

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

MEETING DATE: March 19, 2018

AGENDA TITLE: Information Item and Public Hearing - Upper Goose Creek and Twomile Canyon Creek Flood Mitigation Study

PRESENTERS:

Jeff Arthur, Director of Public Works for Utilities Douglas Sullivan, Utilities Principal Engineer Katie Knapp, Engineering Project Manager

EXECUTIVE SUMMARY

This memorandum provides background information and a summary of alternatives to reduce flooding impacts from Upper Goose Creek and Twomile Canyon Creek. This memorandum is intended to be informational and does not require WRAB action. However, staff are interested in feedback from both WRAB and the public to help with the assessment of the mitigation alternatives and guide recommendations for the flood mitigation plan.

The city retained ICON Engineering, Inc. (ICON) to conduct a study of the watershed and evaluate potential alternatives for this flood mitigation plan including:

1. Detention Facilities
2. Sediment Capture Facilities
3. Channel and Culvert Improvements
4. Piped Storm System Improvements
5. Roadway Conveyance

An overview map showing the different mitigation alternatives is included in **Attachment A**. For clarity, the creeks were broken into different reaches. Maps of each reach with descriptions of the alternatives and the associated costs, benefits and issues are included in **Attachment B**.

BOARD AND COMMISSION FEEDBACK

The Upper Goose Creek and Twomile Canyon Creek Flood Mitigation Study has not been brought to any Boards or Commissions prior to WRAB. However, because one of the alternatives under consideration is a new detention facility at North Boulder Park, both City Council and the Parks and Recreation Advisory Board have been made aware of this planning effort and the potential park impacts.

The March WRAB meeting is intended to be an opportunity for WRAB and the public to provide input on the different alternatives under consideration and offer suggestions on additional

mitigation measures. This feedback will enable staff and ICON to further refine the alternatives and prepare a draft Mitigation Plan for review at a future WRAB meeting.

PUBLIC FEEDBACK

The Upper Goose Creek and Twomile Canyon Creek watershed was greatly impacted by the September 2013 flood. A post-flood open house was held on October 17, 2013 to provide flood recovery information and gather public comments about the extent of the floodwaters and the damages sustained. This information helped identify problem areas and also provided valuable information for the floodplain mapping study for Upper Goose Creek and Twomile Canyon Creek that was underway when the September 2013 flood event occurred. The mapping study included an extensive public process with open house meetings and WRAB public hearings. The email list that was developed for the mapping study is also being used to notify people about the mitigation plan and people have the option to join or leave the list throughout the planning process.

An open house was held on April 12, 2017 to provide the community with city-wide flood planning and mitigation information. This public open house was also the official “kick-off” for the Upper Goose Creek and Twomile Canyon Creek flood mitigation planning process and provided the public an opportunity to discuss problem areas and provide ideas for consideration. An interactive [webpage](#) was developed to compile comments from the meeting and throughout the planning process.

A workshop was held on July 13, 2017, to collaborate with community members on mitigation strategies. A presentation was given that highlighted the development and flood history for Upper Goose Creek and Twomile Canyon Creek and described several different mitigation strategies that could be considered. Table top discussions were arranged and facilitated by city staff to brainstorm options, evaluate priorities, and capture the residents’ preferred flood mitigation strategies. During one exercise, workshop participants collaborated in small teams to determine which mitigation strategies they thought would be most appropriate or desired in different locations and they marked-up maps with suggestions. This input was compiled into one [map](#) and posted on the project webpage along with other [comments and input](#) from the workshop that was then used to help refine the alternatives currently under consideration.

Staff have also held meetings with individual property owners and property managers to explain different alternatives and potential impacts to properties.

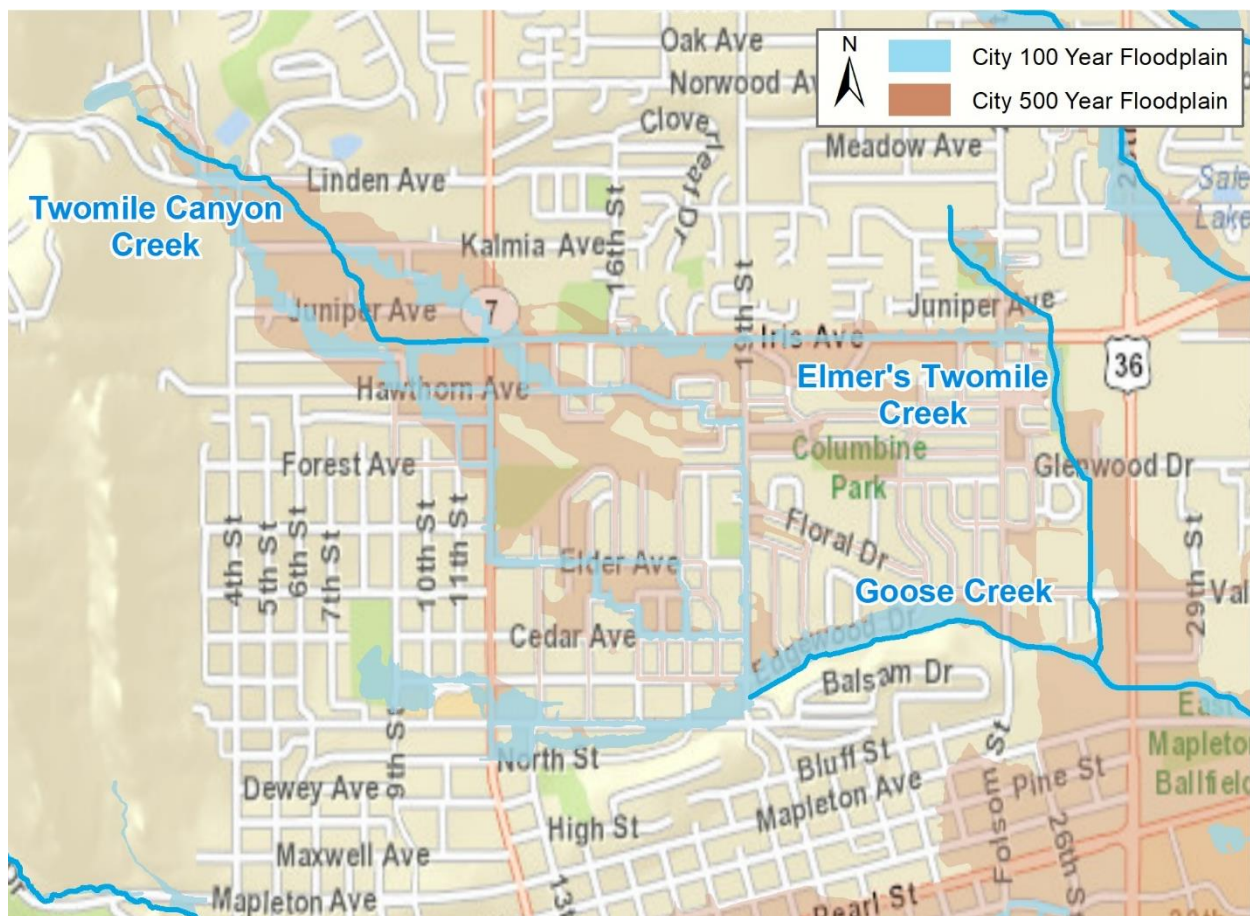
An open house meeting is being held immediately prior to this WRAB meeting to inform the public about the alternatives analysis and obtain their feedback. A summary of public input gathered at the open house will be provided at a future WRAB meeting.

Property owners and residents in the study area are being notified of public meetings using post cards, emails, social media (Nextdoor) and the project webpage:

(<https://bouldercolorado.gov/pages/skunk-creek-bluebell-canyon-creek-kings-gulch-upper-goose-and-twomile-flood-mitigation-studies>). Unfortunately, we recently discovered that the two previous post card mailings for this project did not reach all property owners in the area because the mailing list was inadvertently truncated. These property owners have been sent letters with an apology for the missed communication and information about the project and tonight's meetings.

BACKGROUND

This study is for the Upper Goose Creek and Twomile Canyon Creek drainageways. The floodplain map for this area is depicted below:



Upper Goose Creek and Twomile Canyon Creek Floodplain Map

The floodplain maps for Upper Goose Creek and Twomile Canyon Creek were updated in 2015. The updated floodplain mapping established base flood elevations using detailed methods and incorporated improvements and changes along the drainageways.

Study Area Description

The Twomile Canyon Creek drainage basin originates in the foothills west of Boulder near Pine Brook Hill Fire Station. The upper portion of the drainage basin is narrow, steep and rocky with a well-defined channel. The creek enters the City of Boulder and flows through a residential area near Spring Valley Road. During minor storm events, water flowing in Twomile Canyon Creek is diverted into the Silver Lake ditch near the Linden Ave. and Wonderland Hill Ave.

intersection. The South Juniper Lateral returns water into the creek near Foothills Elementary School. The rocky creek bed is approximately three to four feet wide, and ends on the west side of the intersection of Broadway and Iris. East of this intersection, water flows through a small channel that runs along the north side of Iris and into a storm sewer. The storm sewer discharges into Elmer's Two Mile Park, which flows into Goose Creek, just south of Valmont Road.

The Upper Goose Creek drainage basin is primarily composed of residential and commercial development, and is located just south of Twomile Canyon Creek. During minor storm events, runoff is collected in storm sewers and conveyed to a concrete lined channel at 19th St. and Tyler Rd. During major storm events, water drains to the east side of North Boulder Park located on 9th St. From here to 19th St., floodwaters head east, along Balsam Ave., Alpine Ave. and through backyard areas, because there is no defined stream channel within this portion of the drainage basin. A concrete lined channel starts at 19th St. and continues east for approximately 270 feet before becoming a more natural, vegetated channel. The stream channel runs south of and parallel to Edgewood Dr. and this roadway also carries flood waters during major events. From approximately 600 feet upstream (west) of Folsom, Goose Creek has been improved to convey the 100-year storm event several miles to its confluence with Boulder Creek. The width of the channel is as large as 25 feet with 6 to 15-foot high channel walls.

Development has altered historic channels, stormwater flow paths, runoff characteristics, and surface water quality. Much of the development within the Twomile Canyon and Goose Creek floodplains occurred prior to the city's adoption of floodplain regulations and drainage system requirements, and therefore does not conform to current development standards. There are limited drainage and flood control easements along these creeks.

Flood History

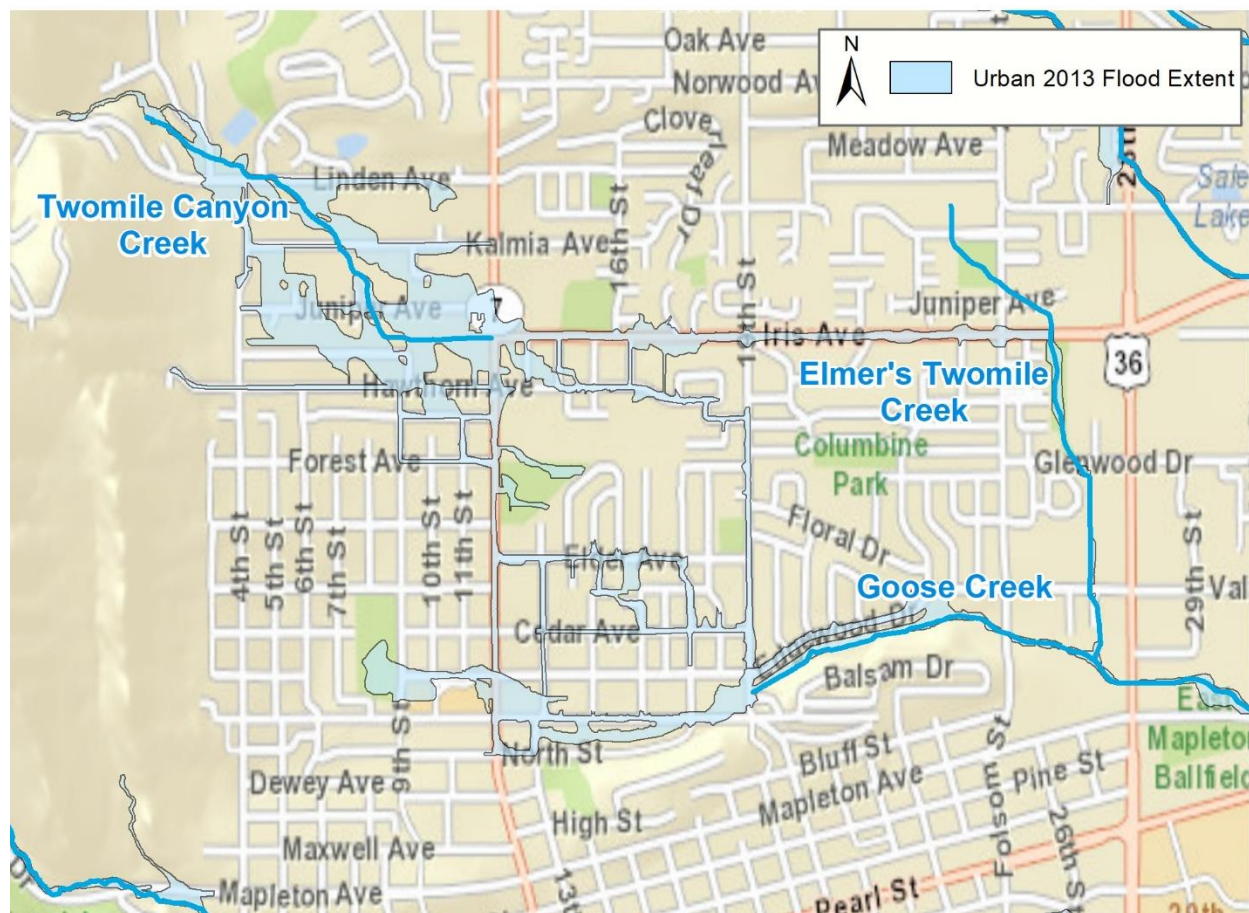
Boulder is highly susceptible to flash flooding because it sits near the mouths of numerous canyons in the foothills. In 1894, damaging floods were experienced in late May, during the time of spring runoff, when a heavy and constant spring rain was pinned against the western mountains by an upslope wind condition, dropping 5 to 8.5 inches of rain during that period.

Significant flooding has also occurred in Boulder in 1896, 1906, 1909, 1916, 1921, 1938, 1969, and most recently, in September of 2013. In 1909, flooding along Twomile Canyon Creek resulted in two deaths. These major storm events generally occurred in either May or June as a result of snowmelt combined with heavy spring rainfall. However, record setting rains were widespread across Boulder from Sept. 9 to 13, 2013 due to a moist tropical air mass from the

Gulf of Mexico. An upper-level high-pressure system locked this storm against the mountains to the west, and rain fell for about a week. 17.6 inches of rain fell over a three-day period, making 2013 the wettest year on record in Boulder. It is estimated that the rainfall return periods for Twomile Canyon Creek and Goose Creek ranged from a 50-year to a greater than 100-year event for the worst case 2-hour duration.

During the 2013 storm, channels and culverts along Twomile Canyon Creek were filled with rocks and debris which had been transported from the canyon upstream. The alluvial nature of the watershed, and already limited conveyance capacity of the channel, caused widespread, overland flooding and sediment deposition. On Sept. 11, 2013 a car got trapped in a mudslide at the intersection of Linden Dr. and South Cedar Rd., near Twomile Canyon Creek; two of the occupants tried to escape but did not survive. Their bodies were found downstream the next day.

The approximate flooding extents for the September 2013 flood are depicted below and are shown in more detail in **Attachment C**:



September 2013: Approximate Flood Extents

ANALYSIS

Typically, flood mitigation plans are developed with the intent to adequately convey a 100-year storm event. Designing major drainageways systems to transport the 100-year event is a policy standard in the Boulder Valley Comprehensive Plan, the Comprehensive Flood and Stormwater Utility Master Plan and the Urban Drainage Flood Control District's Drainage Criteria Manual and is applicable to new development in the city. Due to the existing development within the study area, mitigation alternatives to convey a 100-year event could greatly impact many existing properties. Therefore, alternatives that increase flood conveyance, but do not accommodate the full 100-year flood flows are also under consideration.

The city retained ICON to conduct a study of the watershed and evaluate potential alternatives. Several mitigation options were evaluated and include:

1. Detention Facilities
2. Sediment Capture Facilities
3. Channel and Culvert Improvements
4. Piped Storm System Improvements
5. Roadway Conveyance

An overview map showing the different mitigation alternatives is included in **Attachment A**. For clarity, the creeks were broken into different reaches, although improvements in one reach may also require improvements in other reaches. For example, channel improvements in an upstream reach could require improvements in downstream reaches to accommodate increased flows. Maps of each reach with descriptions of the alternatives and the associated costs, benefits and issues are included in **Attachment B**.

Some of the mitigation alternatives would require significant property/easement acquisitions and the removal or relocation of existing structures. Existing trees and vegetation would also be highly impacted by some of the alternatives. The city-owned Boulder Community Hospital site is along the upper reach of Goose Creek and is currently in a master planning process known as the [Alpine-Balsam Project](#). Utilities staff have been coordinating with this project team and Parks staff on alternatives to reduce flooding risks in this area which include:

- A detention facility at North Boulder Park with a pipe under 9th St. that discharges to an open channel through the Alpine-Balsam site
- A roadway collection system from North Boulder Park to an open channel through the Alpine-Balsam site.

City Council and the Parks and Recreation Advisory Board are aware that a detention facility at North Boulder Park is under consideration and could result in park impacts.

NEXT STEPS

Following input from the Open House and WRAB meeting, Staff will work with ICON to further assess the alternatives, develop recommendations and prepare a draft mitigation plan. Staff will work with potentially impacted property owners to refine the recommendations prior to presenting the draft mitigation plan to WRAB at a future meeting. Following a WRAB recommendation to approve the mitigation plan, it will be presented to City Council for acceptance.

The Upper Goose Creek and Twomile Canyon Creek Flood Mitigation Plan will then be integrated into a citywide flood prioritization study and an update to the Comprehensive Flood and Stormwater (CFS) master plan. The prioritization study and CFS update will provide an opportunity to revisit the CIP prioritization guiding principles and will inform future CIP planning.

Over \$170 million of major drainageway improvements have been identified along Boulder Creek and the 14 tributaries. At current funding levels, it will take approximately 100 years to complete these improvements. It is likely that many changes will occur over that time period, including additional flood events, that will further influence build out of the plan. The prioritization study will identify the most critical needs and evaluate appropriate funding levels.

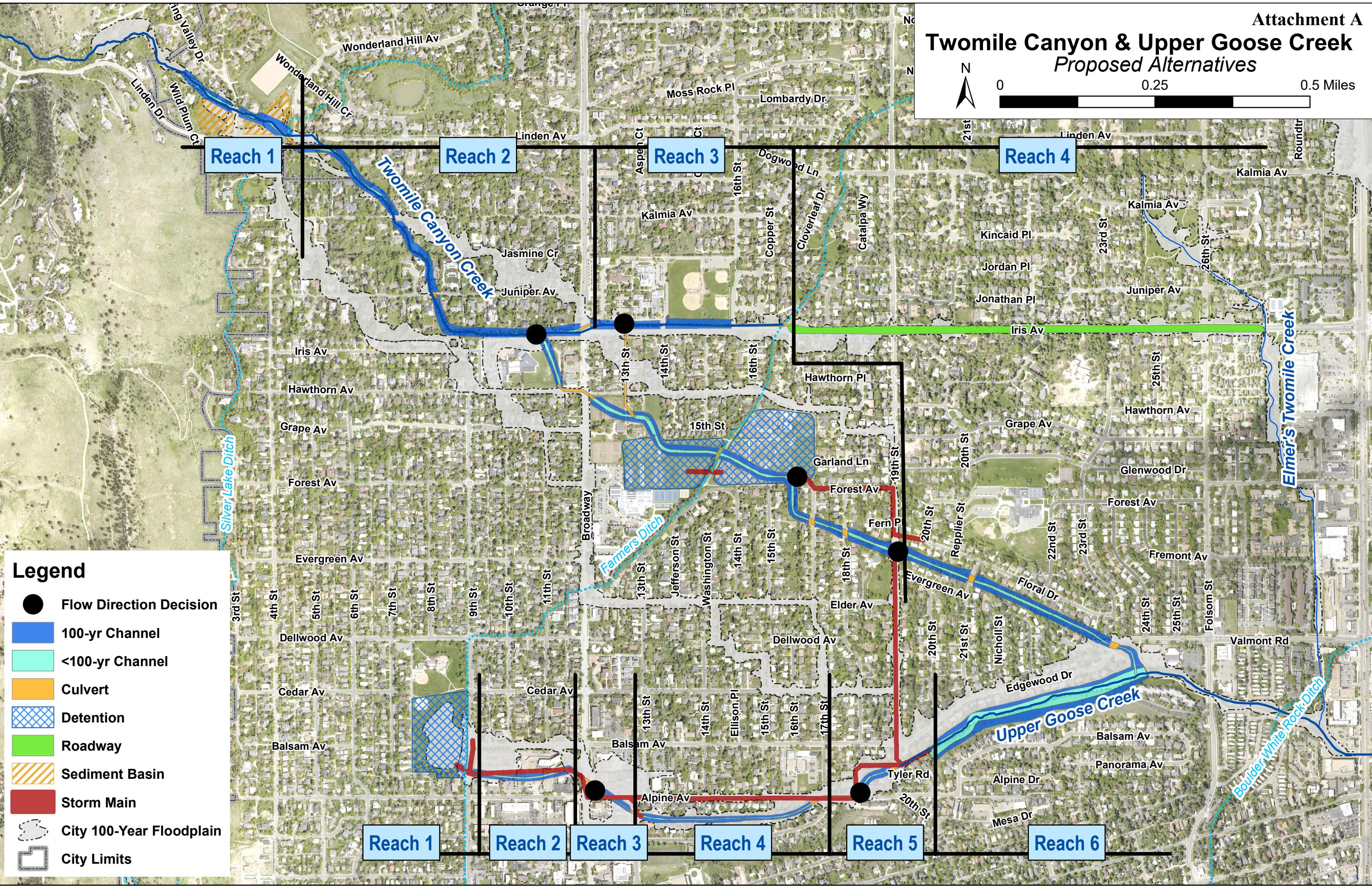
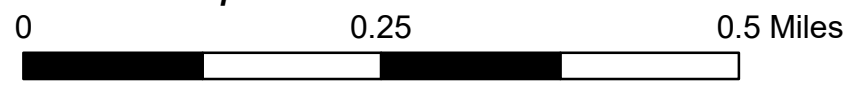
ATTACHMENTS

Attachment A: Overview Map with Mitigation Alternatives

Attachment B: Reach Maps with Mitigation Alternatives

Attachment C: 100-Year Floodplain and 2013 Flood Extents

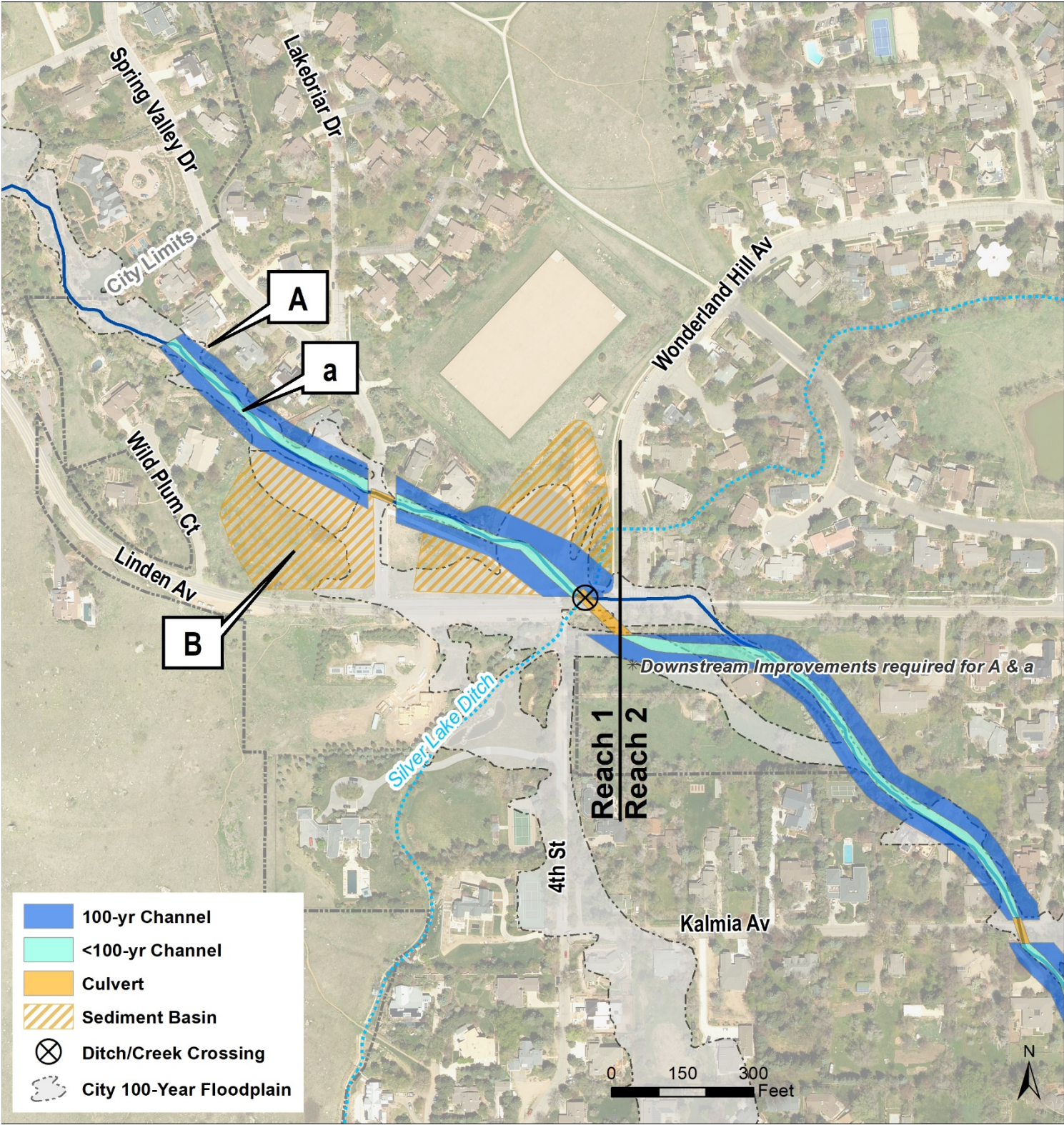
Attachment A
Twomile Canyon & Upper Goose Creek
Proposed Alternatives



Legend

- Flow Direction Decision
- 100-yr Channel
- <100-yr Channel
- Culvert
- Detention
- Roadway
- Sediment Basin
- Storm Main
- City 100-Year Floodplain
- City Limits

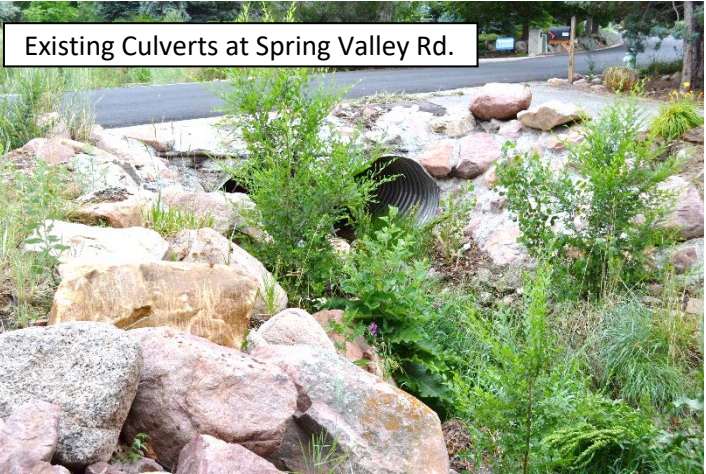
Twomile Canyon Creek
Reach 1: Wild Plum Ct to Linden Av



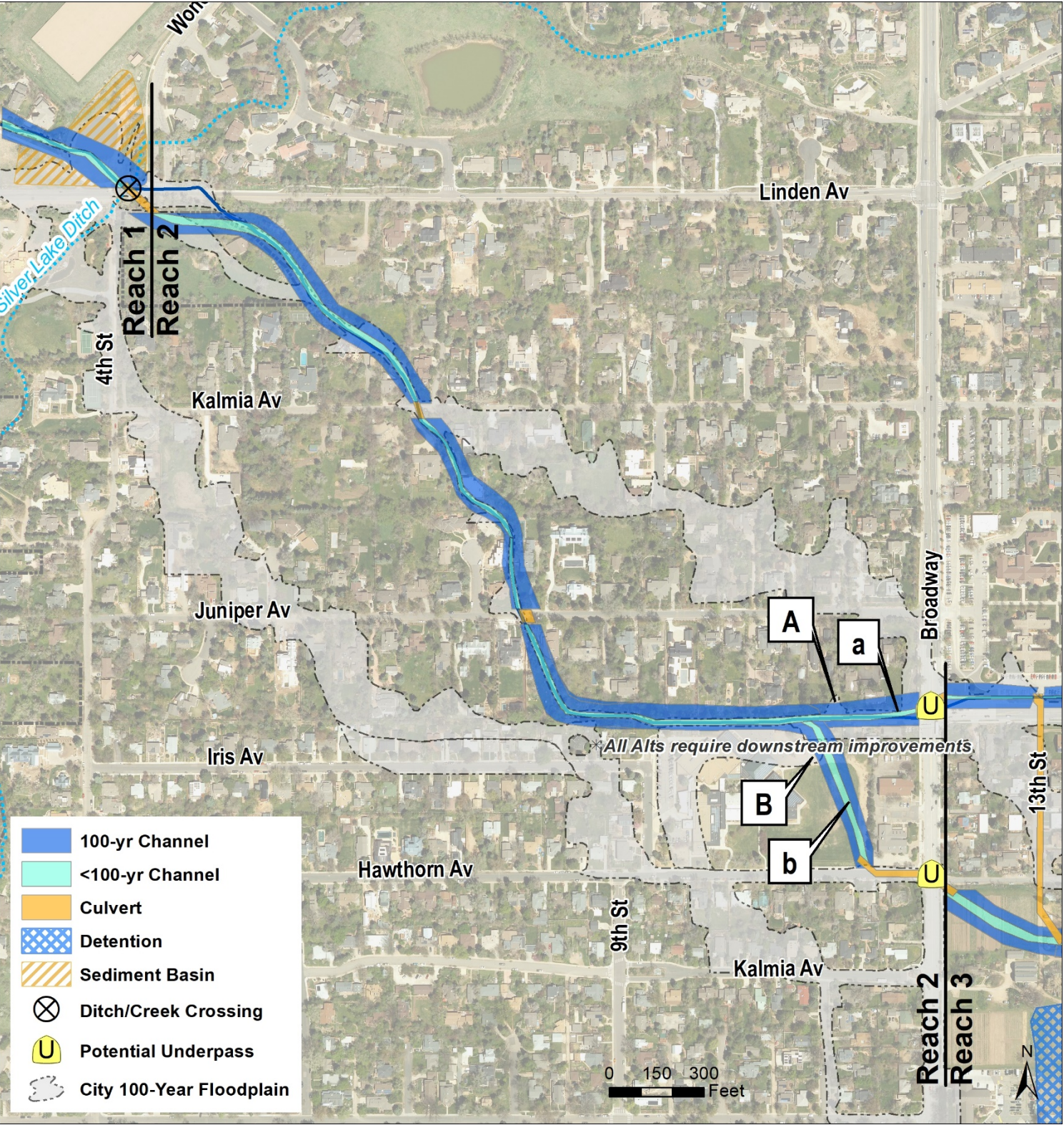
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Information about the Alternatives

Alt	Description	Cost	Benefits	Issues
A	100-year open channel improvements; new culverts at Spring Valley Dr. and Linden Av	\$2.5M	<ul style="list-style-type: none">Eliminates 100-year spill flowsEliminates overtopping of roadways during 100-year storm	<ul style="list-style-type: none">May require mature tree removalDoes not address sediment captureExtensive property impactsRequires downstream improvements
a	<100-year open channel (smaller version of Alt A)	\$1.6M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flood
B	Enlarge existing sediment capture facility	\$1.0M	<ul style="list-style-type: none">Reduces sedimentation impact downstreamExisting City ownership of facility footprintCan be constructed independent of other improvements	<ul style="list-style-type: none">Change in natural sediment transportMay require mature tree removalEmbankment may impact viewscapeImpacts Open Space Mountain Parks landNo significant reduction in flood risk



Twomile Canyon Creek
Reach 2: Linden Av to Broadway



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Information about the Alternatives

Alt	Description	Cost	Benefits	Issues
A	100-year open channel improvements; new culverts at Kalmia Av, Juniper Av, and Broadway; channel to Broadway and Iris	\$27M	<ul style="list-style-type: none">Reduces spill flowsReduces overtopping of roadwaysFollows existing channel alignmentOpportunity for underpass at Broadway	<ul style="list-style-type: none">Requires structure acquisitionExtensive property impactsRequires Iris or 13th St alternativesRequires downstream improvements
a	<100-year open channel (smaller version of Alt A)	\$10M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flood
B	100-year open channel improvements; new culverts at Kalmia Av, Juniper Av, Broadway; channel to Broadway and Hawthorn	\$32M	<ul style="list-style-type: none">Reduces spill flowReduces overtopping of roadwaysMore efficient connection to downstream channelOpportunity for underpass at Broadway	<ul style="list-style-type: none">Not as feasible for Broadway underpassRequires structure acquisitionExtensive property impactsRequires downstream improvements
b	<100-year open channel (smaller version of Alt B)	\$14M	<ul style="list-style-type: none">Similar to Alt BReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt BDoes not contain 100-year flood



Twomile Canyon Creek
Reach 3: Broadway to 19th St



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Information about the Alternatives

Alt	Description	Cost	Benefits	Issues
A	100-year open channel improvements; new culverts at 13 th , 14 th and from 16 th St through Farmer's Ditch; Iris Av Roadway Improvements for surface flow	\$8.4M	<ul style="list-style-type: none">Conveys flood flows to Elmer's Twomile CreekLess property impacts and acquisition than southern alignments	<ul style="list-style-type: none">Major impact to Iris AvRequires downstream improvements
a	<100-year open channel (smaller version of Alt A)	\$5.7M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flood
B	100-year open channel improvements; new culverts at Farmer's Ditch, 17 th , 18 th and 19 th St	\$9.5M	<ul style="list-style-type: none">Utilizes southern alignments	<ul style="list-style-type: none">Significant property impactsRequires downstream improvements
b	<100-year open channel (smaller version of Alt B)	\$3.3M	<ul style="list-style-type: none">Similar to Alt BReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt BDoes not contain 100-year flood
C	100-year open channel improvements; new culvert south on 13th St, Farmer's Ditch, 17th, 18th and 19th St	\$9.0M	<ul style="list-style-type: none">Utilizes southern alignmentsProvides for local drainage along 13th St	<ul style="list-style-type: none">Significant property impactsRequires downstream improvements
c	<100-year open channel (smaller version of Alt C)	\$4.9M	<ul style="list-style-type: none">Similar to Alt CReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt CDoes not contain 100-year flood
D	100-year detention facility; new culvert south on 13th St; outfall to existing storm drain system	\$44M	<ul style="list-style-type: none">Reduces downstream dischargesReduces sedimentation impact downstreamAbility to retain existing use of gardens or re-purpose areaCan be constructed independent from other improvements	<ul style="list-style-type: none">Significant property impactsMay require removal of mature treesEmbankment may impact viewscape
d	<100-year detention facility (smaller version of Alt D)	\$35M	<ul style="list-style-type: none">Similar to Alt DReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt DDoes not detain the full 100-year flood



Twomile Canyon Creek
Reach 4: 19th St to 24th St



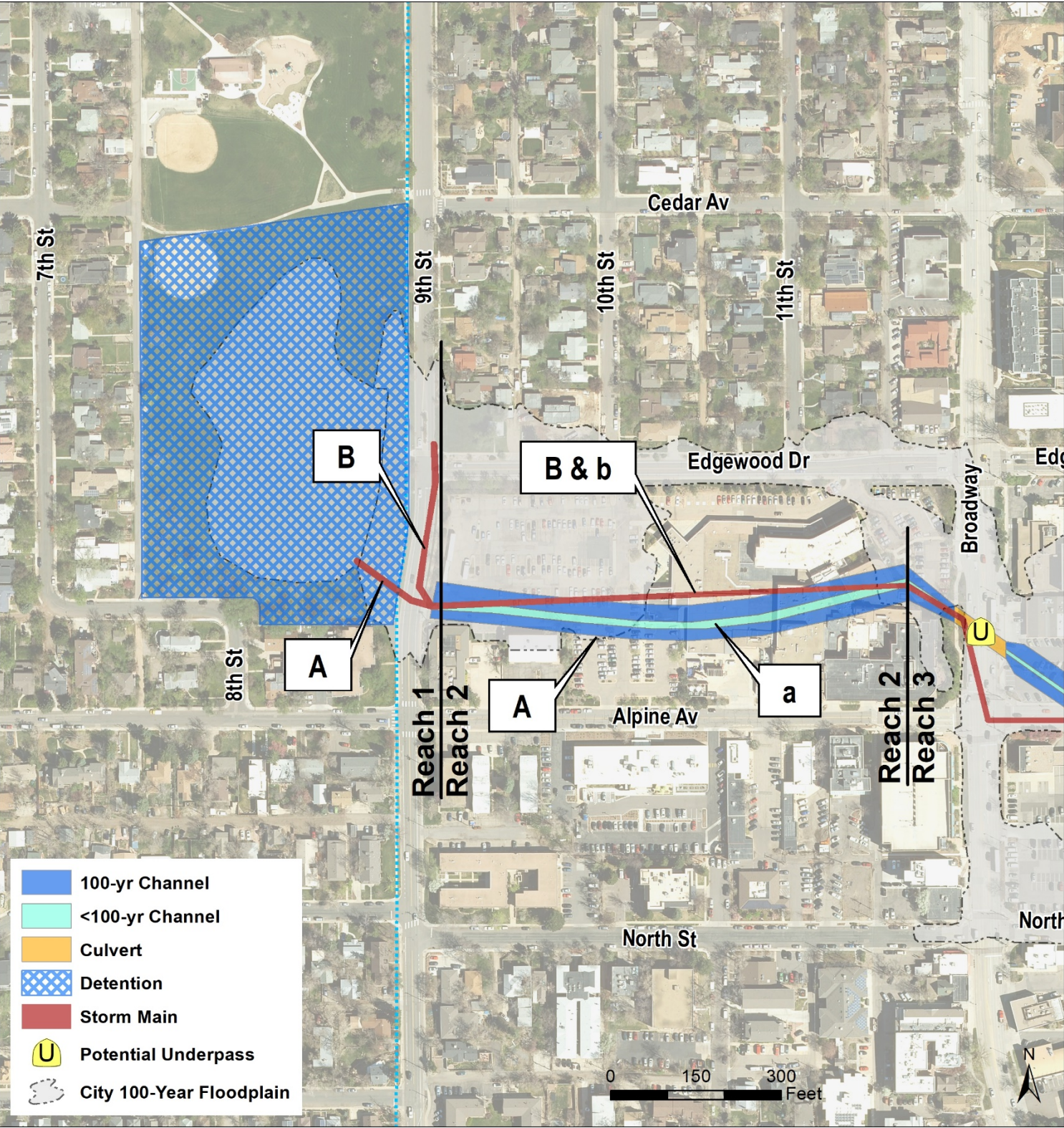
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Information about the Alternatives

Alt	Description	Cost	Benefits	Issues
A	Iris Av roadway improvements for surface flow	\$3.1M	<ul style="list-style-type: none">Conveys flood flows to Elmer's TwomileLess property acquisition than southern alignments	<ul style="list-style-type: none">Major impact to Iris AvLife safety and emergency access concerns with street flooding
a	<100-year roadway improvements (smaller version of Alt A)	\$1.6M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flood
B	100-year open channel improvements; new culverts at 21st St and Edgewood Dr.	\$2.8M	<ul style="list-style-type: none">Provides open channel connectivity to Goose CreekMay reduce groundwater issues in local area	<ul style="list-style-type: none">Significant property impactsMay require mature tree removalPlaces channel in backyards
b	<100-year open channel (smaller version of Alt B)	\$2.0M	<ul style="list-style-type: none">Similar to Alt BReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt BDoes not contain 100-year flood
D	Storm drain outfall system (detained flow)	\$0.5M	<ul style="list-style-type: none">Utilizes existing storm drain infrastructureDoes not require open channel construction	<ul style="list-style-type: none">Relies on existing infrastructureSusceptible to clogging
d	<100-year storm system (smaller version of Alt D)	\$0.3M	<ul style="list-style-type: none">Similar to Alt DReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt DDoes not contain 100-year flood
E	Storm drain outfall system (full flow)	\$3.0M	<ul style="list-style-type: none">Utilizes the 19th St Right-of-WayDoes not require open channel construction	<ul style="list-style-type: none">Does not remove Twomile Canyon Creek discharge from Goose Creek between 19th and historical confluenceSusceptible to clogging
e	<100-year storm system (smaller version of Alt E)	\$2.0M	<ul style="list-style-type: none">Similar to Alt EReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt EDoes not contain 100-year flood



Upper Goose Creek
Reach 1 & 2



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Information about the Alternatives

Reach 1: North Boulder Park to 9th St

Alt	Description	Cost	Benefits	Issues
A	Detention facility within North Boulder Park; new 9th St culvert.	\$3.0M	<ul style="list-style-type: none">Reduces downstream flowsReduces overtopping of 9th StRetain or re-purpose park uses	<ul style="list-style-type: none">Impact to existing park usesMay require mature tree removalEmbankment may impact viewscape
B	No detention; Storm drainage collection to deliver flows to Alpine-Balsam site	\$0.5M	<ul style="list-style-type: none">Provides flooding protection for the Alpine-Balsam siteDoes not impact North Boulder ParkReduces flooding on Balsam St	<ul style="list-style-type: none">No reduction in dischargesConcentrates discharges onto the Alpine-Balsam siteMay require roadway reconfiguration

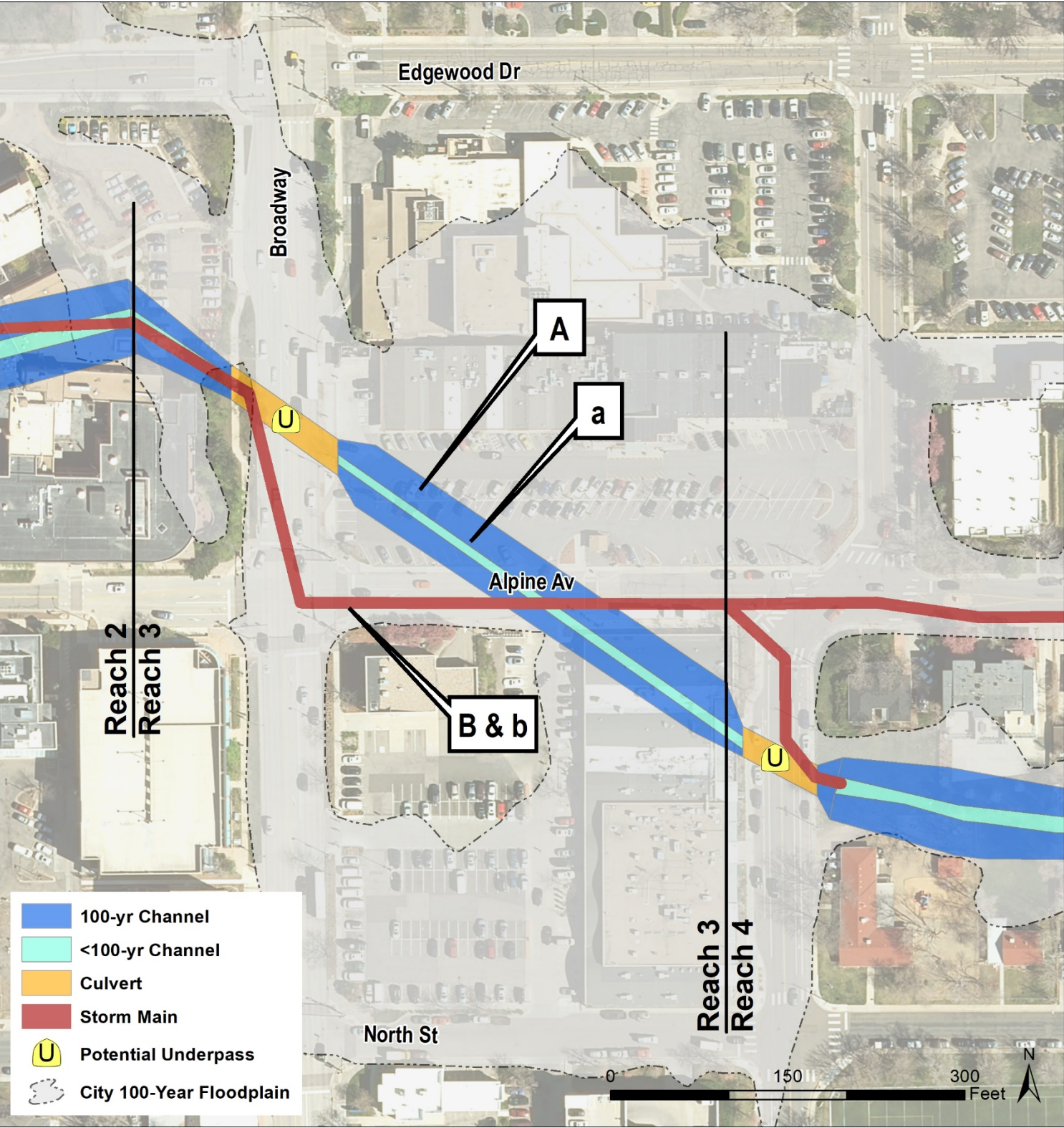
Reach 2: 9th St to Broadway

Alt	Description	Cost	Benefits	Issues
A	100-year open channel	\$0.5M	<ul style="list-style-type: none">Provides additional open channel habitatGreen infrastructureAligns with the Alpine-Balsam Vision Plan	<ul style="list-style-type: none">Final configuration of Alpine-Balsam site unknownCould require more room than piped system
a	<100-year open channel (smaller version of Alt A)	\$0.3M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flood
B	100-year storm system	\$0.6M \$0.2M*	<ul style="list-style-type: none">Could require less room than open channel	<ul style="list-style-type: none">Final configuration of Alpine-Balsam site unknownSusceptible to clogging
b	<100-year storm system (smaller version of Alt B)	\$0.4M	<ul style="list-style-type: none">Similar to Alt BReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt BDoes not contain 100-year flood

*Reduced costs if detention is implemented at Reach 1



Upper Goose Creek
Reach 3: Broadway to 13th St



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Information about the Alternatives

Alt	Description	Cost	Benefits	Issues
A	100-year open channel	\$1.8M \$1.3M*	<ul style="list-style-type: none">Provides additional open channel habitatGreen infrastructureOpportunity for underpasses	<ul style="list-style-type: none">Extensive property impactsDisruptive to existing businesses
a	<100-year open channel (smaller version of Alt A)	\$0.8M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flood
B	100-year storm drain system	\$1.2M \$1.0M*	<ul style="list-style-type: none">Utilizes existing Right-of-WayDoes not require property acquisitionProvides local drainage along Broadway and Alpine Av	<ul style="list-style-type: none">Construction disruption to busy business corridorSusceptible to clogging
b	<100-year storm system (smaller version of Alt B)	\$0.9M \$0.8M*	<ul style="list-style-type: none">Similar to Alt BReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt BDoes not contain 100-year flood

*Reduced costs if detention is implemented at Reach 1



Upper Goose Creek

Reach 4: 13th St to 17th St



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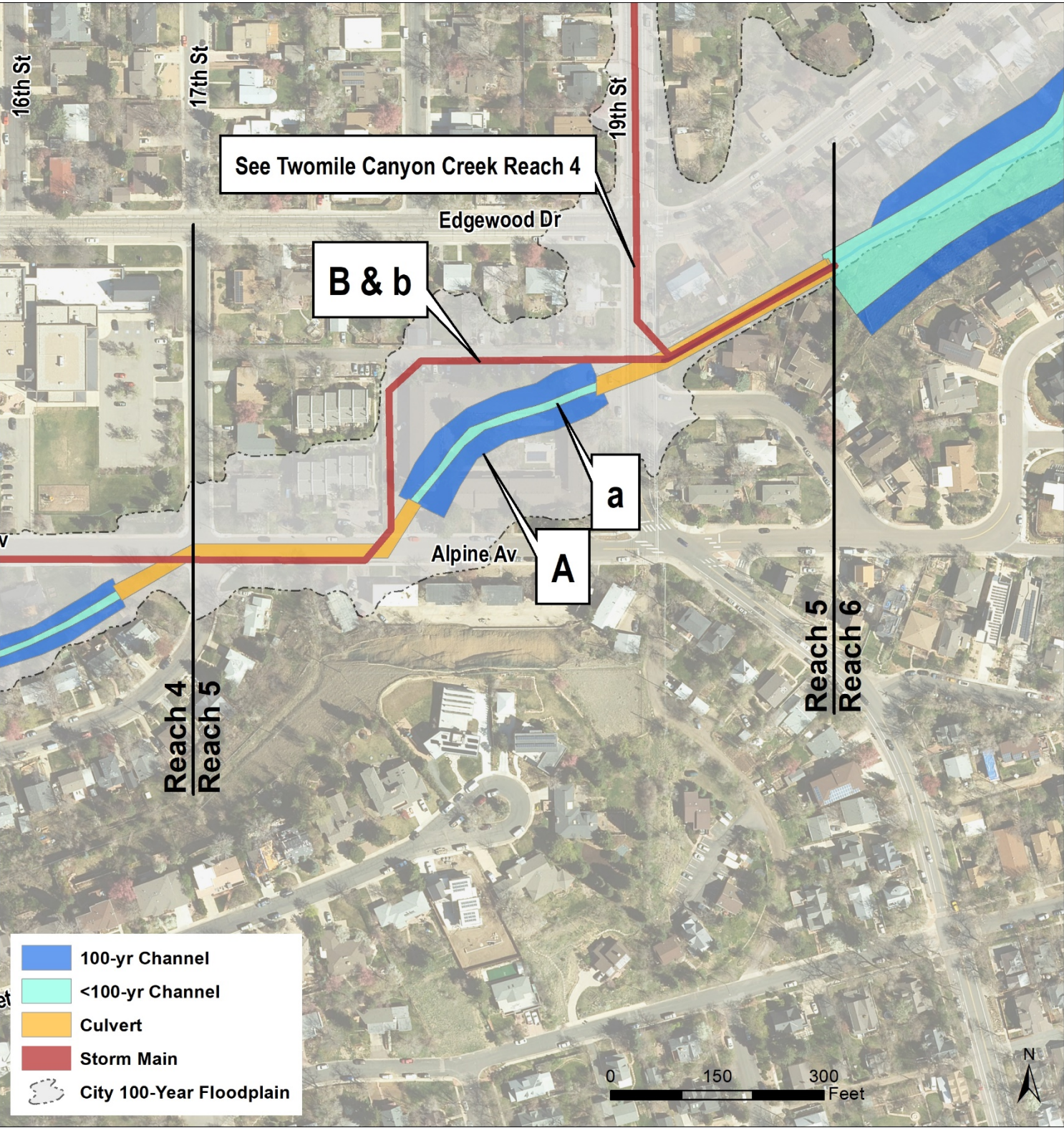
Information about the Alternatives

Alt	Description	Cost	Benefits	Issues
A	100-year open channel	\$2.4M	<ul style="list-style-type: none">Provides additional open channel habitatEnhances existing drainage pathGreen infrastructure	<ul style="list-style-type: none">Extensive property impactsDisruptive to residential back-yards
a	<100-year open channel (smaller version of Alt A)	\$1.2M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flood
B	100-year storm drain system	\$3.1M \$2.9M*	<ul style="list-style-type: none">Utilizes existing Right-of-WayDoes not require property acquisitionProvides local drainage along Alpine Av	<ul style="list-style-type: none">Does not address overland flow in existing flow pathSusceptible to clogging
b	<100-year storm drain system (smaller version of Alt B)	\$2.0M \$1.9M*	<ul style="list-style-type: none">Similar to Alt BReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt BDoes not contain 100-year flood

*Reduced costs if detention is implemented at Reach 1



Upper Goose Creek
Reach 5: 17th St to 20th St



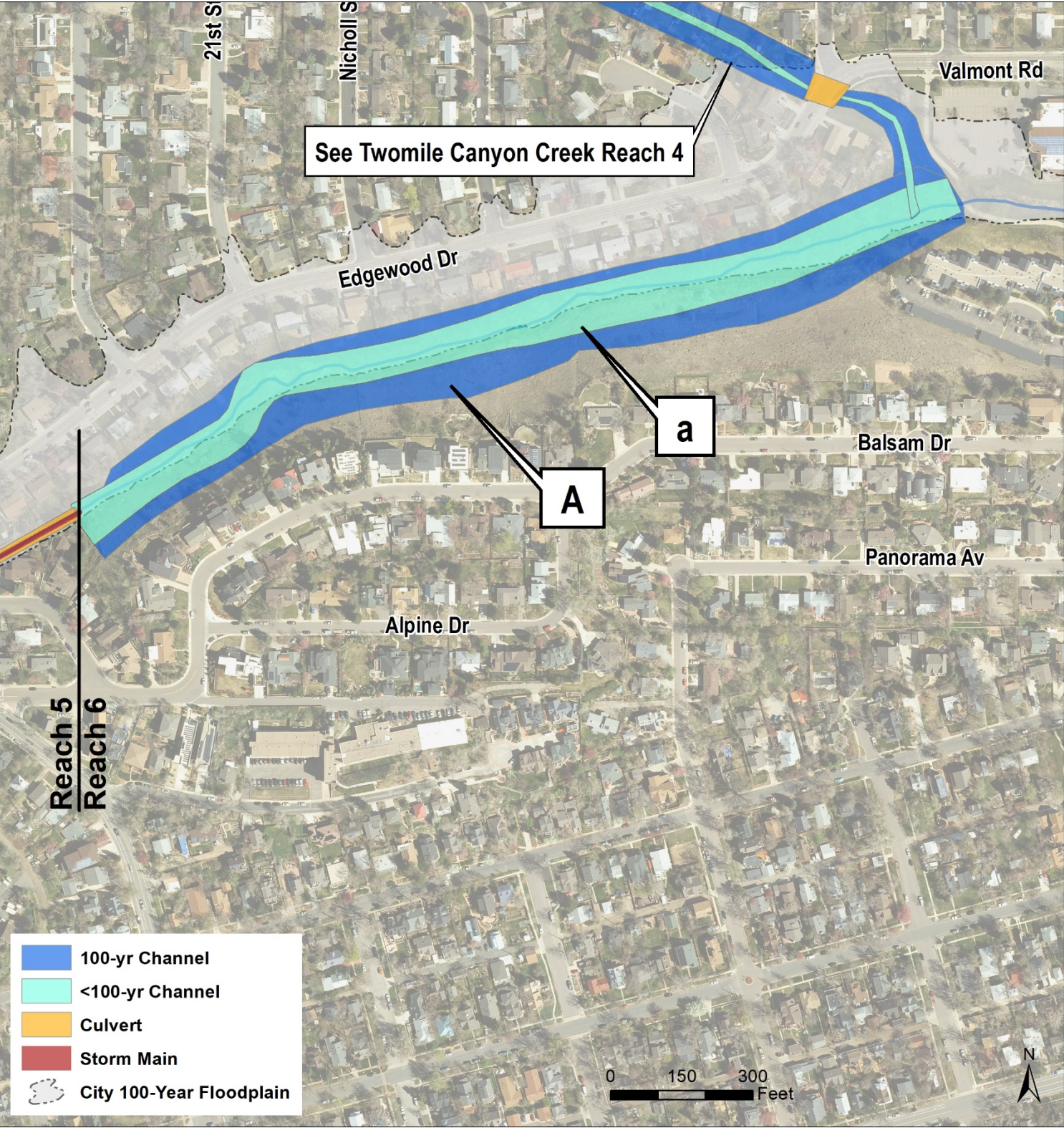
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Information about the Alternatives

Alt	Description	Cost	Benefits	Issues
A	100-year open channel	\$26M	<ul style="list-style-type: none">Provides additional open channel habitatGreen infrastructureRemoves high hazard structures from floodplain	<ul style="list-style-type: none">Requires Alpine Condo acquisitionReduces residential units within City
a	<100-year improvements (smaller version of Alt A)	\$2.9M	<ul style="list-style-type: none">Similar to Alt CReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt CDoes not contain 100-year flood
B	100-year storm drain system	\$2.2M \$2.0M*	<ul style="list-style-type: none">Utilizes some existing Right-of-WayDoes not require Alpine Condos removalProvides local drainage adjacent to Alpine Condos	<ul style="list-style-type: none">Requires drainage easement acquisitionDisruptive to Alpine Condo property (construction)Susceptible to clogging
b	<100-year improvements (smaller version of Alt B)	\$1.6M \$1.5M*	<ul style="list-style-type: none">Similar to Alt BReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt BDoes not contain 100-year flood



Upper Goose Creek
Reach 6: 17th St to 24th St



Information about the Alternatives

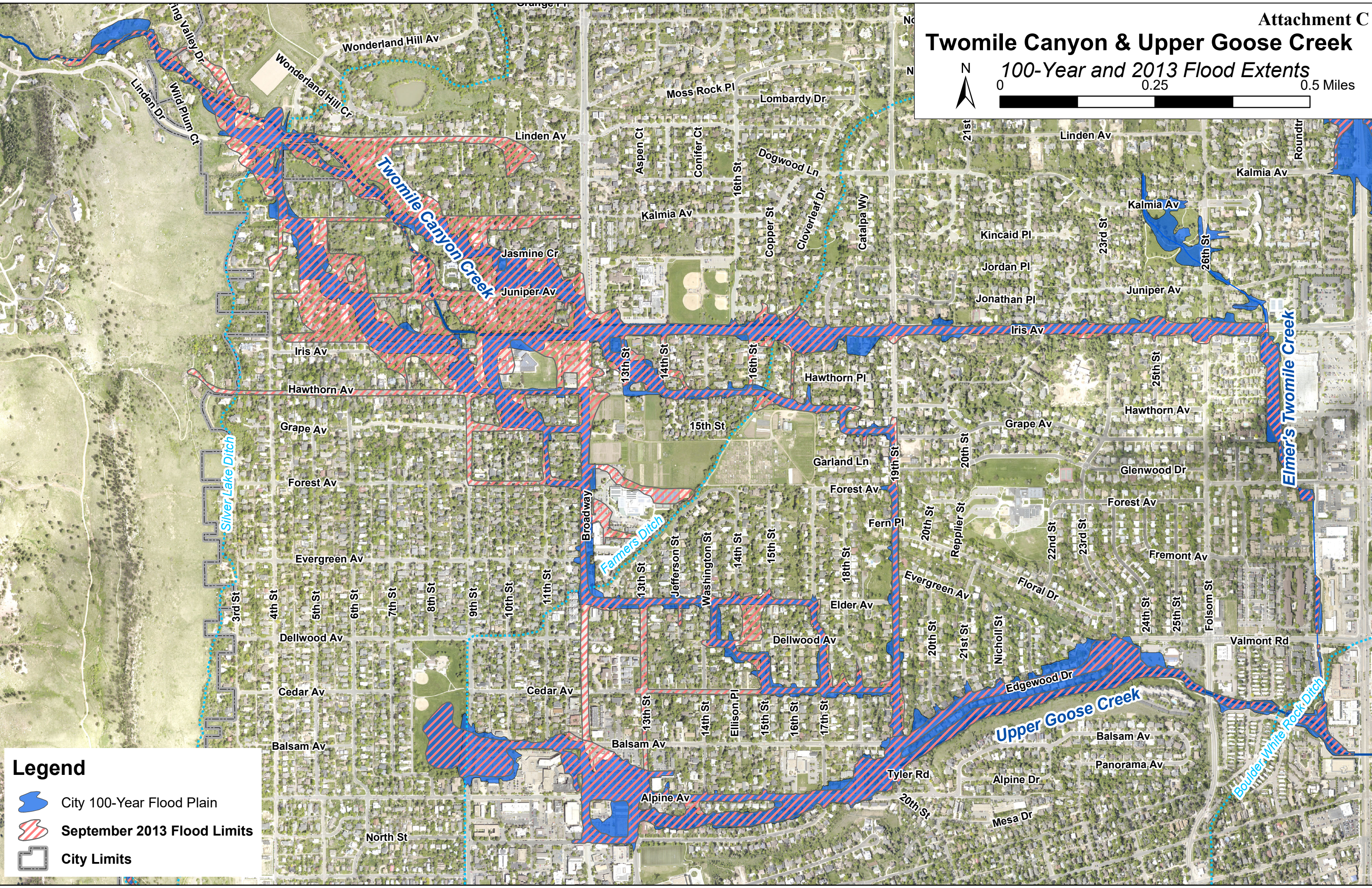
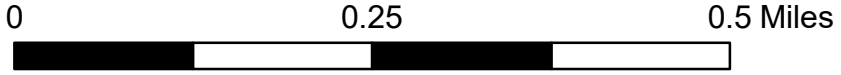
Alt	Description	Cost	Benefits	Issues
A	100-year open channel	\$12M	<ul style="list-style-type: none">Provides additional open channel habitatEnhances existing drainage pathGreen infrastructure	<ul style="list-style-type: none">Extensive property impactsDisruptive to residential back-yardsRequires tall retaining walls on south bank
a	<100-year channel (sizing per previous study recommending a "5-year" improvement; exceeds 5-year with detained flow and/or Twomile improvements)	\$5.7M	<ul style="list-style-type: none">Similar to Alt AReduced cost and property impacts	<ul style="list-style-type: none">Similar to Alt ADoes not contain 100-year flow



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.

Twomile Canyon & Upper Goose Creek

100-Year and 2013 Flood Extents



Legend

-  City 100-Year Flood Plain
-  September 2013 Flood Limits
-  City Limits