodplain mapping was then presented to the WRAB on September 15, 2014. At the time of the WRAB meeting, additional refinements were being done to the mapping because some of the mapping results did not correlate well with observations from the September 2013 flood event. WRAB recommended that an additional peer review be conducted for the work that was completed by ICON Engineering.

A second peer review was completed in January, 2015 by a third party consultant, Anderson Consulting Engineers, Inc. The peer review highlighted some spill areas to study in more detail. Revised floodplain mapping was presented to the WRAB on May 18, 2015. There were still unresolved questions about some of the mapping results. Further analysis resulted in identifying errors in the hydrology used for the study. Therefore, the mapping study was revised starting with a new hydrologic analysis.

PUBLIC FEEDBACK

Public notification post cards about the mapping update have been sent to all property owners in the study area and a project web site has been developed to provide information (https://bouldercolorado.gov/water/skunk-creek-floodplain-mapping-update).

An open house was held on August 18, 2014 immediately prior to the WRAB meeting to inform the public about the mapping update and hear comments and concerns about the study. Public comments were also received at the September 15, 2014 and May 18, 2015 WRAB meetings. Staff has met with residents in person and responded to phone calls and emails. In general, most of the comments and questions have been about impacts to

specific properties and requests for more detailed information such as proposed base flood water elevations. There were also concerns about the high hazard zone delineations and the distribution of the Bluebell Canyon Creek split flow paths downstream of 15th Street. A summary of past public feedback is provided in **Attachment C**.

An open house meeting is being held immediately prior to this WRAB meeting to inform the public about the revisions to the mapping update. A summary of public input gathered at the open house will be provided at a future WRAB meeting.

BACKGROUND

The city has a comprehensive floodplain management program designed to identify flood risks, mitigate the risks of flooding, and support community recovery following a major flood. For additional information about the city's floodplain management program, floodplain regulations and flood insurance, read the Flood Management Program Overview.

Floodplain mapping provides the basis for flood management by identifying the areas subject to the greatest risk of flooding. This information is essential for determining areas where life safety is threatened and property damage is likely and is the basis for floodplain regulations and the National Flood Insurance Program (NFIP). The city's floodplain maps need to be periodically updated to reflect changes in the floodplain resulting from land development, flood mitigation improvements, new topographic mapping information and new mapping study technologies.

The city delineates four flood zones:

500-year floodplain: 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.

100-year floodplain: The 100-year floodplain delineates the flood limits resulting from a storm that has a one percent chance of occurring in any given year.

Conveyance zone: 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.

High hazard zone: The high hazard zone defines the area of the floodplain where water depth and velocity pose the greatest threat to life and safety. This area is delineated for areas in the floodplain where water depths are four feet or greater or where the water velocity (feet per second) multiplied by water depth (feet) equals or exceeds the number four.

Skunk Creek, Bluebell Canyon Creek, and Kings Gulch were first studied in 1987 by the consulting firm Greenhorne & O'Mara and the resulting Flood Hazard Area Delineation

(FHAD) report included the delineation of the 100-year floodplain along these creeks. The Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) approved for these creeks were originally based on the 1987 FHAD and included a federally-regulated one foot rise floodway. Since that time, both the City of Boulder and the State of Colorado have adopted a ½ foot rise floodway, which the City refers to as the Conveyance Zone.

In 1989, Love and Associates delineated the High Hazard Zone and City of Boulder Conveyance Zone (½ foot rise floodway). The delineations were based on the hydraulic models used in the 1987 FHAD.

On May 6, 1991, FEMA issued a Letter of Map Revision (LOMR) for Skunk Creek to incorporate the results of a channel improvement project. The limit of the LOMR was in the University of Colorado's Research Park, downstream of Colorado Avenue to just upstream of the confluence of Boulder Creek.

Several road-crossing structures for Skunk Creek have been improved since 1991: culverts at Broadway and at 27th Way, crossings at Anderson Ditch and the cemetery maintenance road, and the low water crossing upstream of 27th Way. These improvements are being incorporated into the current mapping study.

The City initially contracted with Belt Collins to develop the updated floodplain maps but they closed their Boulder office in 2013. ICON Engineering provided a peer review of Belt Collin's 2011 initial study and was selected to complete the project, using the floodplain models developed by Belt Collins, which used 2003 aerial topography and supplemental ground survey.

In 2013, the city acquired state-of-the-art Light Detection and Ranging (LiDAR) technology to produce high-resolution topographic mapping. The new LiDAR mapping was compared to the 2003 topographic base mapping and areas showing substantial differences were updated in the hydraulic models.

In September 2013, major flooding occurred within the study area. The flood resulted in creeks overtopping and spill flows. A 2-dimensional (2D) hydraulic model was completed to assess the differences between the draft floodplain mapping and the 2013 flood observations. This 2D analysis was used to refine primary flow paths and split flow areas used in the conventional 1-dimensional hydraulic model. In December, 2014, Anderson Consulting Engineers was selected to complete a peer review of the draft floodplain mapping study completed by ICON Engineering. The additional peer review was completed and among other things, recommended that the spill flows north across Baseline Road from Bluebell Canyon Creek, and spill flows north east across US Highway 36 from Skunk Creek be explored further and documented with the floodplain mapping update. Additional review and analysis resulted in questions about the hydrology of the watershed, so a new hydrologic evaluation was initiated.

ANALYSIS

This mapping study updates the hydrologic and hydraulic models and flood hazard mapping for the 500-year floodplain, 100-year floodplain, Conveyance and High Hazard Zones for Skunk Creek, including the King's Gulch, and Bluebell Canyon Creek tributaries.

The revised mapping presented in this memorandum includes several spill flows and is different than the mapping presented in 2014 as it is now based on a new hydrologic model, a 2D analysis developed from LiDAR topographic mapping data, and information collected before and after the September 2013 flood event.

The hydrologic model for the watershed was developed through an iterative process using CUHP, FLO-2D and SWMM computer programs. First, CUHP was used to determine sub-basin runoff hydrographs for the full range of effective discharges at various design points. Second, sub-basin hydrographs were converted to a steady state condition and routed though the project area using FLO-2D to identify watershed flow patterns and areas of split flows diverting to and from the major flow paths. This FLO-2D model was used to develop diversion rating curves for the major split flow locations which were then numerically incorporated into SWMM to establish peak flows along major tributaries. Finally, the resulting flows from SWMM were incorporated into the FLO-2D model to establish main channel and split flow discharges for the reaches that were selected for detailed floodplain modeling. The hydrologic analysis was peer reviewed by the Urban Drainage and Flood Control District (UDFCD) prior to the development of the detailed hydraulic models.

Utilizing the FLO-2D model results, flow paths were selected for detailed hydraulic modeling based on flow concentration locations with depths, on average, of greater than 1-foot for the 100-year floodplain. Discharges for detailed study reaches were taken directly from applicable cross sections in the FLO-2D model. This modeling was also submitted to the UDFCD for a peer review. The peer review comments have all been addressed and the mapping will be resubmitted for concurrence after incorporating comments received from the public and the WRAB.

Attachments A includes figures showing a comparison between existing and proposed floodplain mapping. A summary of how these changes impact existing structures is included in **Attachment B**.

Flooding areas with less than 1-foot depths (shallow, 100-year floodplain areas) are generally mapped to be consistent with the FEMA, non-regulatory Zone X (shaded) mapping zones and are therefore mapped as 500-year floodplain areas on the city's maps. For this study, these areas have been highlighted for further consideration, since shallow flooding can cause significant damage to basements and those damages are not typically covered by flood insurance. The City has the option of mapping these shallow flooding areas as 100-year floodplain for regulatory purposes and is requesting WRAB feedback on this option. If the shallow100-year areas are included in the 100-year floodplain for regulatory purposes, future improvements would be required to be elevated or floodproofed and basements would not be permitted in residential structures, reducing the

flood risk of newly built structures in these areas. The FEMA flood zone would be Zone X (shaded) for either option, so flood insurance would not be mandatory for these areas, and would be available at a reduced rate (preferred risk policy). A total of 43 parcels, 51 structures and 70 dwelling units are included in these areas. The two options are outlined in the following table:

Shallow 100-Year Floodplain Areas

	Option 1	**Option 2**
City Flood Zone	500-Year	100-Year
City Regulations	Flood protection and emergency management plans required for Critical Facilities only	100-year Floodplain regulations apply: - No new residential basements (elevate to flood protection elevation) - Floodproofing/Elevation required for non-residential structures - Sewer back-flow prevention required
Structures within the new 100-Year Floodplain	143	194
FEMA Flood Zone	Zone X (shaded)	Zone X (shaded)
Mandatory Flood Insurance	No	No

NEXT STEPS:

Following input from the public and the WRAB, the mapping will be finalized and presented to the WRAB with a request for a motion to recommend approval of the new floodplain mapping.

The WRAB review of the floodplain mapping update does not require board members to verify analysis and calculations, but indicates the overall mapping study process and results are reasonable and acceptable.

Following a recommendation from the WRAB, the mapping revisions will be considered by City Council. If City Council approves the map revisions, the city will submit a request to FEMA for review. During the FEMA review and approval process it is recommended that the new mapping be used for regulatory purposes by regulating to the more restrictive of the existing and proposed mapping. This would mean that development within the newly identified flood zones would be subject to the city floodplain regulations. In order to comply with FEMA requirements, development within the areas that are being removed from the floodplain would still be subject to the city's floodplain regulations until FEMA officially adopts the new floodplain mapping. Following formal adoption by FEMA, the city would regulate solely based on the new mapping.

ATTACHMENTS

A. Existing and Proposed Floodplain Mapping
B. Summary of Impacts to Existing Structures
C. Summary of Public Comments

*Zone X 100-Year designation is shallow flooding in the 100-year floodplain. Structures in this designation may be mapped as City 100-year floodplain for regulatory purposes and Zone X Shaded for FEMA flood insurance purposes.

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 hereon.

Legend

- Skunk Creek AE Zone
- Skunk Creek AO Zone 1-ft
- Skunk Creek AO Zone 2-ft
- Skunk Creek Zone X 100-Year
- Structure Added
- Structure Unchanged
- Structure Removed
- Zone X (100Year) *see note
- Effective 100 Year Floodplain
- Creek
- City Limits
- LOMC

Skunk Creek

Proposed 100 Year Floodplain Compared to FEMA Effective

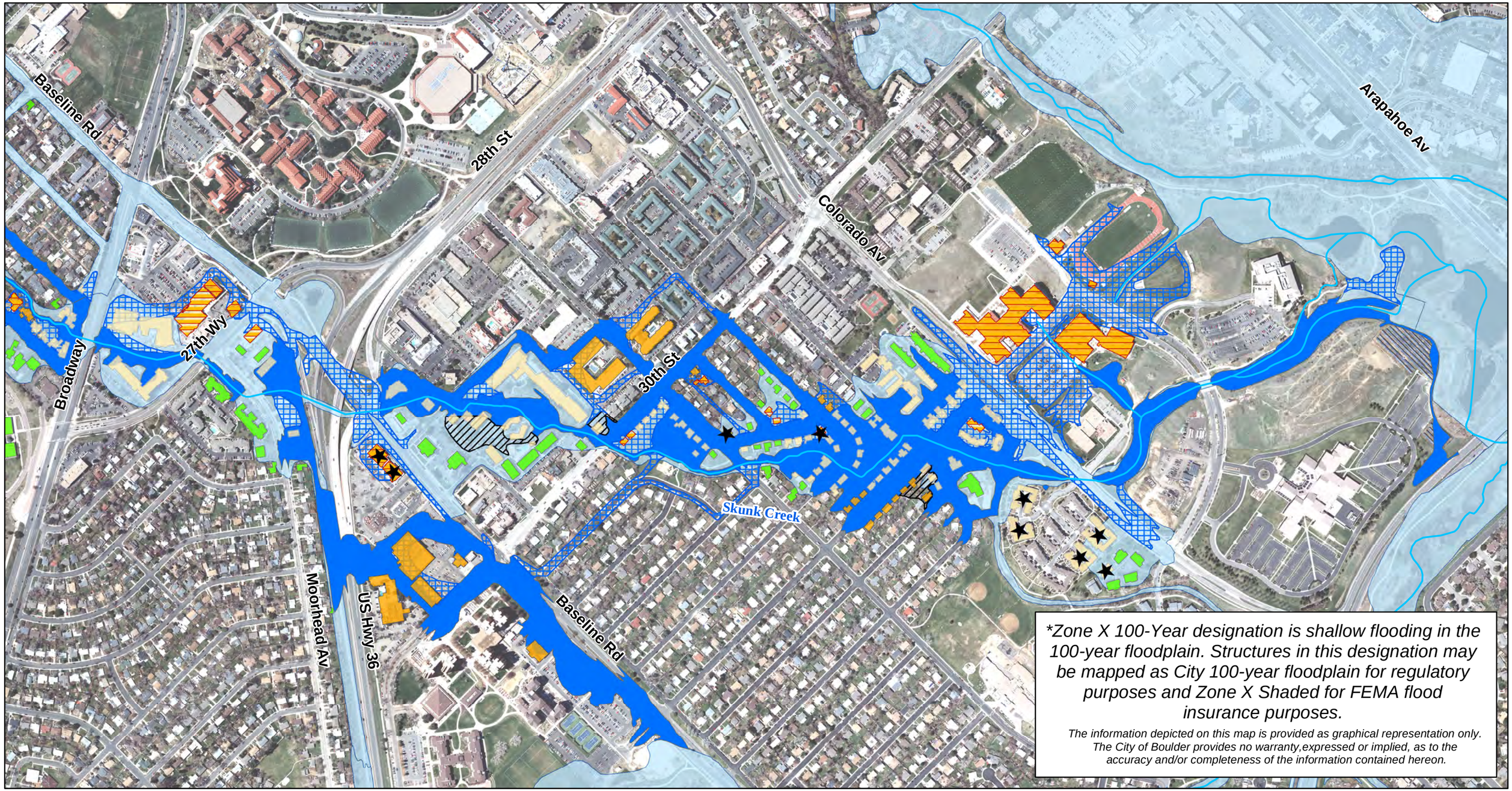
Map 1 of 2

0 250 500 1,000 1,500 Feet

N

Utilities Division

Rev: 11/10/2016



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- Effective 100 Year Floodplain
- Creek
- City Limits
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Skunk Creek

Proposed 100 Year Floodplain Compared to FEMA Effective

Map 2 of 2

0 250 500 1,000 1,500 Feet

Utilities Division

Rev: 11/10/2016

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Legend

- Effective Conveyance Zone
- Proposed Skunk Creek Conveyance Zone
- Structure Added
- Structure Unchanged
- Structure Removed
- Creek
- City Limits

Skunk Creek

Proposed Conveyance Zone Compared to FEMA Effective

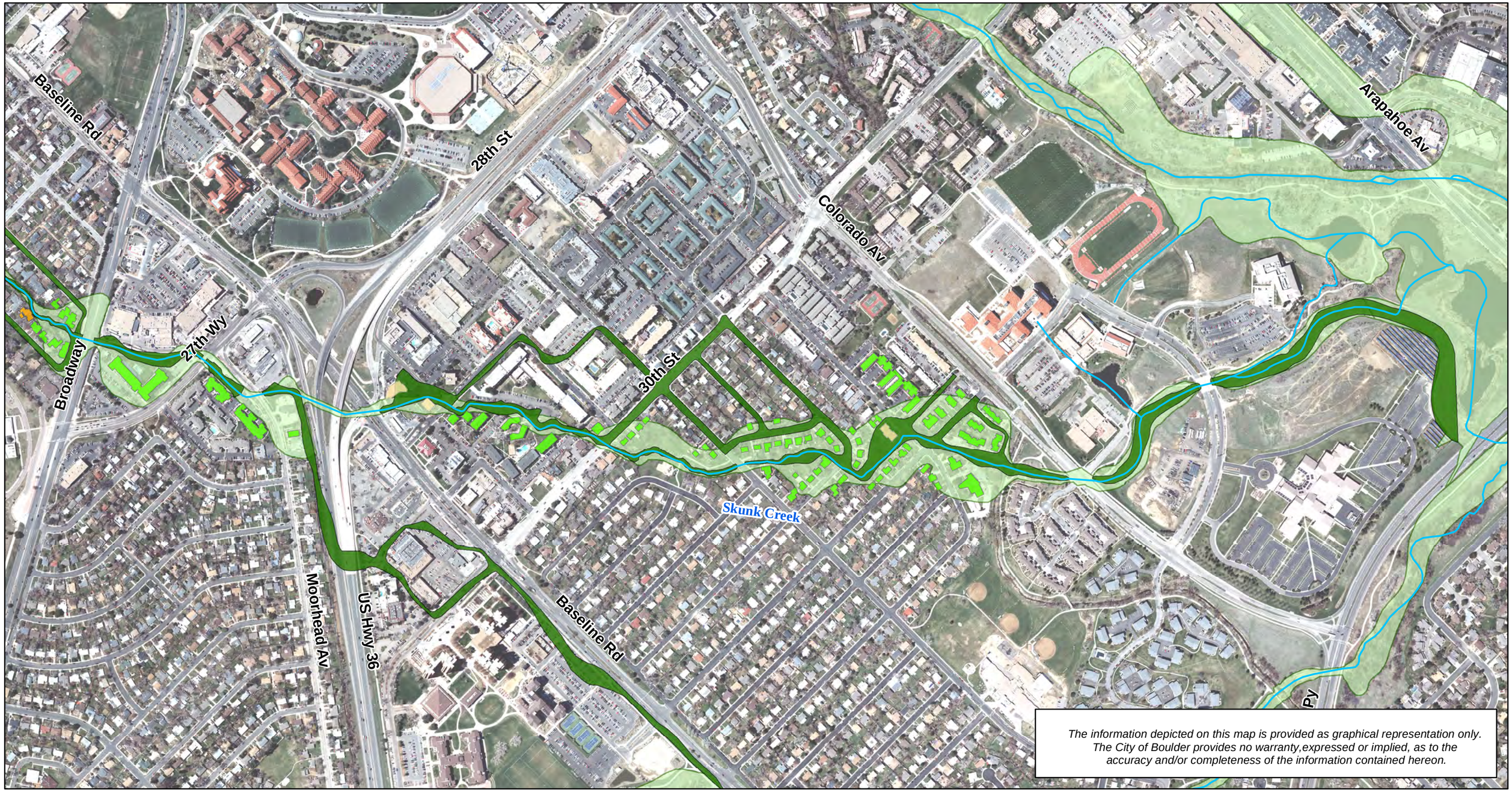
Map 1 of 2

0 250 500 1,000 1,500 Feet

N

Utilities Division

Rev: 11/10/2016



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Legend

- Effective Conveyance Zone
- Proposed Skunk Creek Conveyance Zone
- Structure Added
- Structure Unchanged
- Structure Removed
- Creek
- City Limits

Skunk Creek

Proposed Conveyance Zone Compared to FEMA Effective

Map 2 of 2

0 250 500 1,000 1,500 Feet

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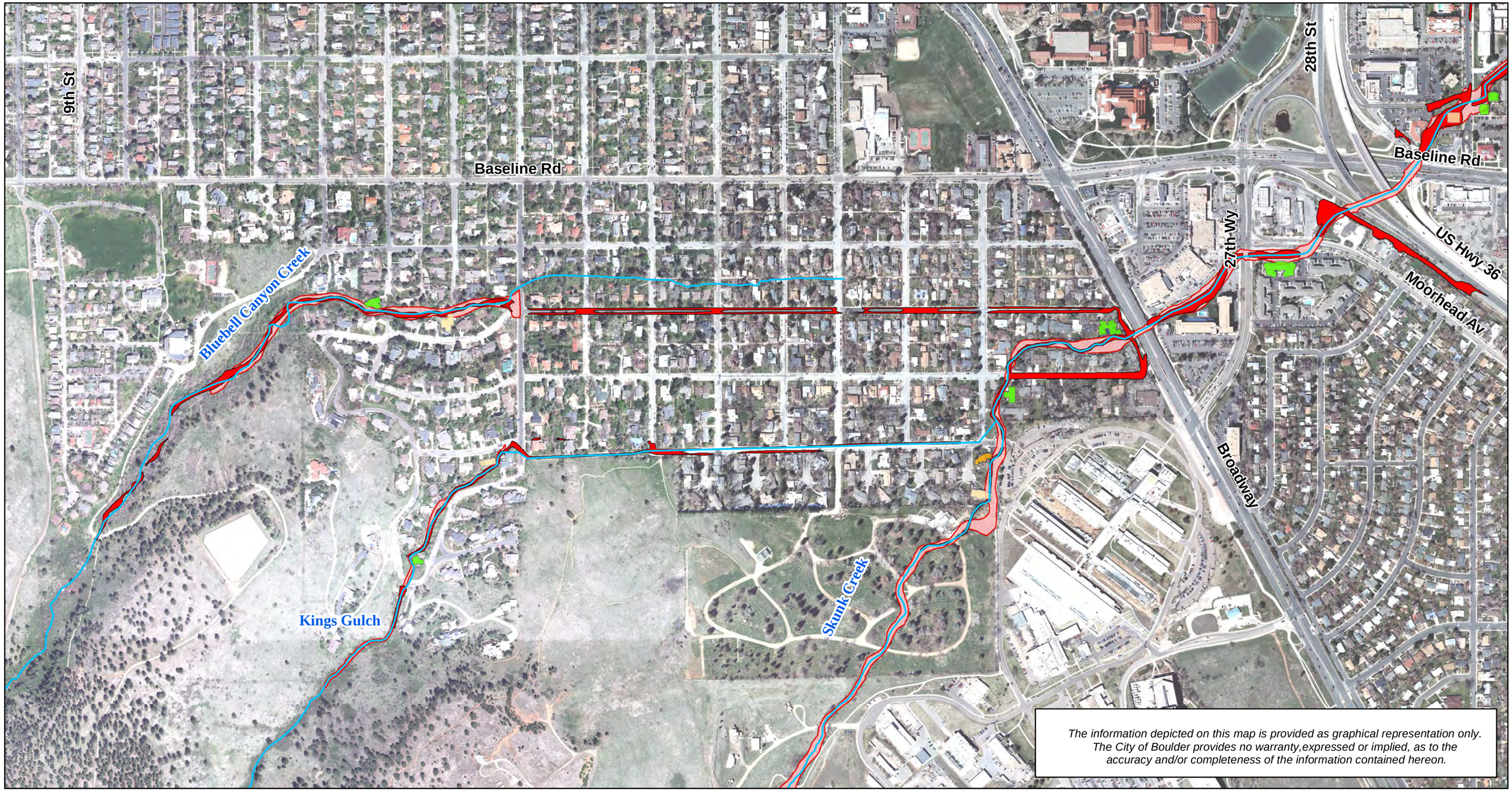
Utilities Division

Rev: 11/10/2016



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Legend

- Effective High Hazard Zone
- Proposed Skunk Creek High Hazard Zone
- Structure Added
- Structure Unchanged
- Structure Removed
- Creek
- City Limits

Skunk Creek

Proposed High Hazard Zone Compared to FEMA Effective

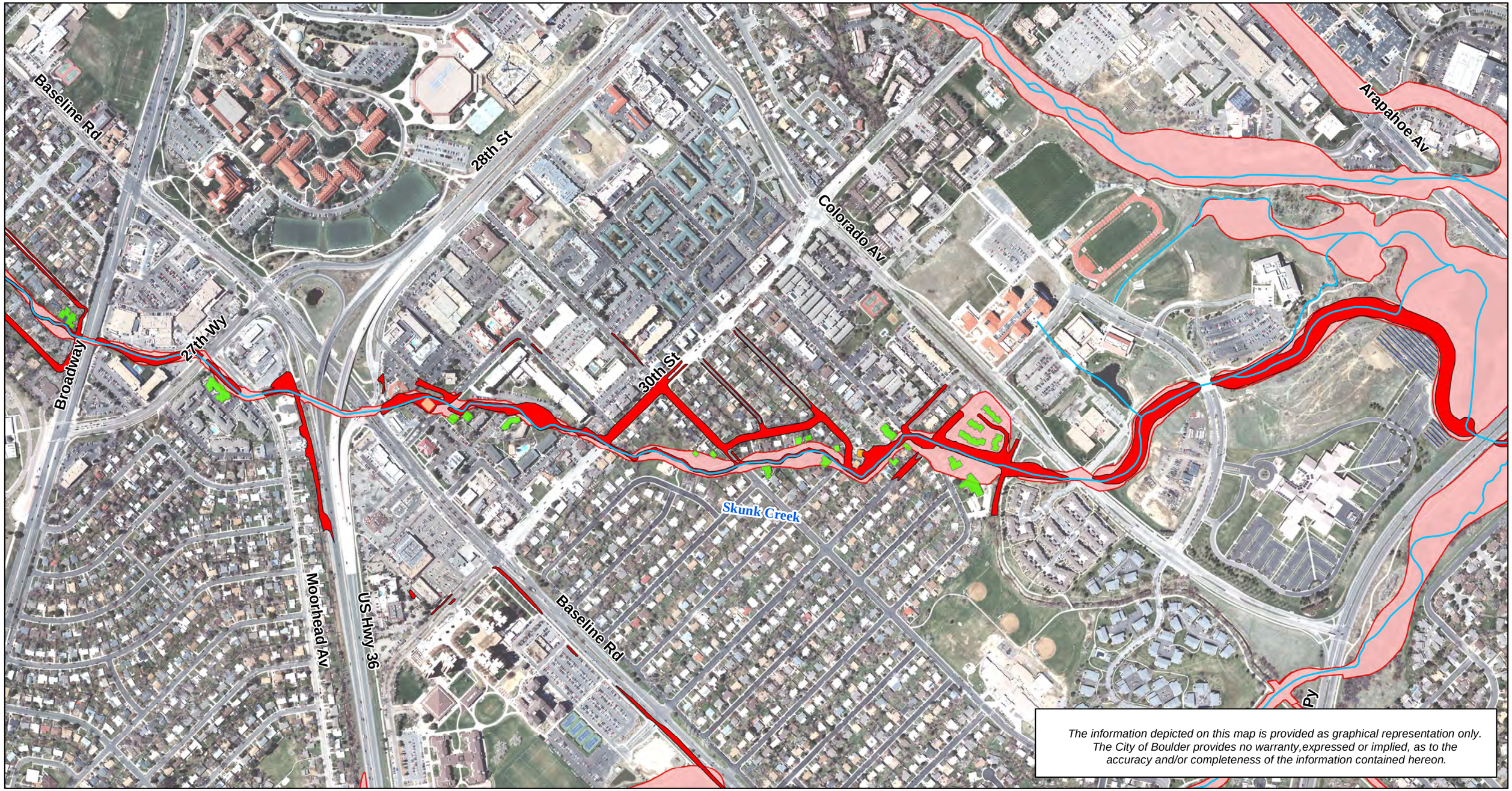
Map 1 of 2

0 250 500 1,000 1,500 Feet

N

Utilities Division

Rev: 11/10/2016



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Legend

- Effective High Hazard Zone
- Proposed Skunk Creek High Hazard Zone
- Structure Added
- Structure Unchanged
- Structure Removed
- Creek
- City Limits

Skunk Creek

Proposed High Hazard Zone Compared to FEMA Effective

Map 2 of 2

0 250 500 1,000 1,500 Feet

Utilities Division

Rev: 11/10/2016

Summary of Impacts to Structures

Skunk Creek				
Number of Structures	**100-Year Floodplain *NOT including* Shallow Flooding**	**100-Year Floodplain *including* Shallow Flooding**	**Conveyance Zone**	**High Hazard Zone**
Existing Floodplain	165	175	82	29
Proposed Floodplain	143	194	10	7
Change				
No Longer Affected	62	62	76	24
Newly Affected	40	81	4	2
No Change	103	113	6	5

There are 10 LOMRs

5 No Change (LOMC in existing mapping and are **not included** in the new mapping)

5 Added to 100 year (LOMC in existing mapping and are **included** in the new mapping)

Skunk Creek, Bluebell Canyon Creek and King's Gulch Remapping Study Public Comment Summary

Open House Date: Aug. 18, 2014

Open House Meeting Location: Municipal Building Lobby

Number of attendees that signed-in: 23

Staff in Attendance:

Robert Harberg	Katie Knapp	Kristin Dean
Laurel Olsen-Horen	Douglas Sullivan	

Public Comments:

1. **Location:** 2042 Baseline
   Commenter: Property owner (Ben Chancellor; Christina Jurgens)
   Comment: Did not see flooding in September 2013 and do not feel that the high hazard designation is warranted; question split values for Mariposa vs. Columbine

2. **Location:** Area south of Baseline Road between 20th and Broadway
   Commenter: Several property owners
   Comment: Flooding in September 2013 was confined to streets; no flow behind homes; water did not appear to be originating from Bluebell Canyon Creek proper.

3. **Location:** 22nd and Mariposa Avenue
   Commenter: Several property owners
   Comment: Flows traveling east on Mariposa turned north on 22nd Street and continued to Columbine Avenue; this is not shown as 100-year flooding.

4. **Location:** 19th and Mariposa Avenue
   Commenter: Property owner
   Comment: structure at south east corner is shown in the 100-year floodplain but did not experience damage during the September 2013 event; please review assumptions here.

5. **Location:** 955 Quinn Street
   Commenter: Property owner (Lee Payne)
   Comment: Structure does not show as impacted on floodplain maps (tree cover issue?); how was floodplain delineated at corner of Denton Avenue and Quinn Street.

6. **Location**: 3130 Aurora
   Commenter: Property Owner
   Comment: It seems like the HHZ could be the result of a small depression that we may not want to include
   in the mapping.

7. **Location**: 1700 Bluebell
   Commenter: Property Owner (Bill Mooz)
   Comment: Structure is shown as in proposed floodplain but was not impacted by September 2013 event; wants to know why actual data was disregarded.

8. **Location**: 1849 Mariposa Ave,
   Commenter: Property Owner (Steve Brown, Guen Simons)
   Comment: Water from Bluebell creek did not flow to Mariposa. It flowed down the Bluebell drainage but primarily to the north along 19th Street and down Columbine.

9. **Location**: 2100 Baseline
   Commenter: Property Owner (Jamie Karpohl)
   Comment: a) There were no eastbound flows observed on Columbine west of 20th Street. b) The flooding at 20th and Columbine originated from the Anderson ditch on the north side of Columbine. This water flowed through properties to the north-east and down the Columbine North alley towards 21st. At 21st the flows split - continuing down the alley and heading north towards Baseline. c) During the flood, there was no flow observed coming down Columbine west of 20th. The only flows observed in Columbine were from Anderson ditch on the north side of the street. When I visited the location of Bluebell Canyon Creek at 15th St. on the morning of September 14th, I observed all of the flow heading down Mariposa. I did not observe any man-made diversions at this location.

Public Hearing: WRAB Meeting, Aug. 18, 2014

Meeting Location: Council Chambers

Public Comments:

1. Steve Brown, Guen Simons - Water from Bluebell creek did not flow to Mariposa. It flowed down the Bluebell drainage but primarily to the north along 19th Street and down Columbine.

2. Lee Payne - My home does not show up as either added, removed or remaining in the 100 year floodplain on the "structures affected proposed 100 year floodplain". I believe this is due to the dense tree cover on my lot. The buildings on this lot look to be un-included in the 100 year flood zone, but it is unclear. The grading and slopes on my lot are high from the street and I believe the new mapping to be close to reality in that the homes are excluded. Can you please contact me to clarify if the structures are excluded and what the base flood elevation is in this area? There is also no information on sections or elevations for this lot on the city's website. Thank you!

Public Hearing: WRAB Meeting, Sept. 15, 2014

Meeting Location: Council Chambers

Public Comments:

1. Christina Jurgens – Concerns are with the Bluebell and that there were no diversions, which isn't reflected accurately in the mapping presented. Question is if a lot of water falls in the area, water will not flow uphill to 19th street and over Columbine if it's natural direction is downhill. She would like for this to be considered when moving forward with the amendment.

2. Bryan Boots – Owns a home at 20th and Columbine, which is in a newly designated hazard zone. He was completely unaware of the changes in zoning and is feeling like he is coming to the conversation late. Questions the assumptions that are going into this decision making and having a hard time reconciling the recent studies with what he actually experienced last September. He would like to better understand the next steps in the process regarding what is decided. It doesn't seem reasonable to put the burden on residents. He is requesting better, more effective outreach to citizens.

3. Tim Fuller-Rowell – Lives on Columbine Avenue, which is affected by the new floodplain, which now makes up half of his property. Increase in the water table flooded the basement. Flow down Mariposa didn't affect us. Rock dam broke causing a flash flood and persistent rainfall and wonders if that was factored into the analysis, but didn't see any major flow on

Columbine. Wants to understand the actual impact of flood to his property and physical reasons why it is now included on the floodplain. What is the process for deciding how the new boundaries are drawn and decided? Premature to start approving a new floodplain before the previous event is fully understood and would like the city to have more interaction with the people who are actually affected.

4. Jamie Krapohl – Property owner affected by the proposed flow split changes at 15th is his major concern. He didn't observe what is being shown on the maps and feels there is a lack of correlation in how the split affects these three blocks. On the Saturday of the flood, he was at 15th and Mariposa and didn't observe any diversions that were put into place by residents. The flooding on his corner was due to the Anderson Ditch overflowing, which is not represented in the changes. Since the open house, he has reached out to neighbors, but there are many renters around his property. He contacted three other property owners and informed them of the recent flood mapping changes. Feels that neighbors were not aware of these new changes. Concerned with the accuracy of the models, based on observations from walking around the neighborhood and what is being reflected in the updated maps. He feels this just doesn't make sense.

Public Hearing: WRAB Meeting, May 18, 2015

Meeting Location: Municipal Service Center

Public Comments:

1. Christina Jurgens – Concerned that too much of the water from Bluebell Canyon Creek is mapped that it flowed down Columbine, rather than where it was actually observed during flood. Concern that there are errors in proposed flood map that misrepresent the risk to her property and possibly other properties. Regarding item 53, which points out in the peer review that flood maps need to follow topography, question of syntheses of two kinds of mapping and worried about errors in representation of potential risk. Worried that proposed map represents inaccuracies that present risk. Residents have not heard of any structures that were flooded in this particular section. Asks why the proposed floods from Bluebell Canyon Creek to Mariposa, from 16th to 17th smaller than the northward flows at 18th and 19th? Seems by looking at it, they should be more similar to each other. Feels this is a mistake. What method was used to determine the split at 20th and Columbine?

2. Beth Robinson – Noticed big difference this time in the conveyance zone on her block. Several people are constructing drainage pipes from the back conveyance zones to the front of the street from the easement at the back of the property. This will impact at least one property owner on the block, who is not able to rebuild without extensive regrading.

3. Kris Miller – Home has been in 100-year flood zone since moved in 2006 and has contacted the city multiple times to state that they should not be. Was told by city that all studies were approximate at that time and no official mapping was done. Was told in 2012 that a "real study" would be conducted and in April 2013, was informed by city that they were going to be taken out of the flood zone with this study, but it is a long process. She and neighbor were not flooded during the 2013 event. Lives on the corner and the flood jumped the banks and flooded south on Mariposa instead and flood didn't even go near her property. When she called again, she was told that she was still in the floodplain. Concerned about the study. The flood actually occurred south of her property. Would like to know what happened and why she is still in the flood zone when the flood didn't affect her property?

4. R. Chris Roark – Asked whether it was taken into account that there is a bridge at lower McClintock that significantly diverted water during the flood event, which washed out and ended up on his property. Bridge is no longer there and is not going to be replaced. Will this be considered in the flood mapping?

5. Ali Yager – Lives at the corner of 20th and Mariposa. All the water at 15th came down Mariposa and wants to know what the city can or should do to deal with the water that jumps onto Mariposa? Maintenance of Bluebell Creek between Mariposa and Columbine, which theoretically is where the water should go. Question is about maintenance of the systems that should be carrying water, which are not working properly.