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

MEETING DATE: August 18, 2014

AGENDA TITLE: Public hearing and consideration of a recommendation to City Council regarding the South Boulder Creek Major Drainageway Mitigation Plan.

PRESENTER/S:
Jeff Arthur, Director of Public Works for Utilities
Bob Harberg, Principal Engineer - Utilities
Annie Noble, Flood and Greenways Engineering Coordinator
Don D'Amico, Ecological Systems Supervisor, Open Space and Mountain Parks
Kurt Bauer, Engineering Project Manager

EXECUTIVE SUMMARY:

The purpose of this memorandum is to provide a summary of the South Boulder Creek major drainageway flood mitigation planning study including the study recommendation. This mitigation plan was initiated in 2010 after the floodplain mapping was updated in 2007. The focus of the study is on developing and evaluating alternatives designed to mitigate flood hazards affecting structures and areas along South Boulder Creek and the West Valley within the current incorporated city limits.

A Risk Assessment completed in 2009 estimates that a 100-year storm event would result in approximately $215 million in damages in the South Boulder Creek drainage basin. The September 2013 flood resulted in overtopping of US36 and corresponding flooding through the West Valley with reported damages of $38 million. The 2013 flood is estimated to have resulted in flows above a 50-year event but below the 100-year flow used in the Risk Assessment to estimate damages.

Since the major drainageway mitigation study was initiated, multiple flood mitigation alternatives have been evaluated to address flooding associated with South Boulder Creek. The alternatives were screened from fifteen concepts down to four via the planning process. Consultants for the study recommend an alternative that would eliminate the overtopping of US36 during a 100-year event and provide flood protection for 362 structures (893 dwelling units) at a cost of $46 million. The $46 million alternative would include a 560 acre-foot regional flood detention facility, three smaller stormwater detention features at various locations ranging from 9 to 58 acre feet and piping a segment of Dry Creek No. 2 Ditch. The alternative could be constructed in phases ranging from $12 to $23 million. Construction of the project would require numerous federal, state and local permits, agreements with the University of Colorado and Boulder Valley School District, and disposal of Open Space and Mountain Park land. The regional detention facility portion of the alternative would be regulated by the State

as a high hazard dam. Construction of the regional detention facility at US36 would result in significant impacts to federal and city regulated wetlands, habitat for federally threatened plant and animal species agricultural resources, the South Boulder Creek State Natural Area (SBCSNA) and other environmental and aesthetic resources.

Staff is recommending that the "West Valley Improvements" and "Arapahoe Detention" components of the "recommended alternative" proceed to the Community Environmental Assesment Process (CEAP) separate from the "Regional Detention at U.S. 36" component. While these measures are not as comprehensive as the full recommended alternative, it is anticipated that they could be designed, permitted, funded, and implemented in the relatively near future. Staff recommends seeking additional direction from City Council regarding the "Regional Detention at U.S. 36" component. If City Council determines that flood mitigation benefits outweigh associated environmental impacts after considering input from the WRAB, the Open Space Board of Trustees, city staff, and the public, the "Regional Detention at U.S. 36," the project could proceed on a separate time table.

STAFF RECOMMENDATION:

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

> The Water Resources Advisory Board recommends that City Council accept the South Boulder Creek Major Drainageway Plan and the "Regional Detention at U.S. 36 with Downstream Improvements" as the recommended comprehensive alternative to mitigate flood risks associated with South Boulder Creek.
>
> However, the Water Resources Advisory Board recommends proceeding only with the "West Valley Improvements and Arapahoe Detention Phases" of the recommended alternative at this time.
>
> The WRAB recommends proceeding with the "Regional Detention at U.S. 36" component of the alternative only if City Council determines that flood mitigation benefits outweigh associated environmental impacts after considering input from the WRAB, the Open Space Board of Trustees, city staff, and the public.

COUNCIL FILTER IMPACTS:

- Economic: A total of 700 structures (442 within city limits) and approximately 1,200 dwelling units (962 within city limits) are located within the 100-year South Boulder Creek floodplain. A risk assessment completed in June 2009 estimated a 100-year event would result in $215 million in damages. South Boulder Creek (SBC) had the greatest reported property damage from the 2013 flood of all the city's 15 major drainageways at $38 million. Approximately 362 structures (893 dwelling units) within the city limits would no longer be located in the 100-year floodplain if the study recommendation is constructed (approximately 80 structures would remain in the floodplain within city limits under this alternative).

- Environmental: One of the Boulder Valley Comprehensive Plan general policies states the city's commitment to open space preservation and the use of open space buffers to define the community. Construction of the regional detention facility at US36 portion of the study recommendation would impact OSMP land with some of the highest ecological values in the Boulder Valley. The project area on OSMP lies entirely within the SBCSNA which was designated by the State of Colorado in recognition of the state-wide significance of this exceptional riparian and floodplain ecosystem – including the federally threatened Preble's meadow jumping mouse (PMJM) and Ute ladies'- tresses orchid (ULTO) habitat, tallgrass prairie, wetlands, habitat for declining grassland and riparian bird species, habitat for declining amphibians such as the Northern Leopard Frog, and habitat for declining native fish. Tallgrass prairie is considered one of the most endangered plant communities in the world and OSMP land in the project area contains some of the highest quality remaining tallgrass prairie in the state and the region. Additionally, Boulder's ULTO population is one of the largest within the entire range for this federally threatened plant species.
- Social: The flood hazards associated with SBC are a risk to life, property and business. Mitigating these hazards would further social sustainability goals and benefit a diverse set of community stakeholders. The areas that would benefit from mitigation contain affordable housing, senior housing, medical facilities, and numerous homes and businesses. . Construction of the study recommendation would result in temporary disruption to local residents, businesses and transportation routes that would be impacted during construction.

OTHER IMPACTS:

- Fiscal: The study recommendation is estimated to cost $46 million. Partial funding ($12.2 million) for this study is included in the Department of Public Works Utilities division budget. The project could be constructed in phases with each phase estimated to cost from $11 - $23 million. The city would seek grant funding for this project.
- Staff Time: Time for completing the study is included in existing work plans.

BOARD AND COMMISSION FEEDBACK:

Nine conceptual alternatives were presented to WRAB in December 2010. Staff recommended five alternatives be selected for further refinement and analysis. WRAB motioned to move forward with four of the nine alternatives (a pipe alternative was eliminated) including:

1. Maintaining the status quo;
2. High Hazard Zone mitigation and critical facility protection;
3. Regional detention at US36 with downstream improvements; and
4. Distributed regional detention.

Attachment A presents the 2010 WRAB memorandum and corresponding meeting minutes.

During the July 21, 2014 information item meeting, WRAB requested that additional background information be presented at the August 21, 2014 agenda item meeting on the original list of nine short-listed alternatives.

The Open Space Board of Trustees has been updated several times during the project's planning process but has not been presented with the preferred alternative. A meeting with the Open Space Board of Trustees is scheduled for August 20, 2014 to present the alternatives as an information item. The Board will be asked to make a recommendation to City Council at a future meeting.

PUBLIC FEEDBACK:

Conceptual alternatives were initially developed by problem area in a matrix format that included a wide range of mitigation measures. These concepts were then presented at a public meeting held in March 2010 and subsequently screened from input received at the meeting, hydraulic modeling and field visits. The concepts were then combined into 15 Alternative Plans. These alternatives were evaluated and nine Best Alternative Plans were developed and presented at a second public meeting in September 2010. Forty one people responded that mitigating flood risk along South Boulder Creek was very important, eight responded it was somewhat important and three stated they had no opinion. A public open house will be conducted just prior to the August 18 WRAB meeting (5 – 6:45 p.m.).

BACKGROUND:

In the mid-1990s the University of Colorado (CU) was evaluating the purchase of land, (the South Campus) located at US36 and Table Mesa. During this evaluation, inaccuracies in the 1986 regulatory flood mapping were discovered. Studies commissioned by the city and the Urban Drainage and Flood Control District (UDFCD) revised the 100-year floodplain and estimated that a 100-year storm event would result in approximately $215 million in damages in the South Boulder Creek drainage basin. South Boulder Creek had the greatest reported property damage from the 2013 flood of all the city's 15 major drainageways at $38 million (the 2013 flood is estimated to have resulted in flows above a 50-year event but below the 100-year flow used in the Risk Assessment to estimate damages). Additional background information can be found on the project web site (www.southbouldercreek.com) and in the study report (Draft South Boulder Creek Major Drainageway Plan).

The South Boulder Creek Flood Mitigation Planning Study began in early 2010 and is being funded by the city and the UDFCD. A consulting team from CH2MHill was selected to perform the study. The study is focused on developing and evaluating alternatives designed to mitigate flood hazards affecting structures and areas within the current incorporated city limits, primarily within the West Valley area (**Attachment A).** A draft report has been updated in July 2014 with the executive summary presented as **Attachment B**.

Conceptual alternatives were initially developed by problem area in a matrix format that included a wide range of mitigation measures. These concepts were then presented at a public meeting held in March 2010 and subsequently screened from input received at the meeting, hydraulic modeling and field visits. The concepts were then combined into 15 Alternative Plans. The 15 Alternative Plans are summarized in tabular format as **Attachment C**. Concept-level sizing, configurations and costs were developed for each of these 15 Plans along with an estimate of likely benefits and environmental and social impacts. From this information, nine Best Alternative Plans were developed. These

alternatives were presented at a second public meeting in September 2010 and to the WRAB in December 2010. **Attachment D** presents the 2010 WRAB memorandum that includes a graphical summary of the nine alternatives and a summary comparison of the alternatives.

At the December 2010 meeting, staff recommended that five alternatives be selected for further refinement and analysis. WRAB motioned to move forward with only four of the nine alternatives (a large diameter, multi-inlet pipe alternative was eliminated). **Attachment D** presents the meeting minutes documenting the discussion leading to the WRAB motion. The WRAB motion of short-listed alternatives included:

1. Maintaining the status quo;
2. High Hazard Zone mitigation and critical facility protection;
3. Regional detention at US36 with downstream improvements; and
4. Distributed regional detention.

ANALYSIS:

Based on further evaluation of the four alternatives recommended by WRAB in 2010, the South Boulder Creek Major Drainageway Flood Mitigation Planning Study recommendation is the Regional Detention at US36 with Downstream Improvements alternative. The alternative is estimated to cost $46 million to construct and includes the following major components:

- An approximately 75-acre (560 acre-feet of storage) regional flood detention facility located on University of Colorado South Campus land and Open Space and Mountain Parks land. The concept does not impact the current South Campus concept development plan.
- A 25 acre-foot stormwater storage facility at or near Manhattan Middle School (or alternative location), a 9 acre-foot detention storage area at the intersection of Foothills Parkway and Baseline Road and placing a segment of Dry Creek No. 2 Ditch in a 72-inch diameter pipe.
- A 58 acre-foot stormwater detention facility at Flatirons Golf Course by constructing earthen berms near Arapahoe Avenue.

The recommended alternative would provide 100-year flood protection within the West Valley area at an estimated cost of approximately $46 million and could be constructed in up to the following three separate phases:

1. Regional detention facility at US36 ($23 million);
2. West Valley improvements ($11 million); and
3. Arapahoe Avenue detention ($12 million).

Construction of all the phases of the recommended alternative would eliminate overtopping of US36 and subsequent flooding in the West Valley during a major storm event. Approximately 362 structures habitable (893 dwelling units) within city limits would no longer be located in the 100-year floodplain if the study recommendation is constructed (approximately 80 structures would remain in the floodplain within city limits) under this alternative. **Attachment E** presents the entire study recommendation. Construction of the regional detention facility at US36 phase would provide 100-year flood protection to approximately 212 structures as shown in **Attachment F**. Construction of the remaining two phases (West Valley improvements and the Arapahoe

Avenue detention facility) would provide 100-year flood protection to approximately 190 habitable structures as shown in **Attachment G**.

Construction of US36 regional detention facility phase would require numerous permits, agreements with the University of Colorado, disposal of Open Space and Mountain Park land and would be regulated by the State as a high hazard dam. Construction of the regional detention facility would also result in significant impacts to OSMP resources including habitat for threatened and endangered species (Preble's meadow jumping mouse, Ute Ladies'-tresses orchid) tallgrass prairie, wetlands, habitat for declining grassland and riparian bird species, habitat for declining amphibians such as the Northern Leopard Frog, and regionally significant agricultural resources and aesthetic resources. This portion of the project would also likely require National Environmental Policy Act (NEPA) compliance and a federal Environmental Assessment (EA) or Environmental Impact Statement (EIS).

The city hired ERO Resources to identify likely environmental impacts and corresponding permitting and mitigation measures that would be associated with constructing the US36 regional detention facility. **Table 1.0** presents a summary of their findings. **Attachment H** presents a summary of the OSMP staff analysis of the impacts**.**

Staff is recommending that the "West Valley Improvements" and "Arapahoe Detention" components of the "recommended alternative" proceed to the Community Environmental Assesment Process (CEAP) at this time, separate from the "Regional Detention at U.S. 36" component. While these measures are not as comprehensive as the full recommended alternative, it is anticipated that they could be designed, permitted, funded, and implemented in the relatively near future. Staff recommends seeking additional direction from City Council regarding the "Regional Detention at U.S. 36" component. If City Council determines that flood mitigation benefits outweigh associated environmental impacts after considering input from the WRAB, the Open Space Board of Trustees, city staff, and the public, the "Regional Detention at U.S. 36," the project could proceed on a separate time table.

Table 1.0 – ERO Summary of US36 Regional Detention Facilities' Potential Environmental Impacts and Mitigation Options

Regulated Resource	Potential Impacts*	Potential Permitting / Mitigation
Waters of the US	Up to 9.5 acres (3.77 open water, 5.72 wetlands)	Will likely require an Individual Permit due to impacts > 0.5 acres. Mitigation option: conversion of Pits D and C (city-owned gravel pits located on OSMP land) to wetlands would provide up to 22 acres.
City-regulated streams, wetlands and water bodies	Up to 9.5 acres	Standard city wetland permit. Mitigation could require a ratio of 1:1 for impacts to open water (3.77 acre) and up to 2.5:1 for high functioning wetlands (up to 14.3 acres of mitigation); city-required mitigation would also satisfy federal (Corps 404) required mitigation
Threatened and Endangered Species	Up to 0.9 acres of PMJM critical habitat and 6 acres of general habitat; assumes up to 10 acres of potential orchid habitat	Preparation of a Biological Assessment. Relies on project team to set reasonable mitigation standards. Generally requires higher than 1:1 mitigation ratio (assumes a 3:1 ratio or 2.7 acres of mitigation for critical habitat; less for general habitat); mitigation for ULTO = avoid plants if possible, otherwise project team will work with the Service to determine mitigation; wetland mitigation.
Migratory birds and raptors	Up to 23 acres of terrestrial habitat	Nest depredation permit for active nest removal. Avoidance of active nest removal does not require a permit. Nests can be removed outside of the breeding season.

*Estimates are conservative as estimated by ERO Resources based on field surveys of wetland and open water and maximum anticipated footprint of the alternative.

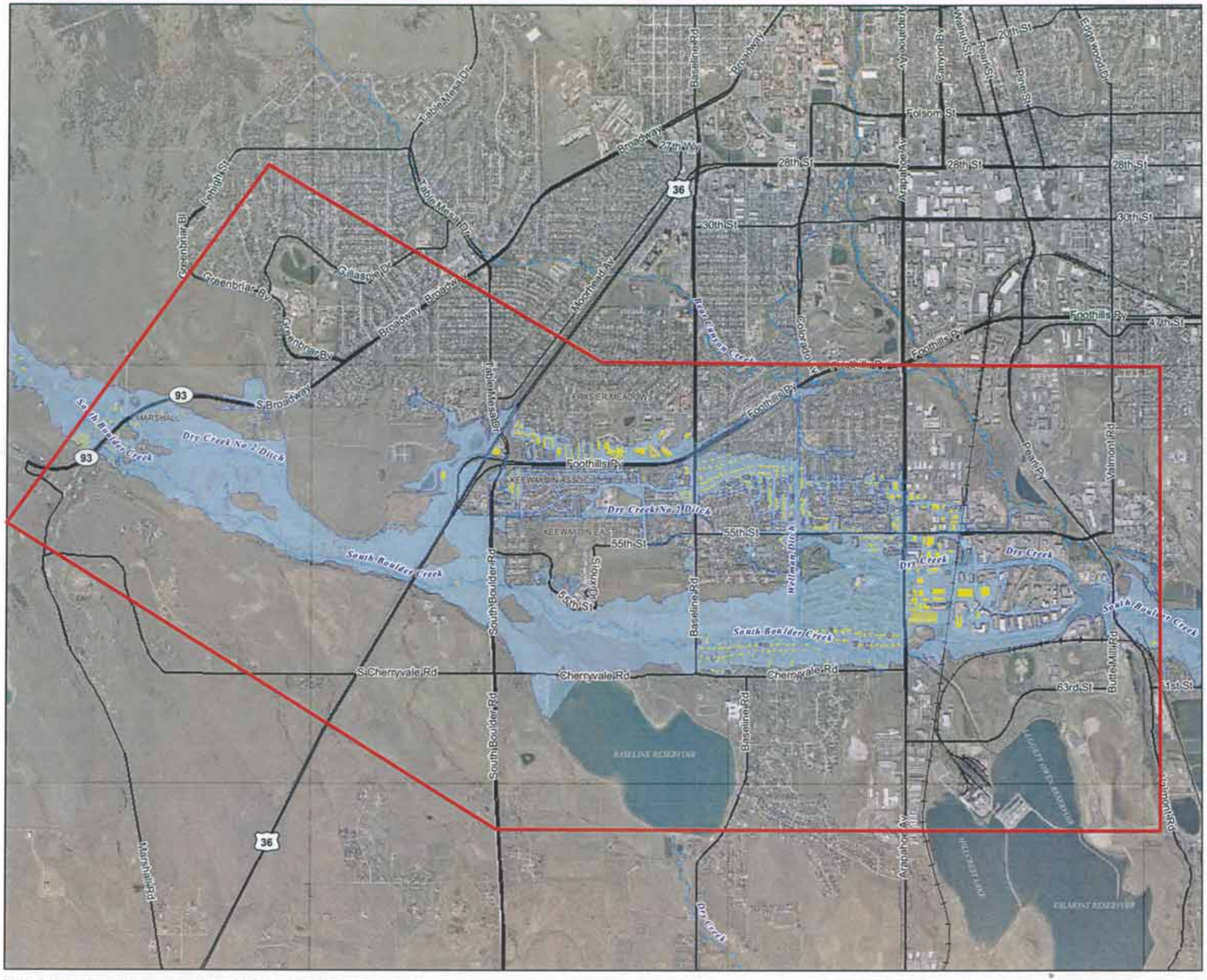
NEXT STEPS:

An open house will be conducted on August 18 from 5 – 6:45 p.m. to present study information to the public. A meeting with the Open Space Board of Trustees is scheduled for August 20 to present the study information OSBT will be asked to make a recommendation to City Council at a future public meeting. A study session with City Council is tentatively scheduled for September 30.

ATTACHMENTS:

A. Study area
B. Draft South Boulder Creek Major Drainageway Plan Executive Summary
C. Tabular summary of original 15 Alternative Plans
D. 2010 WRAB memorandum and corresponding meeting minutes
E. Study recommendation
F. Flood mitigation from Phase 1 of the recommended alternative
G. Flood mitigation from Phases 2 and 3 of the recommended alternative
H. Open Space and Mountain Parks summary of environmental resources and potential impact

Attachment A – Study Area



VICINITY MAP

LEGEND

- Structures within Revised Regulatory Floodplain
- Revised Regulatory Floodplain

Streams, Creeks and Ditches

- Streams, Creeks and Ditches
- Boundary County

Notes:
1. Area of Interest
2. Revised regulatory floodplain impacts 1,253 structures

N

0 1,000 2,000 3,000 4,000 5,000
Feet

FIGURE 2-2
Revised Regulatory Floodplain
South Boulder Creek Flood Mitigation Report
South Boulder Creek Flood Mitigation Project

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CH2MHILL

Attachment B – Draft South Boulder Creek Major Drainageway Plan Executive Summary

ES. Executive Summary

Purpose and Scope

This Major Drainageway Planning Study was prepared as part of the *South Boulder Creek Flood Mitigation Study* (Study) authorized by the City of Boulder (Boulder) through Purchase Order 98 2009 DP005380 on December 23, 2009. The Urban Drainage and Flood Control District (District) was a financial participant in the project and provided oversight during the project execution.

South Boulder Creek is a major drainageway that conveys stormwater runoff from Eldorado Canyon west of the City of Boulder through the eastern portions of the City of Boulder. After leaving Eldorado Canyon and crossing Hwy 93 and US-36, South Boulder Creek follows several flow paths before reaching Boulder Creek. Development and other anthropogenic features subject the lower parts of the basin to periodic flooding because of overflows that propagate to one of the various flow paths. These overflows contribute to the flood hazard at areas far removed from the mainstem. In particular, much of the area known as the West Valley of South Boulder Creek (West Valley) lies along one of the historic low points and is subject to periodic flooding because of spills out of the main channel. The focus of this study is to address flooding problems in the lower portions of the basin within the City of Boulder, with a particular emphasis on the flooding problems through the area of the West Valley.

The project builds on the *Flood Mapping Study* (Mapping Study) completed by HDR Engineering, Inc. (HDR) in late 2008. That study produced floodplain maps. A *Risk Assessment Report (HDR, May 2009)* was also prepared that identified approximately $8.7 million dollars in annual damage from South Boulder Creek flooding and the addition of approximately 700 structures not previously identified as flood prone.

The focus of the Study is to define alternatives that address the flood problems in the West Valley, an area generally bounded by US-36 on the south, Mohawk Drive on the west, 55th Street on the east and Arapahoe Avenue on the North (Study Area). This area had been omitted from earlier flood maps prepared for the City. As such, much of the area was developed without consideration of the large flood threat from South Boulder Creek. The Study identifies drainage improvements that, in combination, provide the most beneficial means of addressing the identified flooding problems.

Planning Process

The process used to prepare the Study is to build a comprehensive master drainage plan using existing information, a suite of viable alternative elements and an evaluation of several alternative plans.

Existing information regarding the South Boulder Creek watershed was reviewed and stakeholders were engaged and asked to provide concerns and constraints. This information was used to develop a screening matrix to assess the effectiveness of the suite of potential solution approaches to address the identified problems. Alternatives elements that were patently infeasible, either for reasons of technical issues, cost, environmental issues or public input were eliminated and the remaining elements were then assembled into alternative plans.

Fifteen alternative plans were developed to address the identified problems in a holistic way, recognizing the benefits of certain upstream improvements to control downstream flood threats. These alternatives included a Status Quo alternative that proposed no improvements but did include the enforcement of the City's floodplain management and development regulations. Other alternatives included various structural components that provided improved storage, collection or conveyance of the flood flows, thereby reducing the flood threat. Sizing, alignments and costs were determined for each of the alternatives for a variety of discharges. Benefits were estimated using information developed previously in the Risk Assessment. Other considerations important to the City, such as preservation of Open Space and habitat areas, minimizing disruption to the community or conforming to broader City Policies were included in the evaluation of the alternatives. This information allowed a direct comparison among the alternatives and provided a foundation for the selection of Best Alternative Plans.

The nine Best Alternative Plans, described in Table ES-1, represent those plans from among the studied alternative plans that were able to address the flood hazard the most effectively. In many cases, these plans were not necessarily the least costly or the ones with the fewest environmental or public issues; rather, they were the plans that provided the greatest benefit for the investment and were felt to have other issues that could be mitigated.

TABLE ES-1

Best Alternative Plans

Alternative	Description
1	Status Quo
2	High Hazard Zone containment with critical structure flood proofing
3	Regional Detention at US-36 with downstream storage and conveyance improvements through West Valley and along Dry Creek No. 2 Ditch
4	Regional Detention near Hwy-93 with downstream storage and conveyance improvements through West Valley and along Dry Creek No. 2 Ditch
5	Distributed Regional Detention with downstream storage and conveyance improvements through West Valley and along Dry Creek No. 2 Ditch
6	Mainstem flow containment with local West Valley improvements
7	Dry Creek No. 2 Ditch pipeline
8	Bear Canyon Creek pipeline
9	Nuisance – Level Flood Improvement Protection

The evaluations conducted for these early alternatives were summarized and presented to key stakeholders representing major landowners and public infrastructure within the basin as well as the public, City Open Space and Mountain Parks (OSMP) Board, and the Water Resource Advisory Board (WRAB).

Based on recommendations from the Water Resources Advisory Board (WRAB) and Open Space and Mountain Parks (OSMP) staff, the Best Alternative Plans were reduced to five Best Alternate Plans that were to be refined based on additional interests and issues that were identified as being important in the selection and implementation of a selected alternative. The five alternatives identified for further evaluation include:

- Status Quo
- High Hazard Zone Mitigation
- Regional Detention at US-36
- Distributed Regional Detention
- Bear Canyon Creek Pipeline

The evaluation of each of the Best Alternative plans included many considerations. In addition to the financial and flood control elements implicit in the evaluation of the alternatives, the stakeholder involvement identified a number of other considerations that were assessed during the evaluation process. These issues are summarized below. Table ES-2 presents a summary of the findings of the Best Alternative Plan evaluation.

Benefit-Cost Analysis - The aggregated costs for each of the Best Alternative Plans were compared to the computed flood reduction benefits to determine a Benefit-Cost relationship for the alternative. This ratio provides a simple numeric measure of the return on investment but is not the sole basis for recommendation of a particular alternative.

Water Quality - All of the alternatives will continue to incorporate the ongoing measures already in place within the City to control impacts to water quality. In general, alternatives employing natural channels and detention storage will provide greater water quality benefits.

Natural Environment - Boulder has a longstanding tradition of nurturing, protecting and integrating greenways, Open Space lands, buffers, wetlands or other habitat areas. Areas containing high functioning wetlands have been avoided to

the extent possible. In some cases, minor impacts to the fringes of these areas may have been unavoidable but the level of encroachment has been minimized.

Along South Boulder Creek, there are numerous areas where the groundwater table supplies an important water source for wetlands. Every effort was made to understand the nature of the groundwater near the proposed improvements and to avoid or minimize any potential adverse impacts.

Threatened and Endangered Species – The locations of threatened and endangered species consisting primarily of the orchid and the Preble's Meadow Jumping Mouse were investigated. The flood control measures proposed in the various Alternative Plans have been formulated to avoid these areas to the extent possible.

Open Space Lands - The alternatives identified in these plans were formulated to minimize the impacts to Open Space lands. However, since many of these lands fall in or near the conveyance areas of the channel, all impacts were unavoidable. The type and function of Open Space lands was considered in the layout of improvements associated with the Alternative Plans to limit physical improvements to the extent possible.

Social Impacts - Each of the projects, other than the Status Quo, has associated construction impacts that can generally be mitigated in the design and construction process. Efforts were made to minimize the potential permanent disruption to mature vegetation and existing sight lines.

The alignments identified for the various alternative plans were chosen to try to minimize the impact on private properties. Unfortunately, not all impacts to private property could be avoided. The costs for each of the plans include provisions for the purchase of easements or outright purchase of the property. The estimates are based on costs derived from the City's recent experience.

City Policies - During past studies of South Boulder Creek, the City identified guidelines that could be used as guidance in the development and evaluation of alternatives. Many of these reflect sound flood control principles while others reflect the collective interests of the community and its leadership. These issues, include avoiding channelization of South Boulder Creek, limiting the amount of private property necessary for the implementation of the alternatives, minimizing the use of large mainstem dams to control flooding, and a continued commitment to floodplain management are all incorporated to the extent possible.

TABLE ES-2
Best Alternative Plan Evaluation Summary

Alternative	Total Implementation Cost ($millions)	Present Worth of Benefits ($millions)	Benefit-to-Cost Ratio	Plan Elements	Significant Considerations
Status Quo	$0.00	$0.00	0	Maintains systems and processes as they are today.	Provides no enhanced flood protection anywhere in the system.
High Hazard Mitigation	$0.14	$0.00	0	Includes grading changes to eliminate structures from the designated High Hazard Zone.	Provides no substantive enhancement to level of flood protection anywhere in the system.
Regional Detention at US-36	$46.91	$77.30	1.65	Detention pond at US-36 reduces US-36 overtopping threat and eliminates 100-year floodplain within West Valley. Local improvements in West Valley and at Arapahoe Avenue address local flood issues.	Meets defined objective of eliminating 100-year floodplain in West Valley. Some encroachment of facilities onto City-owned Open Space lands.
Distributed Regional Detention	$48.10	$75.90	1.58	Three detention ponds reduce US-36 overtopping threat to eliminate 100-year floodplain within West Valley and mitigate increased mainstem flows in channel downstream of US-36. Local improvements in West Valley and at Arapahoe Avenue address local flood issues.	Meets defined objective of eliminating 100-year floodplain in West Valley. Significant encroachment of facilities onto Open Space lands and into identified habitat areas.
Bear Canyon Creek Pipeline	$46.80	$58.00	1.24	Inlets and pipelines to capture and convey overflows from US-36. Local improvements in West Valley and at Arapahoe Avenue address local flood issues.	Generally addresses the objective of eliminating 100-year floodplain in West Valley with the exception of Apache Drive. Nominal impact to Open Space lands and identified habitat areas. Significant disruption to residential properties is expected during construction.

Engineer's Recommended Plan

The agreed upon scope of work requires the Engineer to provide a recommendation for City staff consideration. The Engineer's Recommended Plan is based on the described criteria and evaluations and represents the Engineer's best judgment. However, the Engineer may not be aware of issues or objectives that transcend the flood control objectives defined at the project's outset. As such, the Engineer's Recommended Plan should be viewed as a starting point to help the City understand the flood control issues, objectives and solutions and to allow City decision makers to refine, revise and modify the plan as necessary to achieve the broader community interests of the project.

Based on the refined analysis of the selected Best Alternative Plans, the **Regional Detention at US-36 Best Alternate Plan** was selected as the Engineer's Recommended Plan. The recommended plan includes a series of improvements to address the overtopping of US-36 and the flood concerns through the West Valley. This plan was selected because it removes approximately 700 structures from the 100-year floodplain, achieving the goals set at the onset of the project. In addition, this alternative has the highest Benefit-Cost Ratio of any of the alternatives reviewed.

The Engineer's Recommended Plan includes the following Features.

Engineer's Recommended Plan Refinement

A review of a conceptual version of the Engineers Recommended Plan with the City of Boulder Staff, coordination with stakeholders including CDOT and Open Space and Mountain Parks (OSMP), indicated that a more in depth look at the location and design of the US-36 flood control facility was required. As a result, the US-36 detention berm was refined in early 2014 to understand the constraints, opportunities and cost of this keystone element of the Engineers Recommended Plan. Specifically, the following items were addressed:

1. Options to minimize impacts to OSMP property
2. To ensure the flood control facility was compatible with the CDOT Phase I and Ultimate conditions construction plans for US-36
3. Understand and provide a conceptual mitigation plan for environmental impacts
4. Review geotechnical requirements for the site
5. Understand requirements for design and construction related to the Colorado State Engineers Office (SEO)
6. Refine the cost / benefit analysis to reflect refinements

Environmental Mitigation

As part of the plan refinement, a conceptual level look at environmental impacts was completed to better understand what the environmental impacts of the project would be as well as potential locations for environmental mitigation. Table ES=3 summarizes the environmental impacts of the recommended alternative.

Mitigation for environmental impacts was identified in the South Boulder Creek Basin. Pits C&D at the confluence of South Boulder Creek and Boulder Creek were identified for impacts to Waters of the US, Ute Ladies Tresses Orchid and city regulated wetlands mitigation. Mitigation will include filling the pits and developing wetlands habitat that would replace the wetlands habitat impacted by the project.

Mitigation for impacts to the critical Prebles Meadow Jumping Mouse Habitat will occur along the South Boulder Creek mainstem between Highway 93 and Baseline Road. Through this area, pockets of habitat along the South Boulder Creek channel will be enhanced to better support the Prebles Meadow Jumping mouse. In total approximately 2.7 acres of critical habitat is proposed to be enhanced to mitigate impacts.

TABLE ES-3
Summary of regulated natural resources, potential impacts, and potential permitting and mitigation within the project area

Regulated Resource	Resource IDs	Potential Impacts	Potential Permitting /Mitigation
Waters of the U.S. (including wetlands)	South Boulder Creek, Dry Creek Ditch No. 2, unnamed ponds, and wetlands	Up to 20 acres	More than 0.5 acre = Individual Permit Less than 0.5 acre = Nationwide Permit Mitigation option = conversion of Pits D and C to wetlands would provide up to 22 acres.
City-Regulated Streams, Wetlands, and Water Bodies	South Boulder Creek, Dry Creek Ditch No. 2, and unnamed wetland on OSMP property	Up to 7.4 acres	Standard City wetlands permit. Mitigation could require a ratio of 2.5:1 (up to 18.5 acres of mitigation); city-required mitigation would also satisfy Corps-required mitigation
Threatened and Endangered Species	Preble's meadow jumping mouse; Ute ladies'-tresses orchid	Up to 0.9 acre; assume up to 20 acres of ULTO habitat	Preparation of a Biological Assessment Relies on project team to set reasonable mitigation ratios that will eventually be discussed and set with USFWS staff. USFWS generally requires higher than 1:1 mitigation ratio (mitigation in this report assumes a 3:1 ratio or 2.7 acres of mitigation); mitigation for ULTO is to avoid plants if possible, otherwise project team will work with the USFWS to determine mitigation; wetland mitigation.
Migratory Birds and Raptors	Several species	Up to 20 acres	Nest depredation permit for active nest removal. Avoidance of active nest removal does not require a permit. Nests can be removed outside of the breeding season.

US-36 Stormwater Detention Facility

The US-36 Detention facility provides 100-year protection from the overtopping flows of South Boulder Creek to downstream properties in the West Valley. The selected US-36 detention pond alignment and configuration is the ***US-36 Zoned Earthen Berm combined with the US-36 Ultimate Conditions ROW.*** Although this configuration was selected due to the construction cost and the impacts to both OSMP and environmental resources can likely be mitigated. The alternative combines excavation and fill to produce a configuration that minimizes the impacts to Open Space land and the University of Colorado (CU) South Campus and to minimize the potential visual impact by integrating the detention berm into existing Foothills Parkway overpass berm that is outside both the Ultimate Conditions ROW and the Phase 1 ROW.

The Recommended Plan does create some unavoidable impacts to areas defined by the city as environmentally sensitive. This includes city regulated wetlands and some areas that may include critical habitat. These impacts have been addressed explicitly for the US-36 flood control berm and mitigation areas and a general conceptual plan has been identified. Costs have been added to the analysis to reflect this better understanding of the environmental impacts and mitigation.

Arapahoe Avenue Detention

The detention pond and associated outfall structures at Arapahoe Avenue take advantage of the Flatirons Golf Club golf course to provide 58 AF of storage that reduces the impact to downstream industrial and commercial properties. This facility also helps to collect shallow floodwaters that over top Arapahoe Road from the main stem of South Boulder Creek and the West Valley and convey them through two outlet channels below Arapahoe Avenue. The proposed west outfall will discharge flows to an existing flood channel that has adequate capacity while the east flood channel will require the construction of an outfall conveyance to return water to the South Boulder Creek mainstem. Both of these outfalls will

work in tandem the detention to store and attenuate flows helping to alleviate flooding issues downstream of Arapahoe Road. There are some unavoidable impacts to City regulated wetlands that will require mitigation and the alternative requires the acquisition of some private property.

Improvements in the West Valley

Although the detention at US-36 eliminates the overtopping flooding from South Boulder Creek, facilities through the West Valley were still required to convey 100-year storm flows generated through the West Valley and discharged from the US-36 Detention outfalls. Improvements in the West Valley are either in the form of small detention facilities that are used to capture and attenuate flows or improvements to existing conveyance infrastructure. Alignments of all the facilities take full advantage of existing publically owned lands and minimize the number of individual property owners impacted and impacts to known utility lines.

- 25-AF of detention at Manhattan Middle School - Captures locally generated flows that can be discharged to the existing downstream infrastructure minimizing additional downstream system improvements.
- 9 AF Detention at the intersection of Foothills Parkway and Baseline Road - Collects flood flows at this intersection and discharges them to the channel parallel to Baseline Road taking advantage of the capacity of the downstream system.
- 2' Extension of the concrete retaining wall of along Baseline Road east of Foothills Parkway - Increase capacity of the channel and prevents overflows from entering the lower West Valley.
- Conveyance improvements to the New Anderson Ditch - Prevents overflows from entering the West Valley and conveys additional flow that results from the increased head generated by the storage above US-36.
- A wasteway structure for the Wellman Canal, east of Foothills Parkway - This will allow flood flows from Bear Canyon Creek that enter the Wellman canal to be discharged back into the Bear Canyon Creek historic channel. This improvement is required to help eliminate flood flows overtopping the Wellman Canal from causing additional flood hazards through the West Valley.
- 72 - Inch diameter pipe along Dry Creek No. 2 Ditch - This will convey 420 cfs of flows down the Dry Creek No. 2 Ditch corridor.

Engineer's Recommended Phasing

Implementation of the Recommended Plan will require the resolution of some issues that were outside the scope of the current Mitigation Planning Study. The study team believes these issues are not insurmountable and does not impose any fatal flaws on the Recommended Plan. Coordination with the University on the layout of the facilities associated with the US-36 Detention should continue. The proposed layout reflects early discussions but some further refinement may be desirable to optimize the use of the area while minimizing impacts from the berm. Similar refinements may be possible to further reduce the impact to Open Space lands. Working in concert with both CU and OSMP may provide further refinements that further optimize the use of the space.

Phasing of the elements of the Recommended Plan provides an opportunity to distribute the cost of implementation over a longer time and allows the community to reap benefits from the individual aspects of the improvements without full plan implementation. The elements of the Recommended Plan do allow for a phased implementation. The discussion below summarizes a possible Recommended Plan phased implementation recommendation.

Priority 1 – US-36 detention:

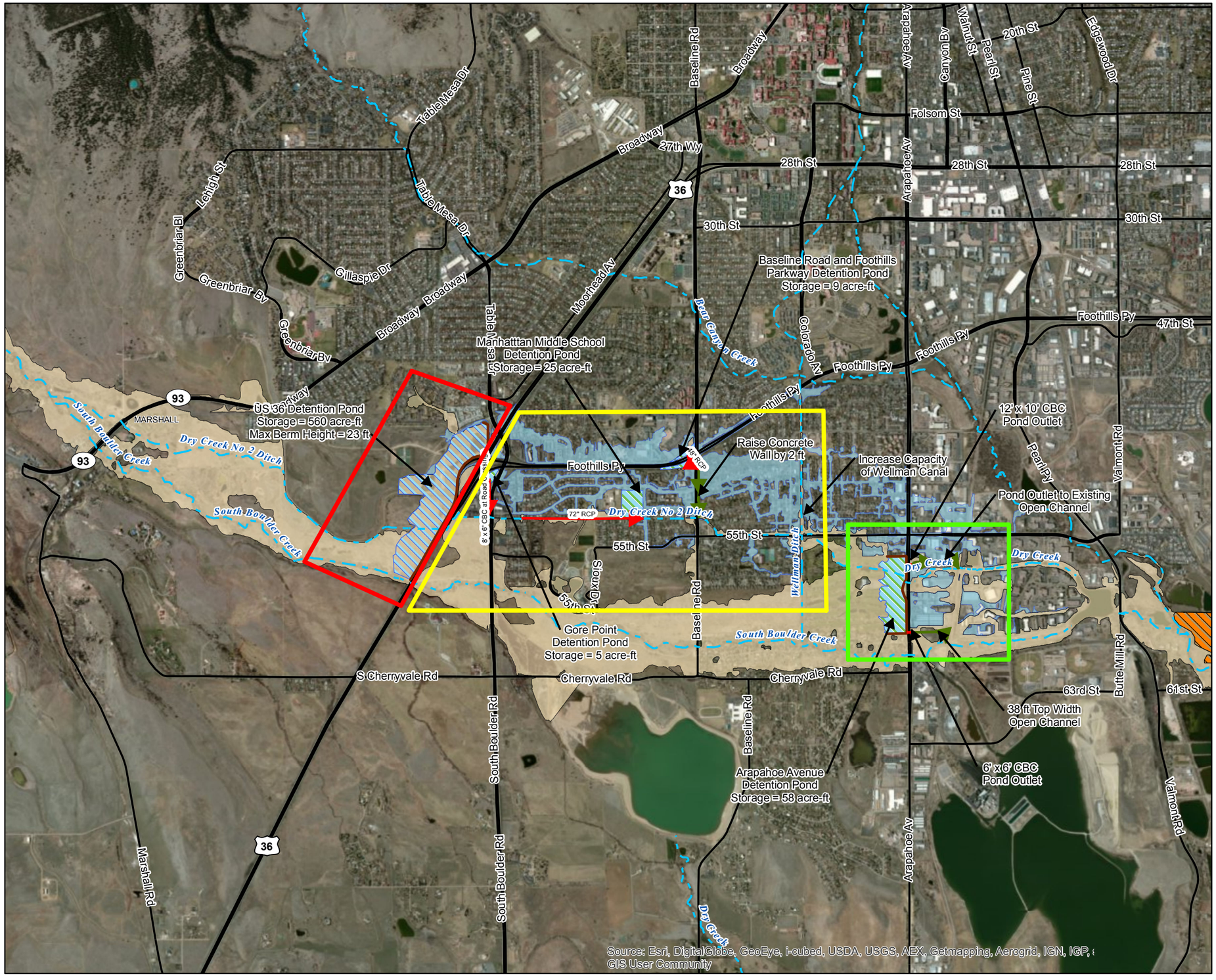
US-36 Detention is the recommended first element to be implemented. This project element fulfils the defined purpose of the project (reduce the flood hazard due to US-36 overtopping in the West Valley) without the need for further investment. In doing so, the flood insurance burden associated with the South Boulder Creek 100-year flood for those properties in the West Valley is eliminated and the real flood threat reduced to that of locally generated runoff flooding. . The proposed US-36 Detention facility has an element benefit-cost ratio of approximately 1.11 and an approximate capital cost of $26.3 million.

Priority 2 – Local West Valley Improvements

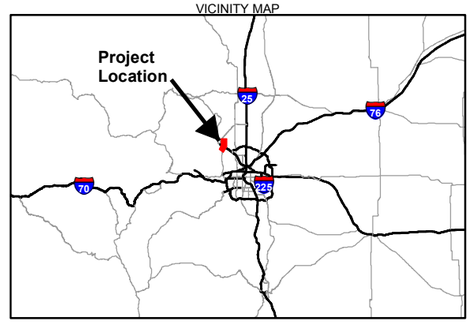
The proposed improvements in the West Valley address a number of different issues and are comprised of several smaller elements, including: local detention at Manhattan Middle School, Dry Creek No. 2 Ditch pipeline improvements, local detention at Baseline Road and Foothills Parkway, floodwall improvements along Baseline Road, improvements to the New Anderson Ditch and improvements to the Wellman Canal. Implementation of these elements should generally follow broad drainage facility implementation guidance. That is, detention can and should be implemented early in the process to fully exploit the flow reduction realized through these facilities. Then the flood control measures such as the pipeline improvements along Dry Creek No. 2 Ditch and along Baseline Road should be implemented to provide adequate conveyance of the remaining flows. The improvements to the other irrigation ditches are intended to prevent overflows and contain those flows in the original system. These can often be done independently of any other improvements and can be implemented as need or opportunities arise. In aggregate, these improvements are expected to cost $11.0 million to implement and result in a benefit-cost ratio of 3.2.

Priority 3 – Arapahoe Avenue Detention

The Arapahoe Avenue detention pond and associated downstream improvements provide considerable flood relief to those properties below Arapahoe Avenue however; the floodplain reduction associated with these improvements is relatively localized making this the last of the suggested implementation priorities. The improvements are estimated to cost $11.9 million and will result in a benefit-cost ratio of 1.3.



VICINITY MAP



LEGEND

Conveyance Alignment

Category

- Open Channel Improvement
- Pipeline/Culvert Improvement
- Embankment
- Environmental Mitigation (Pits C&D)
- Streams, Creeks and Ditches
- Detention at US 36
- Local Detention
- Post Project Floodplain
- Existing Floodplain

Notes:

1. Phase 1 Improvements
   US-36 Detention
   B/C Ratio = 1.1
2. Phase 2 Improvements
   West Valley Improvements
   B/C Ratio = 3.2
3. Phase 3 Improvements
   Arapahoe Avenue Detention
   B/C Ratio = 1.3

N

0 1,000 2,000 3,000 4,000
Feet

FIGURE ES-1
Regional Detention at US-36
South Boulder Creek Flood Mitigation Report

Attachment C: Tabular Summary of Original 15 Alternative Plans

TABLE 6-4

Summary of Conceptual Alternative Plans

Alternative	Description	Estimated Construction Cost	Estimated Benefit	Benefit to Cost Ratio	Environmental Impacts	Social Impacts
1	Status Quo	$0	-	-	• No Impacts	• No reduction in flood risk
2	High Hazard Zone containment with critical structure flood proofing	$11,500,000	$1,150,000	0.10	• Limited Impacts	• No reduction in flood risk • Flood proofing reliability concerns
3	US-36 detention with downstream conveyance along Dry Creek No. 2 Ditch	$24,600,000	$46,700,000	1.90	• Habitat and wetland impacts • Periodic inundation of Open Space	• Requires formal agreement with CU • Provides 100-year protection in West Valley
4	US-36 detention with downstream conveyance through West Valley	$28,000,000	$46,700,000	1.67		
5	US-36 detention with downstream storage and conveyance through West Valley and along Dry Creek No. 2 Ditch	$24,200,000	$46,700,000	1.93		
6	US-36 detention with downstream diversion to Bear Canyon/Boulder Creek	$25,500,000	$46,700,000	1.83		
7	US-36 detention with downstream diversion to mainstem	$25,600,000	$46,700,000	1.82		
8	Detention near Hwy-93 with downstream conveyance along Dry Creek No. 2 Ditch	$24,100,000	$46,700,000	1.94	• Habitat and wetland impacts • Periodic inundation of Open Space	• Requires purchase of currently developed private property or OSMP • Provides 100-year protection in West Valley
9	Detention near Hwy-93 with downstream conveyance through West Valley	$27,500,000	$46,700,000	1.70		
10	Detention near Hwy-93 with downstream storage and conveyance through West Valley and along Dry Creek No. 2 Ditch	$23,700,000	$46,700,000	1.97		
11	Detention near Hwy-93 with downstream diversion to Bear Canyon/Boulder Creek	$25,000,000	$46,700,000	1.87		
12	Detention near Hwy-93 with downstream diversion to mainstem	$25,100,000	$46,700,000	1.86		
13	No upstream detention with downstream conveyance along Dry Creek No. 2 Ditch	$39,100,000	$46,700,000	1.19	• No water quality enhancement opportunities • Limited wetland impacts	• Construction traffic, road closures, and noise near homes • Traffic disruption on major roads including possible closures • Utility disruption during construction • Requires easement coordination with ditch companies • Provides 100-year protection in West Valley
14	No upstream detention with downstream conveyance through West Valley	$47,900,000	$46,700,000	0.97		
15	No upstream detention with downstream diversions	$38,900,000	$46,700,000	1.20		

Attachment D – 2010 WRAB Memorandum and Corresponding Meeting Minutes

CITY OF BOULDER
WATER RESOURCES ADVISORY BOARD
AGENDA ITEM

MEETING DATE: Dec. 14, 2010

AGENDA TITLE: Discussion about South Boulder Creek Flood Mitigation Plan Alternatives and selection of a short list of best alternatives for further evaluation and consideration.

PRESENTERS:	Ned Williams, Director of Public Works for Utilities Bob Harberg, Utilities Planning and Project Management Coordinator Annie Noble, Greenways Coordinator Kurt Bauer, Engineering Project Manager Don D'Amico, Ecological Systems Supervisor, Open Space and Mountain Parks

PURPOSE:

The purpose of this memorandum is to present and discuss the South Boulder Creek flood mitigation alternatives, including a newly developed alternative and select a short list of best alternatives for further evaluation and consideration. Project alternatives range from maintaining the status quo to providing 100-year flood protection.

BACKGROUND:

In 1996, the University of Colorado commissioned a flood study as part of its due-diligence review to purchase the 315-acre CU-Boulder South Campus. This study identified significant flood spills over US 36 that would impact east Boulder areas in what has subsequently been called the "West Valley Overflow" area.

In 1997, the city, Boulder County, the Urban Drainage and Flood Control District (UDFCD) and the Colorado Water Conservation Board, in cooperation with the Federal Emergency Management Agency (FEMA), commissioned another flood study (called the Taggart study) to verify the results of the CU study and to compare the results to the adopted floodplain mapping. Ultimately, the Taggart study was not approved and a new flood study using more advanced hydraulic modeling and hydrology techniques was commissioned by the city and the UDFCD. This study was performed by HDR Engineering and included a Climatology and Hydrology Report with reviews by an independent review panel, citizen advisory group and a hydrology advisory panel. The HDR Engineering study was completed in 2007 and resulted in a new flood map that formally identified the flood hazard that would impact the West Valley neighborhoods west of South Boulder Creek and north of US 36.

On April 17, 2007, City Council approved a motion authorizing the submittal of the flood study to FEMA. The flood mapping study was submitted in August 2007 and is anticipated to be adopted late 2011. If the revised mapping is officially adopted by FEMA, there will be a total of

700 structures (with a total of approximately 1,200 dwelling units) in the 100-year floodplain. Currently, there are approximately 460 structures (with approximately 500 total dwelling units) in the South Boulder Creek 100-year floodplain. Most structures within the existing regulatory mapping will remain in the floodplain; therefore, approximately 240 additional structures (with approximately 700 total dwelling units) will be newly designated as 100-yr floodplain properties. The majority of these structures are located within existing developed areas of the city within the West Valley area. A Risk Assessment completed in June 2009 estimated a 100-year event would result in $215 million in property damages.

The South Boulder Creek Flood Mitigation Planning Study began in early 2010 and is being funded by the city and the UDFCD. A consulting team from CH2MHill was selected to perform the study. The study is focused on developing and evaluating alternatives to mitigate flood impacts to structures and areas within the current incorporated city limits, primarily within the West Valley area (**Attachment A).** It is anticipated that the study will be completed in the second quarter of 2011.

A project workshop held on Jan. 27, 2010 was attended by representatives from Open Space and Mountain Parks, UDFCD, United States Army Corps of Engineers, Colorado Department of Transportation, University of Colorado, a representative from the Water Resources Advisory Board (WRAB), city staff and the consultant team. An overview of the study goals and timeline were offered along with a presentation and discussion of known constraints and potential conceptual solutions.

An initial public meeting was held on March 3, 2010 with approximately 50 people in attendance. A formal presentation included an overview of the study purpose, need, goals and process. Staff answered questions following the presentation and provided area-specific information at four work stations. Attendees were encouraged to identify problem areas and potential solutions for consideration during the planning process.

An update on the flood mitigation study was presented to WRAB on June 21, 2010. Project progress and seven conceptual alternatives and one status quo option (for a total of eight alternatives) were presented for discussion and input. Information about this WRAB agenda item may be found at the following Web site:
www.bouldercolorado.gov > Departments > Public Works, Utilities > Water Resources Advisory Board > Previous Agenda > Agenda for June 21, 2010
or
(http://www.bouldercolorado.gov/index.php?option=com_content&task=view&id=13370&Itemid=1189)

A second public meeting was held on Sept. 2, 2010. A summary of the study progress to date and eight conceptual alternatives were presented for public comment. Concept-level costs along with estimated benefits for each alternative were also presented. Staff emphasized that none of the alternatives had been ranked and no alternative was currently being recommended. More than 100 members of the public, mostly from the Marshall area, attended the meeting and 63 comment sheets were received. Most of the comments focused on concerns with the alternative that included the use of private property from unwilling sellers for flood detention near Highway 93.

WRAB members participated in a field trip on Oct. 7, 2010 to view the project area and several residents attended the Oct. 18, 2010 WRAB meeting and spoke during the *Public Participation* portion of the meeting.

PROGRESS TO DATE:

In response to feedback received at the second public meeting on Sept. 2, 2010, a new and ninth alternative (referred to below as Alternative 5: Distributed Regional Detention) for a flood detention facility that uses city Open Space property or private property with owners willing to sell was developed. **Attachment B** presents a summary comparison table of the nine conceptual alternatives. **Attachment C** presents figures of each of the nine conceptual alternatives. The alternatives are detailed below:

- **Alternative 1: Status Quo**. This alternative would maintain the status quo within the watershed and therefore has no associated cost or corresponding benefit-to-cost ratio. Limits of the existing floodplain would not change under this alternative and all properties would remain in the 100-year floodplain. This alternative, along with all the other alternatives investigated, would include the continued enforcement of the city's floodplain management efforts to assure that new development does not exacerbate existing flood hazards and that measures such as flood warning and participation in the National Flood Insurance Program remain in place.

- **Alternative 2: High Hazard and Critical Facility Protection**. Two multi-family structures are located within the high-hazard zone northwest of the intersection of Foothills Parkway and US 36 and 25 structures identified as critical facilities are located within the 100-year floodplain. This alternative would include limited site work to eliminate the high-hazard risk and floodproof the critical facilities. The cost is estimated cost at $10.7 million. The estimated benefit-to-cost ratio of this alternative is 2.2. This alternative would not change the limits of the existing floodplain but would provide 100-year protection for critical facilities.

- **Alternative 3: Regional Detention at US 36 with Downstream Improvements**. This alternative proposes to construct an approximately 75-acre (560 acre-feet of storage) regional flood detention facility to prevent overtopping of US 36 during a major storm event. The proposed location is on University of Colorado South Campus land, but would inundate approximately 37 acres of city Open Space lands during a major event. This alternative also includes downstream improvements including smaller flood detention facilities near the intersection of Foothills Parkway and Baseline Road, at Manhattan Middle School, and at Flatirons Golf Course along with flow capacity upgrades to Dry Creek Ditch Number. 2. This alternative would provide 100-year flood protection within the West Valley area. The estimated cost of this alternative is approximately $29 million and has a benefit-to-cost ratio of 2.68.

- **Alternative 4**: **Regional Detention near Hwy 93 with Downstream Improvements**. This alternative proposes to construct an approximately 40-acre (422 acre-feet of storage) regional flood detention facility east of Highway 93 near Marshall Road, preventing the overtopping of US 36 during storms up to the 100-year event. The location includes land owned by the University of Colorado, city Open Space and two privately owned parcels. This alternative would provide 100-year flood protection within the West Valley area. This alternative also

includes downstream improvements including smaller flood detention facilities near the intersection of Foothills Parkway and Baseline Road, at Manhattan Middle School, and at Flatirons Golf Course along with flow capacity upgrades to Dry Creek Ditch Number. 2. The estimated cost of this alternative is approximately $31 million and has a benefit-to-cost ratio of 2.52.

- **Alternative 5**: **Distributed Regional Detention**. This alternative was developed in response to feedback opposing Alternative 4. The objective of this alternative is to provide 100-year flood protection within the West Valley area using lands owned by the City Open Space and Mountain Parks Department (OSMP) or undeveloped private land that could be purchased from willing sellers. This alternative proposes a series of three regional detention facilities as follows:
  - Approximately 130 acre-feet of detention storage (38 acres surface area) at US36. Flood waters would be stored behind a berm constructed along the south side of US36 on the west side to South Boulder Creek. The berm would begin at the bridge, reach a maximum height of 13 feet near the Foothills Parkway interchange and be constructed entirely on OSMP lands, avoiding construction on CU property.
  - Approximately 130 acre-feet of detention storage (49 acres surface area) at South Boulder Road. Flood waters would be stored behind a berm constructed along the south side of South Boulder Road, have a maximum height of six feet above South Boulder Road and be constructed entirely on OSMP lands.
  - Approximately 295 acre-feet of detention storage (38 acres of surface area) at Baseline Road. The water would be stored behind a berm constructed along the south side of Baseline Road that would have a maximum height of approximately 13 feet above Baseline Road. The berm would be constructed on OSMP land but would also require the purchase of privately owned parcel. Construction of this detention facility would require relocating an OSMP trail head and access parking lot from the south side of Baseline Road likely to the west side of Cherryvale Road.

  All three of these detention facilities would require control structures to convey flood waters from South Boulder Creek to the detention sites. The control structures have not been designed but the current concept is to leave the existing capacity of the bridges intact and control the flood flows via control structures located upstream of the bridge. The structures could involve berms on both sides of the creek and buried grouted rock or concrete sill located at the existing creek invert to provide erosion protection.

  This alternative also includes downstream improvements including flood detention facilities near the intersection of Foothills Parkway and Baseline Road, at Manhattan Middle School, and at Flatirons Golf Course along with flow capacity upgrades to Dry Creek Ditch Number. 2. The estimated cost of this alternative is approximately $29.5 million and has a benefit-to-cost ratio of 2.57.

- **Alternative 6: Containment of Flood Flow in South Boulder Creek**. This alternative would construct a berm to force all flood flows through the main channel under the US 36 bridge. It proposes using Baseline Reservoir for storage of flood flows to avoid downstream impacts. Baseline Reservoir is a drinking water storage facility for the City of Lafayette. This alternative would provide 100-year flood protection within the West Valley area. This alternative is estimated to cost approximately $39 million, excluding any studies or

improvements that would be required by the State Engineer. The estimated benefit-to-cost ratio is 1.94.

- **Alternative 7: Bear Canyon Creek Pipeline**. This alternative would provide 100-year flood protection within the West Valley area without using regional detention upstream of US 36. Flood flows would continue to overtop US 36 but would be collected downstream and conveyed through the West Valley via two pipe systems with diameters ranging from 7.5 feet to 9 feet. One system would divert flow to Bear Canyon Creek and the other parallel to Dry Creek Ditch Number 2. This alternative includes flood detention on Flatirons Golf Course. The estimated cost of this alternative is approximately $46 million and has a benefit-to-cost ratio of 1.25.

- **Alternative 8: Dry Creek Ditch No. 2 Pipeline**. This alternative is similar to alternative six but would involve constructing one pipe system along Dry Creek Ditch No. 2 with pipe diameters in the range of 7.5 feet to 11 feet. This alternative also includes the detention storage at Flatirons Golf Course. The estimated cost of this alternative is approximately $46 million and has a benefit to cost ratio of 1.24.

- **Alternative 9: Nuisance-level Flood Improvement Protection**. This alternative would provide pipe system upgrades to prevent nuisance flooding during minor storm events at an estimated cost of approximately $14 million and has a benefit-to-cost ratio of 0.1. Improvements would not effectively change the 100-year floodplain and most properties would remain in the floodplain.

STAFF RECOMMENDATION:

Staff recommends that a short list of five best alternatives be selected for further refinement and analysis. The five short list plans would be evaluated further to identify recommended construction phasing of each and further discussions would be conducted with the public and property owners to identify any additional issues related to construction of proposed improvements. This evaluation, along with a final recommended plan, would be presented to WRAB and OSMP Board of Trustees during first quarter of 2011, after which the final selection would go to City Council for consideration.

The staff recommends the following five alternatives to move forward onto the short list of best alternatives:

- **Alternative 1: Status Quo** – It is typical for planning studies to include a 'do nothing' alternative. This alternative does not require any funds for construction.

- **Alternative 2: High Hazard and Critical Facility Protection** – This alternative would remove the High Hazard Zone threat to existing structures and provide some level of protection to critical facilities during a major storm event at a relatively low cost and high benefit-to-cost ratio. Protection of the critical facilities also provides the benefit of enhanced protection to at-risk populations and reduces the potential of spills of hazardous materials during large flood events.

- **Alternative 3: Regional Detention at US 36 with Downstream Improvements** – This alternative would provide 100-year flood protection within the West Valley without requiring condemnation or major impacts to OSMP lands at a high benefit-to-cost ratio (2.68). This alternative also provides the additional benefit of enhanced emergency response and vehicular movement by preventing overtopping of US36 during a major storm event.

- **Alternative 5: Distributed Regional Detention** – This alternative would provide 100-year flood protection within the West Valley without requiring condemnation or the need to impact CU lands at a high benefit-to-cost ratio (2.6). Similar to Alternative 3, this alternative also provides the transportation and emergency response benefits of US36 protection.

- **Alternative 7**: **Bear Canyon Creek Pipeline** – This alternative would provide 100-year flood protection within the West Valley area without using regional detention upstream of US 36. This alternative, though slightly higher in cost than the other pipeline alternative (Dry Creek Ditch No. 2 pipeline, Alternative 8), also has a slightly higher benefit-to-cost ratio than the other pipeline alternative and would have far less impacts to residential areas during construction. The estimated cost of this alternative is approximately $46 million and has a benefit-to-cost ratio of 1.25.

WRAB ACTION:

Staff is recommending that Alternatives 1, 2, 3, 5 and 7 be considered as the short list of best alternatives to be further evaluated and considered in the South Boulder Creek Flood Mitigation Plan process.

Staff is requesting a WRAB recommendation on the alternatives to be considered on the short list for best alternatives to be further evaluated.

NEXT STEPS:

The following next steps are recommended for this planning process:

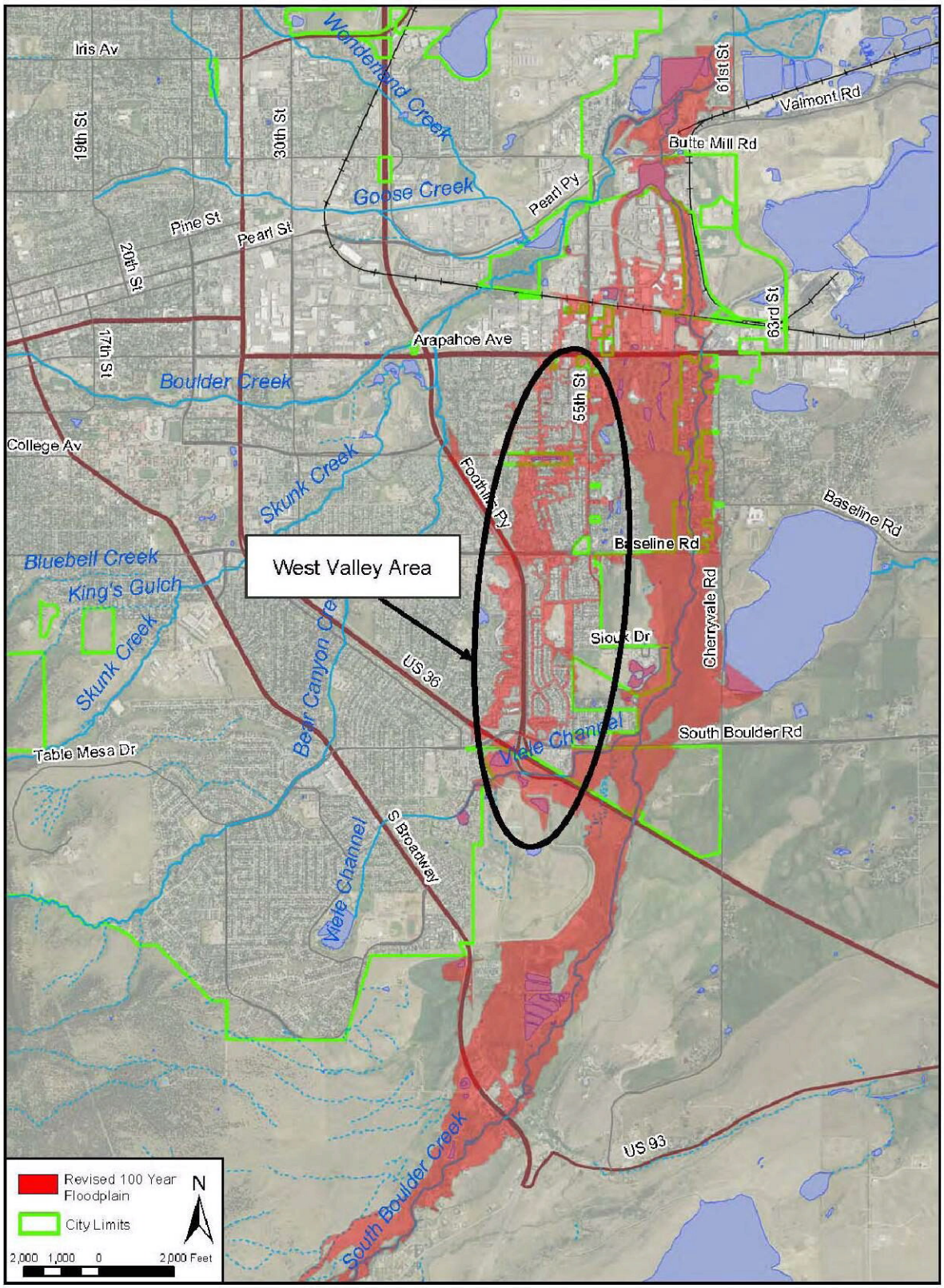
- Presentation to OSMP Board of Trustees in Jan. 2011 and recommendation of short list of best alternatives
- Inform City Council in Febuary 2011 about project status
- Further evaluation of the short list of best alternatives
- Presentation to WRAB and OSMP Board of Trustees in second quarter of 2011, including a recommended best alternative
- City Council decision about the best alternative to implement on South Boulder Creek in second or third quarter 2011

ATTACHMENTS:

Attachment A: Location Map
Attachment B: Summary Comparison Table of Conceptual Alternatives
Attachment C: Figures of the Nine Alternatives

ATTACHMENT A
LOCATION MAP

Attachment A: Location Map



ATTACHMENT B
SUMMARY COMPARISON TABLE OF CONCEPTUAL ALTERNATIVES

Attachment B: Summary Comparison of Conceptual Alternatives

Alternative		Estimated Construction Cost	Benefit-to-Cost Ratio	Environmental Impacts	Social Impacts
1	Status Quo	$0	0	• No impacts	• Flood risk still remains
2	High Hazard and Critical Facility Protection	$10,700,000	2.2	• Limited impacts	• Flood limits do not change • Floodproofing reliability concerns
3	Regional Detention at US36 with Downstream Improvements	$28,800,000	2.68	• Habitat and wetland impacts • Periodic inundation of Open Space Lands	• Requires formal agreements with CU, BVSD, OSMP, CDOT, ditch companies and City Parks • Provides 100-year protection in West Valley Area
4	Regional Detention near HWY93 with Downstream Improvements	$30,700,000	2.52	• Habitat and wetland impacts • Periodic inundation of Open Space Lands	• Requires purchase of property from unwilling sellers • Requires formal agreements with CU, BVSD, OSMP, ditch companies and City Parks • Provides 100-year protection in West Valley Area
5	Distributed Regional Detention	$29,500,000	2.57	• Habitat and wetland impacts (including Critical Wildlife Area near Baseline Road) • Periodic inundation of Open Space Lands • Requires hydraulic control structures along the creek	• Requires formal agreements with BVSD, OSMP, CDOT, ditch companies and City Parks and purchase of private property • Provides 100-year protection in West Valley Area
6	Containment of Flood Flow in South Boulder Creek	$39,200,000*	1.94*	• Limited habitat and wetland impacts	• Requires approval from State Engineers Office • Requires formal agreements with City of Lafayette, BVSD, CDOT, OSMP, ditch companies and City Parks • Provides 100-year protection in West Valley
7	Bear Canyon Creek Pipeline	$46,300,000	1.25	• No water quality enhancement opportunities • Limited wetland impacts	• Extensive disruption during construction • Requires easement coordination with ditch companies • Provides 100-year protection in West Valley Area
8	Dry Creek Ditch No. 2 Pipeline	$45,700,000	1.24	• No water quality enhancement opportunities • Limited wetland impacts	• Extensive disruption during construction • Requires easement coordination with ditch companies • Provides 100-year protection in West Valley Area
9	Nuisance Flood Improvements Only	$14,000,000	0.1	• No impacts	• Limited changes to 100-year floodplain limits or risk

* Does not include any costs to upgrade Baseline Reservoir as may be required to store the additional flood water

ATTACHMENT C
CONCEPTUAL ALTERNATIVES

Alternative 1 - Status Quo

Foothills Py
47th St
Pearl Py
Boulder Creek
BNSF Railroad
Arapahoe Av
55th St
Valmont Rd
61st St
Butte Mill Rd
South Boulder Creek
63rd St
Dry Creek
Colorado Av
Wellman Ditch
Foothills Py
Bear Canyon Creek
Baseline Rd
Dry Creek No 2 Ditch
Sioux Dr
55th St
South Boulder Creek
Cherryvale Rd
Moorhead Av
Table Mesa Dr
South Boulder Rd
S Cherryvale Rd
36
Broadway

Legend

- Streams, Creeks and Ditches
- 100-Year Floodplain
- Railroad

N

0 500 1,000 2,000
Feet

SOUTH BOULDER CREEK
FLOOD MITIGATION STUDY
Figure C-1:
Status Quo
Boulder, Colorado

CH2MHILL

Alternative 2 - High Hazard and Critical Facility Protection

Flood Proof Critical Facilities

Protect Two Properties within the High Hazard Zone with Localized Improvements

Foothills Py
47th St
Pearl Py
Boulder Creek
BNSF Railroad
Arapahoe Av
55th St
Valmont Rd
61st St
Butte Mill Rd
South Boulder Creek
63rd St
Dry Creek
Colorado Av
Wellman Ditch
Foothills Py
Bear Canyon Creek
Baseline Rd
Dry Creek No 2 Ditch
Sioux Dr
55th St
South Boulder Creek
S Cherrvale Rd
Table Mesa Dr
South Boulder Rd
36
Broadway

Legend

- Streams, Creeks and Ditches
- Buildings in High Hazard Zone
- Flood Proof Critical Facilities
- Existing High Hazard Zone
- 100-Year Floodplain
- Railroad

N

0 500 1,000 2,000

Feet

SOUTH BOULDER CREEK FLOOD MITIGATION STUDY

Figure C-2: High Hazard and Critical Facility Protection

Boulder, Colorado

CH2MHILL

Alternative 3 - Regional Detention at US 36 with Downstream Improvements

25 Acre Detention Pond at Flatirons Golf Course with Outfall Improvements

Waste Away Structure on the Wellman Canal

4 Acre Detention Pond at Foothills Parkway/ Baseline Road

Raise Downstream Concrete Wall

9 Acre Detention Pond at Manhattan Middle School

34' Top Width Open Channel

8' x 6' Box Culverts at New Anderson Road Crossings

Berm Height = 18 feet

Berm Height = 6 feet

Detention Pond on CU and City of Boulder Open Space Property
Surface Area = 75 acres
Max Depth = 23.5 feet

Valmont Rd
Foothills Pky
47th St
KOA Lake
South Boulder Creek
Leggett Owen Reservoir
63rd St
Boulder Creek
BNSF Railroad
Bear Canyon Creek
Dry Creek
Arapahoe Av
55th St
Colorado Av
Wellman Ditch
Foothills Pky
Baseline Rd
Dry Creek No 2 Ditch
Baseline Reservoir
Cherryvale Rd
Moorhead Av
Table Mesa Dr
South Boulder Rd
36
S Cherryvale Rd
Broadway
Dry Creek No 2 Ditch

Legend
- LAKES
- CU Storage Berm Location
- Outfall from CU Pond
- CU Detention Pond

Dry Creek Alignment
- No Improvement
- Open Channel Improvement
- Pipeline/Culvert Improvement
- Local Detention
- Streams, Creeks and Ditches
- Post Project Conditions Floodplain
- Existing Floodplain
- Railroad

N

0 500 1,000 2,000
Feet

SOUTH BOULDER CREEK FLOOD MITIGATION STUDY
Figure C-3: Regional Detention at US 36 with Downstream Improvements
Boulder, Colorado
CH2MHILL

Alternative 4 - Regional Detention near HWY 93 with Downstream Improvements

BNSF Railroad

South Boulder Creek

Dry Creek

Dry Creek No 2 Ditch

25 Acre Detention Pond at Flatirons Golf Course with Outfall Improvements

Waste Away Structure on the Wellman Canal

Wellman Ditch

Raise Downstream Concrete Wall

Bear Canyon Creek

4 Acre Detention Pond at Foothills Parkway/ Baseline Road

9 Acre Detention Pond at Manhattan Middle School

34' Top Width Open Channel

South Boulder Creek

8' x 6' Box Culverts at New Anderson Road Crossings

Dry Creek No 2 Ditch

Max Berm Height = 13 feet

Two Stage Detention Pond on City of Boulder Open Space and Private Property
Surface Area = 40 acres
Max Depth = 18 feet

Max Excavation = 5 feet

South Boulder Creek

Legend

- South of CU Pond Outfalls
- Viele Channel Improvements

South of CU Detention Pond

- AREA OF EXCAVATION
- EMBANKMENT

Dry Creek Alignment

- No Improvement
- Open Channel Improvement
- Pipeline/Culvert Improvement
- Local Detention
- Streams, Creeks and Ditches
- Post Project Floodplain
- Existing Floodplain
- Railroad

N

0 750 1,500 3,000
Feet

SOUTH BOULDER CREEK FLOOD MITIGATION STUDY
Figure C-4: Regional Detention near HWY 93 with Downstream Improvements
Boulder, Colorado

CH2MHILL

Alternative 5 - Distributed Regional Detention

25 Acre Detention Pond at Flatirons Golf Course with Outfall Improvements

Waste Away Structure on the Wellman Canal

Raise Downstream Concrete Wall

4 Acre Detention Pond at Foothills Parkway/ Baseline Road

Culverts through Baseline Road
Size: 4' x 4' CBC
Approx Length = 80 feet

9 Acre Detention Pond at Manhattan Middle School

Max Berm Height = 13 feet above Baseline Road
Maximum Pool Height = 10 feet above Baseline Road
Maximum Pool Depth = 16 feet
Approximate Additional Storage = 375 acre-ft
Approximate Surface Area = 58 acres

34' Top Width Open Channel

Approx Top Width = 20 feet
Approx Depth = 6 feet

Max Berm Height = 6 feet above South Boulder Road
Maximum Pool Height = 4 feet above South Boulder Road
Maximum Pool Depth = 13 feet
Approximate Additional Storage = 130 acre-ft
Approximate Surface Area = 49 acres

Max Berm Height = 13 feet
Maximum Pool Depth = 17 feet
Approximate Additional Storage = 130 acre-ft
Approximate Surface Area = 38 acres

Legend
- Hydraulic Control Structures
- Baseline Road Berm
- South Boulder Road Storage Berm
- Berm
- Baseline Road Culverts
- Viele Channel Improvements
- Granite_Property

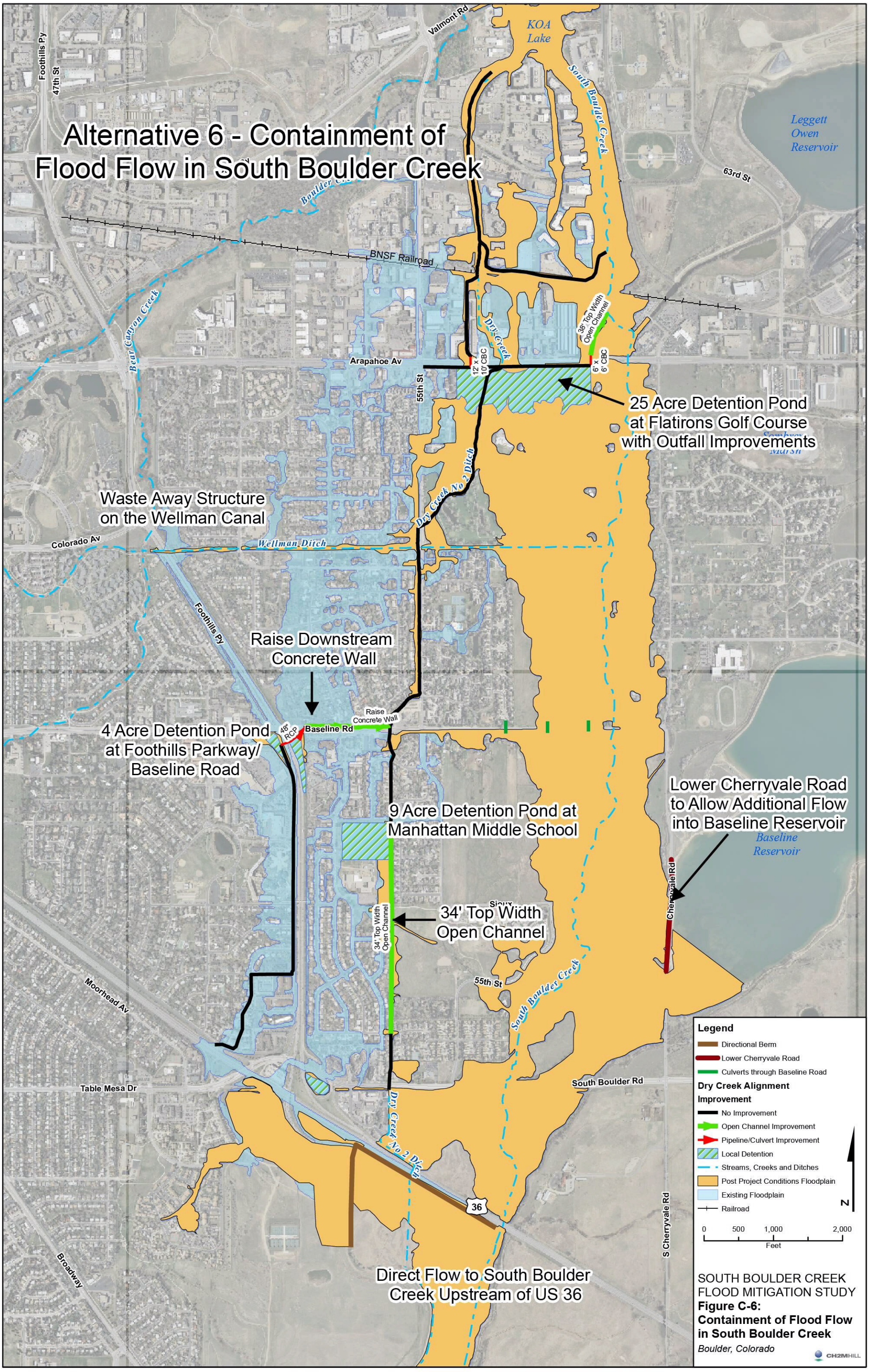
Dry Creek Alignment Improvement
- No Improvement
- Open Channel Improvement
- Pipeline/Culvert Improvement
- Local Detention
- Distributed Regional Detention
- Streams, Creeks and Ditches
- Post Project Conditions Floodplain
- Existing Floodplain
- Railroad

N

0 500 1,000 2,000
Feet

SOUTH BOULDER CREEK FLOOD MITIGATION STUDY
Figure C-5: Distributed Regional Detention
Boulder, Colorado
CH2MHILL

Alternative 6 - Containment of Flood Flow in South Boulder Creek



Alternative 7 - Bear Canyon Creek Pipeline

Waste Away Structure on the Wellman Canal

25 Acre Detention Pond at Flatirons Golf Course with Outfall Improvements

9.5' Reinforced Concrete Pipe

7.5' Reinforced Concrete Pipe

8' x 6' Box Culverts at New Anderson Road Crossings

Foothills Py
47th St
Valmont Rd
South Boulder Creek
63rd St
Pearl Py
Boulder Creek
BNSF Railroad
Bear Canyon Creek
Dry Creek
Arapahoe Av
55th St
Colorado Av
Wellman Ditch
Foothills Py
Dry Creek No 2 Ditch
Baseline Rd
Sioux Dr
Cherryvale Rd
55th St
South Boulder Creek
Moorhead Av
Table Mesa Dr
South Boulder Rd
36
S Cherryvale Rd
Broadway
Dry Creek No 2 Ditch

Legend

- Streams, Creeks and Ditches

Bear Canyon Creek Alignment

- No Improvement
- Open Channel Improvements
- Piipeline/Culvert Improvement
- Local Detention
- Residual Floodplain
- Zone AE
- Bear Canyon Creek Inflows
- C2 Loadpoint
- Main Road
- Railroad

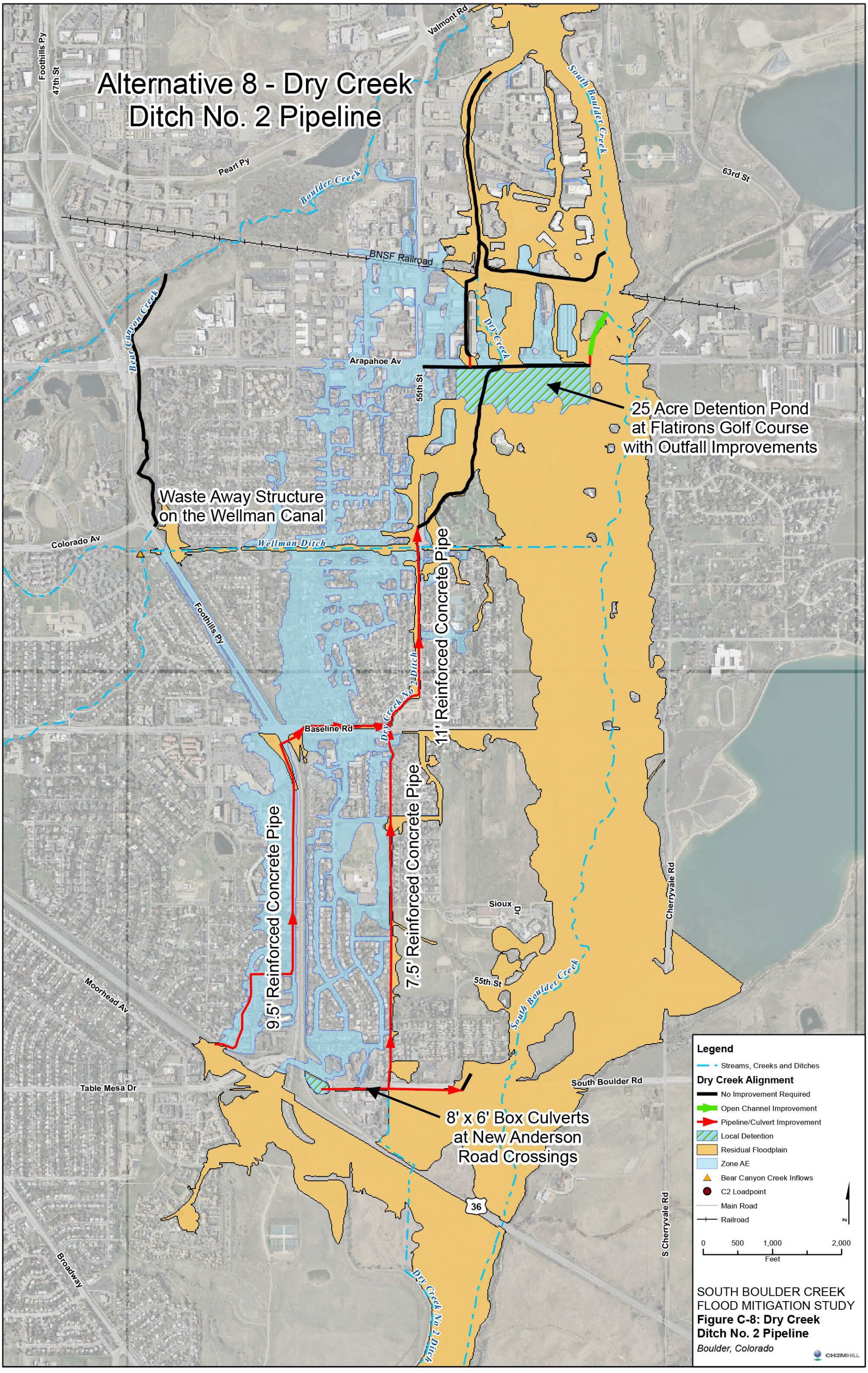
N

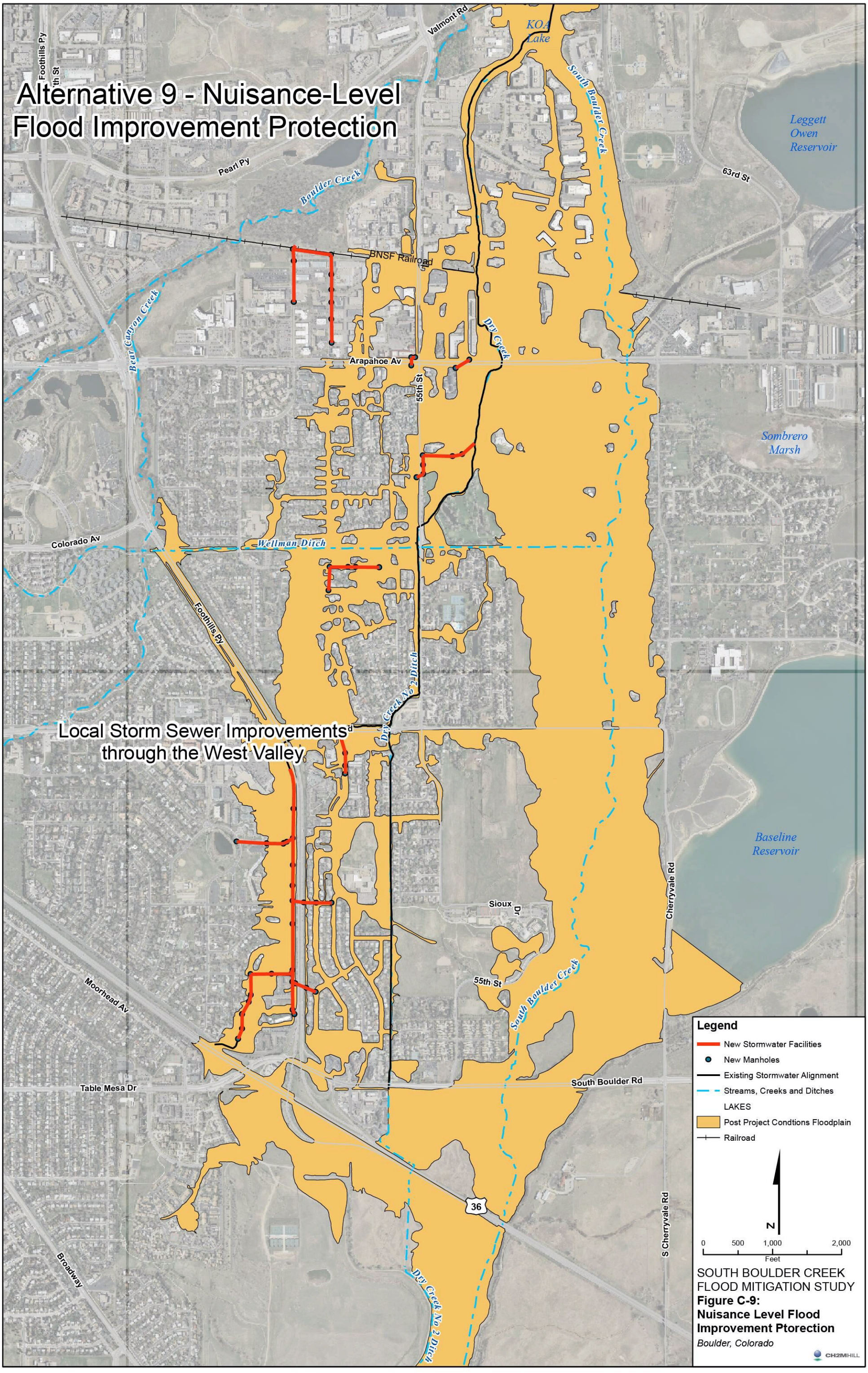
0 500 1,000 2,000
Feet

SOUTH BOULDER CREEK FLOOD MITIGATION STUDY
Figure C-7:
Bear Canyon Creek Pipeline
Boulder, Colorado

CH2MHILL

Alternative 8 - Dry Creek Ditch No. 2 Pipeline




Alternative 9 - Nuisance-Level Flood Improvement Protection
Local Storm Sewer Improvements through the West Valley
Foothills Py
Valmont Rd
KOA Lake
South Boulder Creek
Leggett Owen Reservoir
63rd St
Pearl Py
Boulder Creek
BNSF Railroad
Bear Canyon Creek
Dry Creek
Arapahoe Av
55th St
Sombrero Marsh
Colorado Av
Wellman Ditch
Foothills Py
Dry Creek No 2 Ditch
Baseline Reservoir
Cherryvale Rd
Sioux Dr
55th St
South Boulder Creek
Moorhead Av
Table Mesa Dr
South Boulder Rd
36
S Cherryvale Rd
Broadway
Dry Creek No 2 Ditch
Legend
New Stormwater Facilities
New Manholes
Existing Stormwater Alignment
Streams, Creeks and Ditches
LAKES
Post Project Condtions Floodplain
Railroad
N
0
500
1,000
2,000
Feet
SOUTH BOULDER CREEK FLOOD MITIGATION STUDY
Figure C-9:
Nuisance Level Flood Improvement Ptorection
Boulder, Colorado
CH2MHILL

CITY OF BOULDER, COLORADO
BOARDS AND COMMISSIONS MEETING MINUTES

Name of Board / Commission: Water Resources Advisory Board

Date of Meeting: 14 December 2010

Contact Information of Person Preparing Minutes: Laurel Olsen-Horen; 303-441-3203

Board Members Present: Bill DeOreo, Susan Iott, Chuck Howe, Vicki Scharnhorst
Board Members Absent: Kate Ryan

Staff Present: Ned Williams, Director of Public Works for Utilities
Bob Harberg, Engineering Project Management Coordinator
Kurt Bauer, Engineering Project Manager
Carol Ellinghouse, Water Resources Manager
Bret Linenfelser, Water Quality and Environmental Services Coordinator
Annie Noble, Greenways Coordinator
Laurel Olsen-Horen, Board Secretary

Consultants Present:
Alan Turner, CH2MHill Project Engineer for South Boulder Creek
Mark Glidden, CH2M Hill Project Manager
Aaron Cook, CH2M Hill Staff Engineer
Alan Taylor, consultant
Ronni Sperling, Special Water Counsel to the City

Meeting Type: Regular

Agenda Item 1 – Call to Order **[7:00 p.m.]**
This meeting was called to order at 7:00 p.m.

Agenda Item 2 – Approval of the 15 November 2010 Meeting Minutes: **[7:02 p.m.]**
Motion to approve by: Iott; Seconded by: Howe
Motion Passes; 4:0

Agenda Item 3 – Public Participation and Comment **[7:02 p.m.]**
Public Comment:
None

Agenda Item 4 – Matters from Board and Staff **[7:06 p.m.]**

Matters from Board:
Howe brought up the below matters:

- Handed out a copy of an E-mail between him and Reagan Waskom.

Iott brought up the below matters:

- When was the last time the city did a rate study? Staff response: the last comprehensive study was done in 2007

Matters from Staff: **[7:07 p.m.]**

- The Boulder Reservoir Master Plan went to the City Council. City Council approved moving forward with option two (the same option that both WRAB and PRAB recommended).
- At the November WRAB meeting, the board recommended the drought item; however, it will not be presented to Council until February / March

Agenda Item 5 – Update on South Boulder Creek Flood Mapping Study and selection of short list of alternatives for further evaluation **[7:15 p.m.]**
Kurt Bauer presented item to the board.

Executive Summary from Packet Materials:
The purpose of this memorandum is to present and discuss the South Boulder Creek flood mitigation alternatives, including a newly developed alternative and select a short list of best alternatives for further evaluation and consideration. Project alternatives range from maintaining the status quo to providing 100-year flood protection.

WRAB discussion included: **[7:27 p.m.]**
Clarifying questions:

- Why did staff settle with five as the final number of alternatives chosen for the short list? Staff response: five seems to give a broad enough spectrum of possibilities.
- What is the nature of the disturbance to the neighborhoods with the pipeline options? Staff response: both alternatives with pipelines will cause some disruption.
- What are the characteristics of the diversion structures for the detention ponds? Staff response: While the specific characteristics have not been developed, the diversion structures will need to be able to divert water, still allow normal creek flow to pass through and allow trails to continue.
- Are the models specific enough to say what the downstream flow conveyances for the pipeline alternatives will be and how much greater that is than the retention effect we get from the regional holding areas? CH2MHill response: yes, the pipelines will convey the water much quicker to Boulder Creek than the detention alternatives. The detention alternatives are in place to make sure that no additional impacts downstream occur in terms of increased flow rates or increased velocities in the channel.

Public Comment: **[7:37 p.m.]**

- Ruth Blackmore: Wants to make sure that Alternative Four is truly taken off of the option list. Ms. Blackmore is concerned with alternative five, and would like to know what the OSMP has to say in regards to the potential environmental impact (damage) with creating the berms would be. At a previous Urban Drainage meeting, a rep from Urban Drainage stated that they do not like the use of earthen levies, they do not like piping systems, they would like for the water to flow naturally across the land and that is what the City should try to do without impacting any individual property. In the Taggart study, they suggested using the land along US 36 since it's a low lying land. Ms. Blackmore believes that more work needs to be done, but that being said, agrees with the five alternatives proposed by staff.
- Gary Swanstrom: Would have been one of the properties obtained through eminent domain in alternative four, and thank you to staff for taking it off of the list.
- John Militzer: Would like to thank staff on their hard work. Mr. Militzer understands why the City is offering a "do nothing" option, however, he would like to see Council find a way to mitigate potential flood issues. Mr. Militzer would like to see staff from the City and the County work together to help the residents upstream and in the valley.
- Jeannette Hillery: Ms. Hillery would like to know how many structures are going to be taken out of the floodplain. That information would be very helpful to residents in terms of their need to carry FEMA flood insurance. Ms. Hillery would support some disturbance in her neighborhood if it meant that the flood mitigation would benefit the residents and take them out of the floodplain.
- Vince Wayland: None of the alternatives take Mr. Wayland's property out of the floodplain. All of the alternatives affect Dry Creek Ditch No. 2. The first five alternatives all include creating a 34' wide channel from a 7' channel which will have a rather large impact to the homes on each side of the ditch. How does the staff justify minimal neighborhood disturbance?
- Jim Randa: Mr. Randa's property abuts the Dry Creek Ditch No. 2. How deep will it be, will it be earthen, and will the expanded ditch be placed on top of the current one? How does the city justify placing a 34' wide ditch in the place of a 7' current one? How will the detention pond at Manhattan Middle School be viewed by the school and users and what does BVSD think about having a 34' ditch on their property?
- Peter Ornstein: Would like clarification on the ditch behind Manhattan Middle School. Mr. Ornstein is in support of flood mitigation and believes the City does need to find a way to mitigate major destruction to the community. He would like to have the final FEMA flood study put on hold pending the complete analysis from the City, so that another floodplain study does not need to be conducted.
- Ben Binder: Mr. Binder voice disappointment with the number of public meetings offered during this project. People at the public meetings believed that the consultants spent too much time working on options that should have been removed by common sense. Also, Urban Drainage stated that the use of pipelines for flood mitigation is not a good option. Mr. Binder brought up the old Flatiron gravel pits (CU South) as a possible flood mitigation option. The costs presented for the alternatives, were they based on an asking price, or were they actually appraised.
- Charles Wellman: Mr. Wellman would like to make sure that the board is aware of the actual cost of the presented options. Also, keep in mind how many people the alternatives are really impacting. This needs to be thought of in the human regard, not just the material cost
- Joanne Turner: would like information on the proposed wall which would be erected on Baseline.
- Steve Craig: Mr. Craig believes that the proposed 34' ditch would block access to the adjacent fields and would be a major disturbance to the neighborhood. Mr. Craig is worried what the ditch

would do to his and his neighbor's property values. A buried pipeline would be preferred over a 34' ditch.

- Lauren Noyes: The term "minimal impact" doesn't seem to be an accurate description of the proposed options 3 and 5. Ms. Noyes believes that option 6 should have been kept on the option alternatives. If the 34' ditch is implemented then Ms. Noyes would no longer be able to allow for her children to play in the back yard.

WRAB discussion: **[8:05 p.m.]**

Continuing Clarifying Questions:

- What is the possibility of the use of CU property to a greater extent? Was there any way we could have used the old gravel pits as a detention area? Staff response: City staff does have a proposal to use part of the CU South property, however the University has indicated that they are not supportive of notching the berm and using the balance of their property. They have other needs for that area, and would thus be considered unwilling sellers. However, alternative 3 does include some use of CU property as a detention area.
- What does the OSMP staff think of the proposed alternatives? Staff response: what is being presented tonight is a compilation of work done by City staff which does include OSMP, Parks and Recreation and Utilities and the BVSD during numerous discussions.
- How often will these areas actually contain water? CH2MHill response: the frequency of which these areas will contain water depends on where they are and which ones they are. Some of the areas, (US 36 in particular) is likely to see water much more frequently since the channel there is very narrow. The same could be said of the storage at South Boulder Road and Baseline Reservoir because those are on the main channel of South Boulder Creek. As the water flows down, it has a chance to collect and thus flow slower downstream. How long it takes for those detention areas to drain will depend on the size of the flood event.
- Is it appropriate to delay the FEMA study until the City completes its study? And at what point would the results of a flood improvement project get reflected in flood mapping? Staff response: in 2007 the city decided to submit the revised flood study results to FEMA as best available information. At that time, the City also decided to start regulating the floodplain areas according to the flood study results. At this point in time, FEMA intends to adopt that study as part of the Digital Flood Insurance Rate Map which has been delayed for a couple of years. The City's expectation is that FEMA will formally adopt that flood study in late 2011. The results of a flood improvement project would be submitted to FEMA after the construction work was completed.
- How many facilities will be removed per each alternative? The numbers presented in the table below include residents in both the city and the county and encompass all dwelling types.

Alternative Number	Number of Dwellings removed from floodplain
Alternative 1	0
Alternative 2	0
Alternative 3	1,024
Alternative 4	1,024
Alternative 5	810
Alternative 6	810
Alternative 7	959
Alternative 8	947
Alternative 9	0

- What is the possibility of running an underground pipeline rather than a ditch? Staff response: staff could dig deeper into that option based on the recommendation from the WRAB.
- Why was Alt 6 taken off of the table? Staff response: city staff met with staff from Lafayette, and they are trying to do some minor improvements to Baseline Reservoir and the dam. At this time, if the City put any more water in the reservoir, the State Engineer would require massive upgrades to the Reservoir and dam. The cost for alternative 6 would have been very expensive, and there were also some concerns around water quality as a result of diverting flood water into Baseline Reservoir.
- The proposed 34' ditch would be a grass bottom ditch rather than a concrete ditch with a depth of

around four feet. 34' is the largest width, and the size is not final.

- How are the monetary benefits determined? Staff response: the $215 million was not a benefit; that number came from a risk assessment from 2009 and was the estimated structural damage (homes, buildings, property) that might occur if a 100 year flood event were to occur.
- How deep are the Manhattan detention ponds? Staff response: they range from 1-7 feet; however this is conceptual at this point.

Motion by Iott: To move forward with the staff recommended five options for further evaluation; a friendly amendment by Howe to drop alternative 7 was accepted by Iott. moved by Iott ; seconded by; DeOreo
Vote: 3:1 Scharnhorst voted against the motion stating that Alternative 7 should be included.

Agenda Item 6 – Final 2011 Goals letter to City Council [9:05 p.m.]
Susan Iott and Chuck Howe presented item to the board.

Executive Summary from Packet Materials:
At the City Council study session on Boards and Commissions on October 26, 2010, the council spoke several times about the end of year (looking forward to next year) goals and that they would like to receive goals from each of their boards and commissions. An issue that they raised is that the council sometimes receives the list of goals just before the January retreat and this gives them no time to read the goals, much less incorporate them into the work plan.

As such, the City Manager's Office has asked that each board and commission prepare their list of goals, maybe the top three goals, that they would like council to help them accomplish in 2011 and to submit this written statement not later than January 5, 2011. The annual council retreat will be January 21-22, 2011.

At the November 15 WRAB meeting, WRAB designated Susan Iott and Chuck Howe to prepare a draft letter of the goals so that it could be reviewed, revised and approved by the WRAB at the Dec. 14, 2010 WRAB meeting.

WRAB discussion included: [9:20 p.m.]
General Comments:

- Drop number 7 off of the list of priorities.
- Should the priorities be action items, or are they items of high interest? The list should contain both.
- What should the obligations of the City to those who lose property value as a result of steps taken in the broad public interest? Can Council consider cases like Cordrey Court for example?

Public Comment:
None
WRAB supported the letter and Iott will make the changes and submit to staff.

Agenda Item 7 – Update and discussion about wastewater reuse by individual customers [10:20 p.m.]
Carol Ellinghouse presented item to the board

Executive Summary from Packet Materials:
Recently, the city has had a few inquiries about possible use of on-site wastewater reuse systems by individual city water customers. These reuse systems would collect wastewater derived from the first use of water in a separate tank for the customer to reuse for a second type of use. Some systems put the wastewater to a second use with little consumption, such as toilet-flushing, and others propose high-consumptive uses, such as secondary use for irrigation.

There are both benefits and drawbacks for the city if these reuse systems are installed by city water customers due to the particular configuration of Boulder's water supply system facilities and water rights portfolio. Issues to consider include: benefits to customers due to reduced water use; possible effects on city water system drought resiliency; changes in return flows to Boulder Creek; risk to city water rights yields; effects on other water rights owners; expense of providing sufficient reusable water in the city water system; impacts of using more Western Slope water; effects on water system operations; impacts to city water revenue; and reduction in hydropower production from Boulder's water system due to change in water sources.

WRAB discussion included: **[10:29 p.m.]**

The board expressed concerns about entering into a pilot study with CU, as follows:

- Does the city see any issues with starting a pilot study? Staff response: no, staff believes a pilot study can be successful.
- Is the city conceding at the very beginning that the recirculation systems and reuse systems are officially effluent reuse, and they constitute injury? Where does the City draw the line, since it's all domestic use? Staff response: the City has not conceded that a reuse system is injury. This is a pilot program to gather information for future decisions.
- The mechanical recirculation systems within the customer's premise are still in the dominion and control of the customer, as it has not been returned to the system. Do the water decrees forbid customers from using whatever type of systems are available in their facilities to maximize their water use? Staff response: it's not about dominion and control; it comes down to the definition of "single use". When a water supply is used a second time for a different purpose, it is considered to be a reuse of the water. There is not currently any state statute, legislative direction or court decree precedence supporting a definition of a single use of water as including more than the first use for a single purpose or that would include the capture of domestic wastewater from one use for subsequent use for a different domestic purpose. However, Windy Gap water, which is what is being proposed, is decreed for reuse.
- The City should think about performing a depletion study rather than a pilot study. Staff response: the City has already done that.
- What is the flexibility of the Windy Gap, and taking it away from CU's use? Staff response: since the university is investing a lot in the plumbing they would like some kind of commitment beyond the five year pilot study, and at this point the City is not sure what kind of commitment they can give, thus the reason for the pilot study.
- Could the City exchange Windy Gap water with CBT water? Staff response: there could be specific times when exchange could be possible.

Public Comment:

- None

At the current time, staff does not have an IGA to present. If staff and CU proceed with an IGA, then staff is going to recommend starting out with Windy Gap water, and try to recover the additional costs associated with using Windy Gap water.

Agenda 8 – Decide on January and February 2011 meeting dates **[10:17 p.m.]**

Agenda item 8 occurred out of order on the agenda.
WRAB selected January 20th and February 24th

Agenda Item 9 – Discussion on Future Schedule **[11:12 p.m.]**

- At the January meeting – final recommendation on the Boulder Creek Study
- Update on the Critical Facilities Ordinance

Agenda Item 10 – Adjournment **[11:17 p.m.]**

There being no further business to come before the Board at this time, by motion regularly adopted, the meeting was adjourned at 11:17 p.m.
Motion to adjourn by: Iott; Seconded by: Scharnhorst
Motion Passes 4:0

Date, Time, and Location of Next Meeting:

The next WRAB meeting will be – Thursday, 20 January at 7:00 p.m., special meeting date, at the 13th Street Conference Room located at 1720 13th Street, unless otherwise decided by staff and the Board.

APPROVED BY: ATTESTED BY:

_____ _____
Board Chair Board Secretary

_____ _____
Date Date

An audio recording of the full meeting for which these minutes are a summary, is available on the Water Resources Advisory Board web page.

Attachment E – Study Recommendation

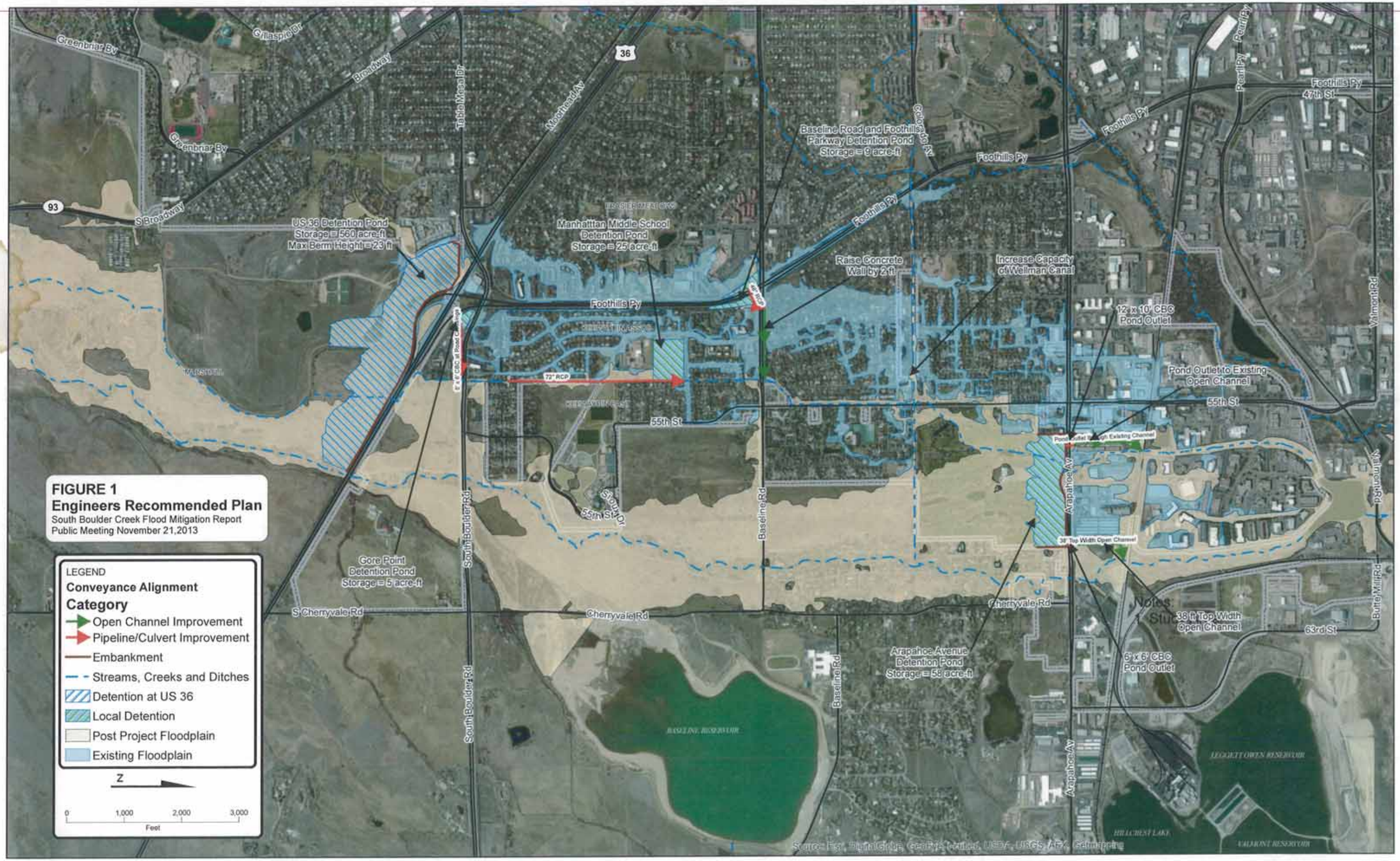


FIGURE 1
Engineers Recommended Plan
South Boulder Creek Flood Mitigation Report
Public Meeting November 21,2013

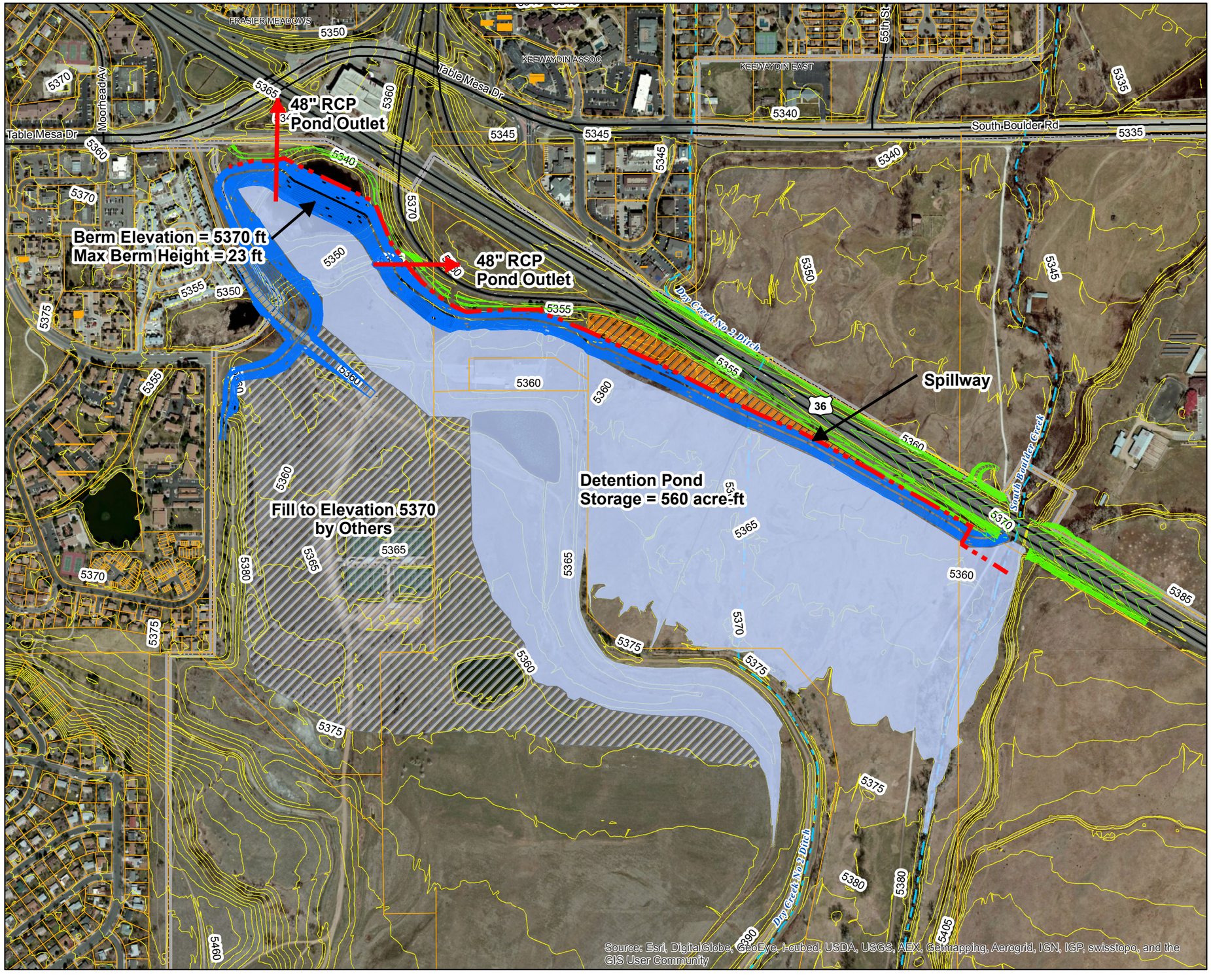
LEGEND
Conveyance Alignment
Category
- Open Channel Improvement
- Pipeline/Culvert Improvement
- Embankment
- Streams, Creeks and Ditches
- Detention at US 36
- Local Detention
- Post Project Floodplain
- Existing Floodplain

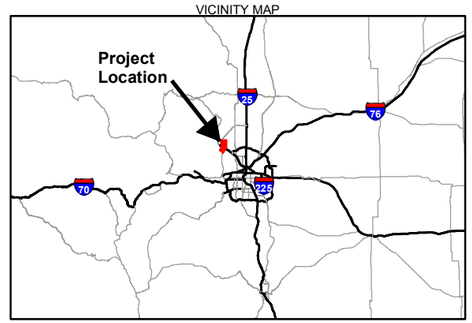
N

0 1,000 2,000 3,000
Feet

\\gecko\wbgl\403168_South_Boulder_Creek_Phase_A\06_GIS\MapFiles\Report\Chapter 09\Figure 9-1 Regional Detention at US 36.mxd

CH2MHILL





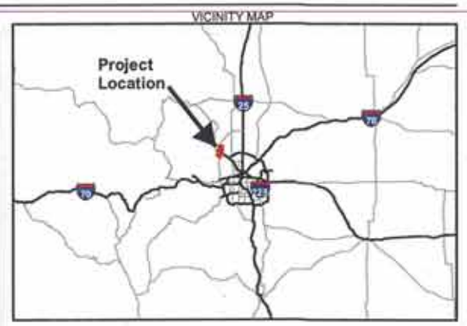
LEGEND

- CDOT US-36 Proposed Ultimate ROW
- US-36 Phase I Improvements
- US-36 Detention Parallel to CDOT Ultimate ROW
- CountyParcels
- Orphaned OSMP Property
- Detention Pond Limits
- Streams, Creeks and Ditches
- Main Road
- Existing 5' Contours
- Fill by Others

N

0 400 800 1,200
Feet

FIGURE 9-8
US-36 Detention Berm Parallel to US-36 Ultimate ROW
South Boulder Creek Flood Mitigation Report



LEGEND

Depth (ft)

- 6 - 7
- 5 - 6
- 4 - 5
- 3 - 4
- 2 - 3
- 1 - 2
- 0 - 1

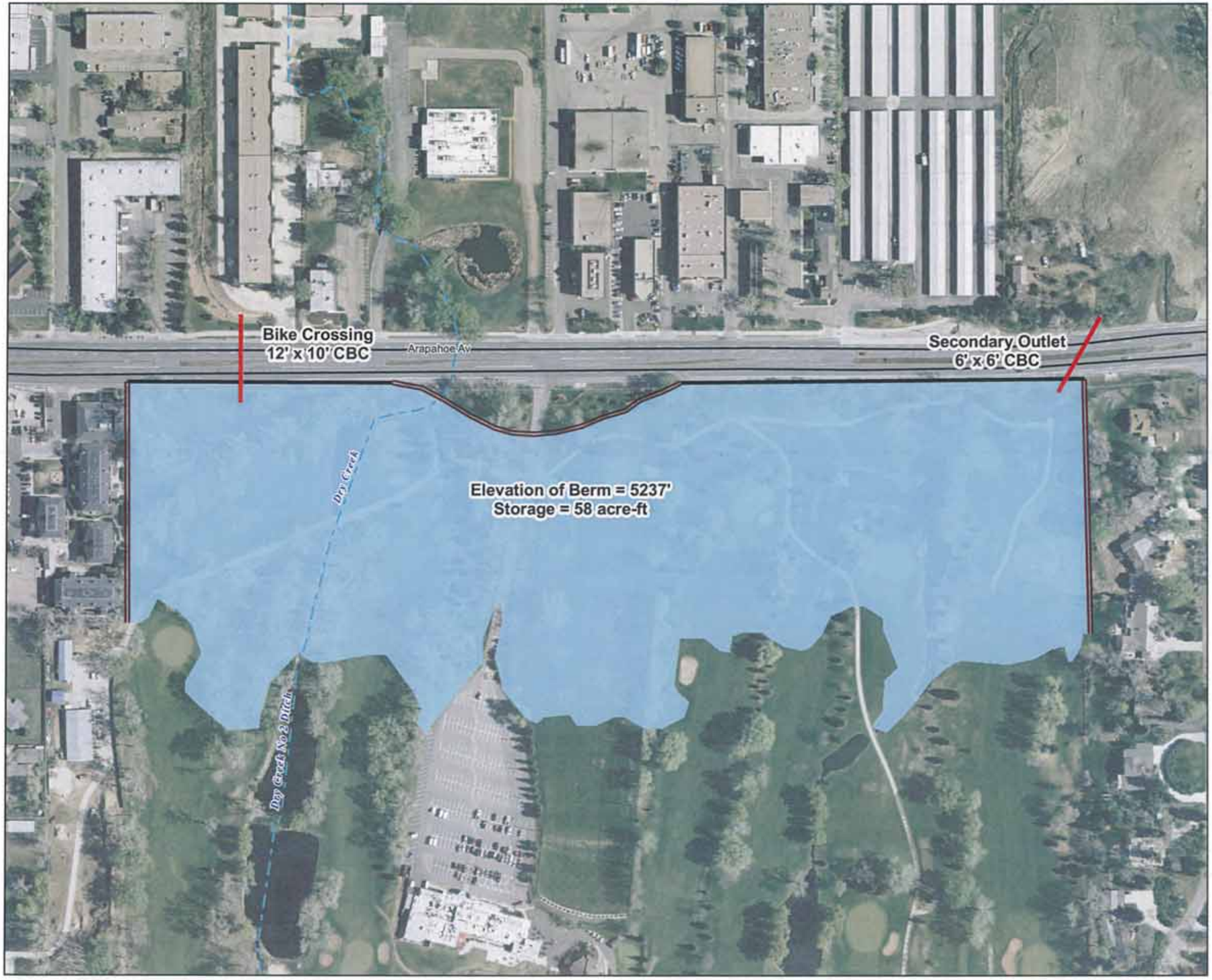
Pond Outlet

Streams, Creeks and Ditches

N

0 50 100 200 300 Feet

FIGURE 9-4
Manhattan Middle School Detention
South Boulder Creek Flood Mitigation Report



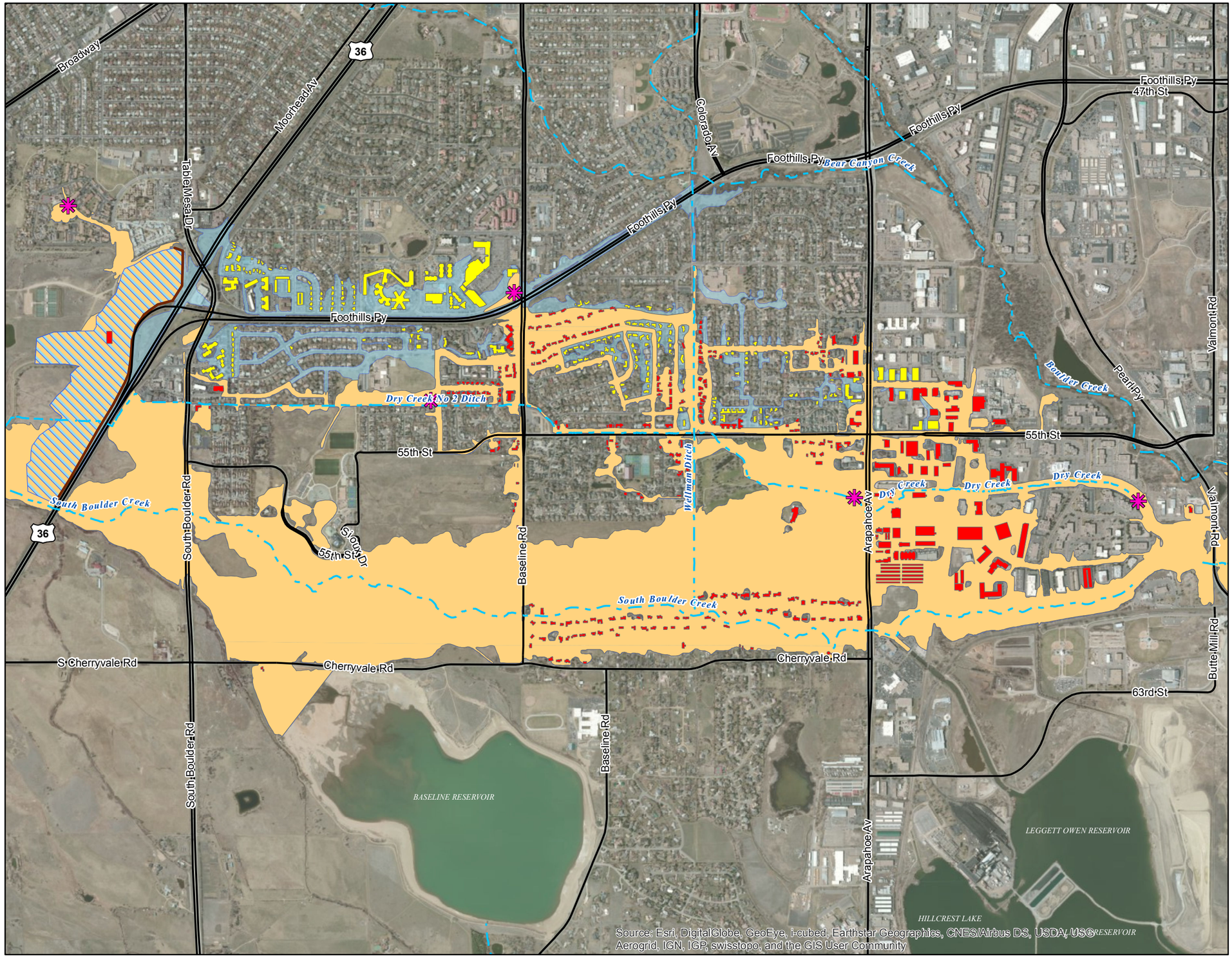
LEGEND
- Detention Pond Limits
- Culvert Outlet
- Berm
- Wall
- Streams, Creeks and Ditches

N

0 100 200 400 Feet

FIGURE 9-3
Arapahoe Avenue Detention
South Boulder Creek Flood Mitigation Report

Attachment F – Flood Mitigation from Phase I of the Recommended Alternative



LEGEND

- C2 Basin Hydrologic Loading Points

Structure Removal Status

- Not Removed From 100-Year Floodplain
- Potentially Removed From 100-Year Floodplain
- Streams, Creeks and Ditches

- Main Road
- US-36 Embankment
- Detention at US 36
- Post Project Condtions Floodplain
- Existing Floodplain (Regulatory Zone AE)

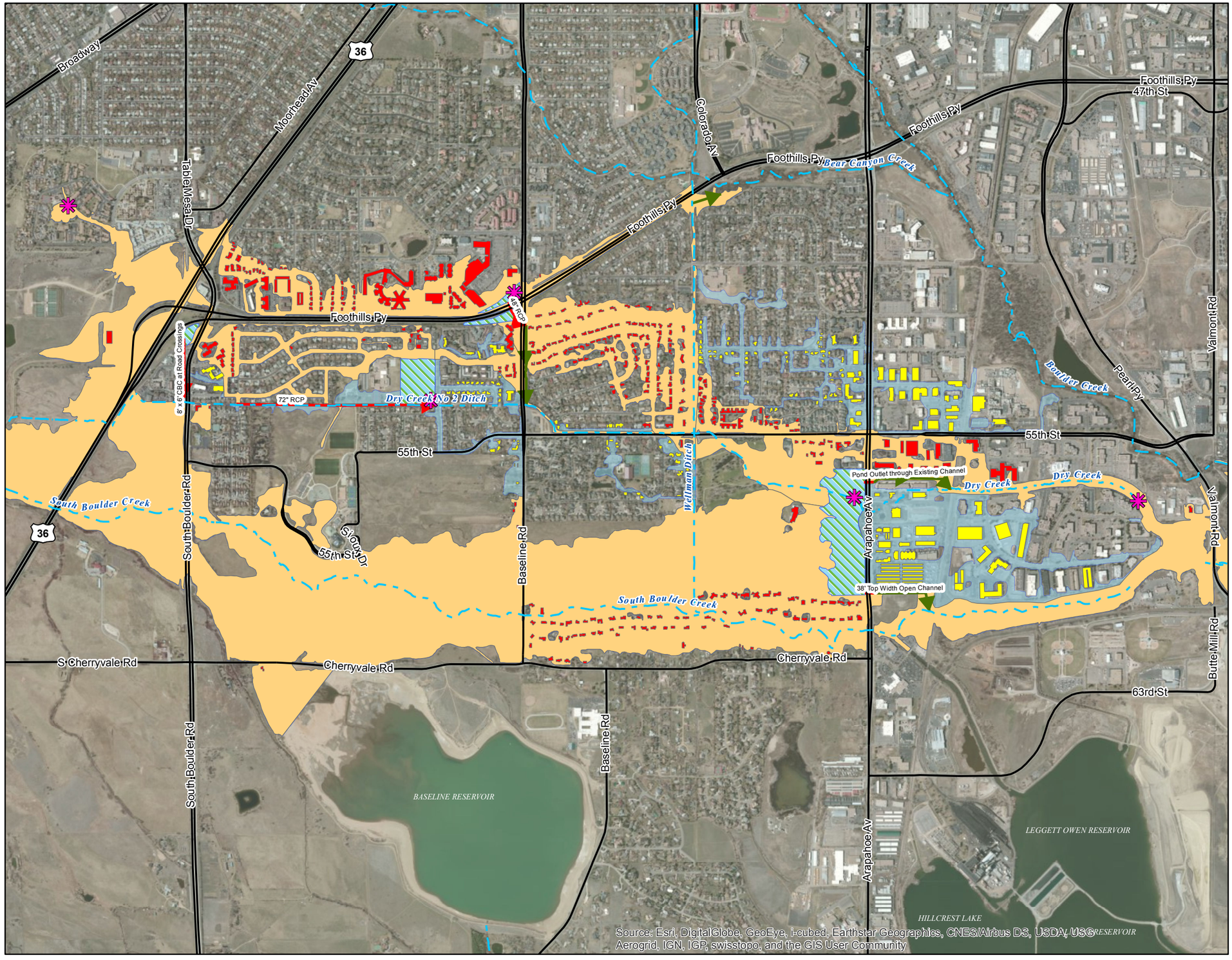
N

0 380 760 1,520 2,280 3,040 Feet

Potential Structures Removed from the 100-Year SBC Floodplain by Implementing the US-36 Detention Facility (Phase 1 Improvments)

For South Boulder Creek

Attachment G – Flood Mitigation from Phases 2 and 3 of the Recommended Alternative



LEGEND

- C2 Basin Hydrologic Loading Points

Structure Removal Status

- Not Removed From 100-Year Floodplain
- Potentially Removed From 100-Year Floodplain
- Streams, Creeks and Ditches
- Main Road

Engineers Recommended Conveyance Improvements

- Open Channel Improvement
- Pipeline/Culvert Improvement
- Engineers Recommended Local Detention
- Post Project Condtions Floodplain
- Existing Floodplain (Regulatory Zone AE)

N

0 380 760 1,520 2,280 3,040 Feet

Potential Structures Removed from the 100-Year SBC Floodplain by Implementing Phase 2 and Phase 3 Improvments

For South Boulder Creek

Attachment H – Open Space and Mountain Parks Summary of Environmental Resources

APPENDIX H

Environmental resources of South Boulder Creek and potential resource impacts of the US 36 with Downstream Improvements flood mitigation alternative

A number of issues were assessed during the evaluation process of the flood mitigation alternatives in addition to the financial and flood control elements implicit in the evaluation. The Regional Detention at US36 with Downstream Improvements alternative was further evaluated by city staff and the public for impacts to resources on OSMP land. The West Valley improvements and Arapahoe Avenue detention components of this alternative will not impact resources on OSMP land. The regional detention facility at US36 component will impact OSMP land with high value ecological resources including:

- Wetlands that are considered to be among the best preserved and most ecologically significant in the Boulder Valley.
- An important population of the federally threatened Preble's meadow jumping mouse.
- An important occurrence of the federally threatened Ute ladies' tresses orchid.
- A population of northern leopard frog, a species experiencing marked declines along the Front Range and classified as sensitive in nine Western US states.
- Populations of two native fish species in decline in Colorado, plains topminnow and orange-spotted sunfish.
- A population Bobolink, a declining grassland nesting bird.
- An important remnant of the plains cottonwood riparian ecosystem.
- Relicts of the tallgrass prairie ecosystem.

- **Wetlands**: Extensive high-quality wetlands and riparian areas exist throughout the South Boulder Creek floodplain, including riparian forests, willow shrublands, freshwater marshes and wet meadows. These wetlands are considered to be among the best preserved and most ecologically significant in the Boulder Valley. Several of these wetland types provide refuge for rare species such as Preble's meadow jumping mouse, Ute ladies-tresses orchid, groundnut and toothcup, while others are rare or imperiled on a statewide or global scale. A regional detention facility at US36 would impact this resource via direct burial of wetlands and the possible alteration of the hydrology of adjacent wetlands. An additional undetermined area will be temporarily impacted from construction activities. Wetland permits would be required from the city of Boulder and the US Army Corps of Engineers for this project. Mitigation would be necessary for all unavoidable impacts.

- **Preble's Meadow Jumping Mouse:** This species is listed as threatened under the Endangered Species Act. Research by Carron Meaney (biologist with Walsh Environmental and co-author of *Mammals of Colorado*) and others found extremely high densities of Preble's in the South Boulder Creek floodplain (one of highest densities anywhere in their range). In recognition of the importance of this habitat for the overall conservation and recovery of this species, the US Fish

and Wildlife Service designated critical habitat as occurring 140 meters (460 feet) adjacent to the South Boulder Creek channel. In their description of the area in the Federal Register, the USFWS states "A wide floodplain, complex ditch system, and the irrigation of pastures makes the lower portions of this unit unique". In addition to the habitat included in the critical habitat area, Preble's use areas further from the stream including irrigated fields, ditch corridors and upland grassland. PMJM has been recently trapped along South Boulder Creek and in the adjacent mesic tallgrass prairie south of US36. This area is also considered occupied habitat. A regional detention facility at US36 will directly impact Prebles habitat and may also contribute to fragmentation of remaining habitat by creating barriers to movement to and from suitable habitat.

- **Ute Ladies' Tresses Orchid:** Ute ladies' tresses orchid is a wetland plant designated as threatened under the Endangered Species Act. In Colorado, the orchid is restricted to low elevation valleys in wetlands, riparian areas and irrigated fields. Within these sites, it is found only in specialized conditions of soil and hydrology. The populations of the orchid on OSMP lands are among the largest and most important to the conservation of this species throughout its range. The largest populations on OSMP are found immediately south of US 36 where the mosaic formed by mesic bluestem prairie (a globally rare plant community) and wetlands occur. Monitoring by OSMP staff has documented over 3,000 orchids in this area. Smaller numbers of the orchid are found adjacent to South Boulder Creek. The detention facility at US36 would impact this resource via direct burial of orchid plants and orchid habitat and the possible alteration of the hydrology of adjacent wetlands and mesic bluestem prairie. An additional undetermined area will be temporarily impacted from construction activities.

- **Northern Leopard Frog:** Populations of the northern leopard frog in the Western US are in marked decline, suffering local extinctions in some areas, including the Front Range. They are classified as a species of interest in nine western states as well as considered sensitive by the Bureau of Land Management and the US Forest Service. Numerous interacting threats have disrupted the frog's ecology. These include: habitat loss and degradation, pesticide use, fungal pathogens, the spread of non-native species like predaceous fish and bullfrogs into otherwise suitable breeding habitats, changes in the hydrological regime (which allows completion of bullfrog's reproductive cycle), and increased variability in temperature and precipitation. The decline of this species in Boulder County is well documented. Despite recent population declines, leopard frogs are still consistently found in a number of wetland and aquatic habitats on OSMP, including those along South Boulder Creek. In 2011, OSMP staff documented a northern leopard frog breeding site in wetlands near South Boulder Creek. These local populations contribute to the conservation of this species throughout its declining range.

- **Native fish and ground-nesting birds:** Plains topminnow and orange-spotted sunfish, two native fish species in decline in Colorado and state species of special concern have been documented in South Boulder Creek in the project area. The wet meadows and tallgrass prairie adjacent to SBC provide habitat for bobolink, a declining grassland nesting bird. This species is considered "vulnerable to extirpation" ("S3B") by the Colorado National Heritage Program and a "rare breeding species" by the Boulder County Comprehensive Plan. Habitat for these species in the SBC floodplain will likely be degraded or destroyed by a detention facility at US36.

Other Environmental Values

- **South Boulder Creek State Natural Area (SBCSNA):** The Colorado Natural Areas Act established a statewide Colorado Natural Areas Program to provide a means by which specific examples of Colorado's natural features and ecological phenomena can be identified, evaluated and protected through a statewide system of designated natural areas. Designation of the SBCSNA provides statewide recognition of the important natural features in this area. The Colorado Natural Areas Council has determined that the South Boulder Creek floodplain qualifies as a state natural area because of the presence of a number of important biological resources including an important remnant of the plains cottonwood riparian ecosystem and relicts of the tallgrass prairie ecosystem in addition to the resources listed above. Tallgrass prairie is considered one of the most endangered plant communities in the world and OSMP land contains some of the highest quality remaining tallgrass prairie in the state and the region. The project area on OSMP lies entirely within the SBCSNA.

- **Agricultural Resources:** The South Boulder Creek floodplain supports some of the richest agricultural lands in the OSMP system with cattle grazing and hay production the primary agricultural uses. Much of the land is flood irrigated with long-standing water rights. Irrigation infrastructure is common throughout the area to distribute this water efficiently across the landscape. A detention facility at US36 would destroy irrigated pasture because of the inability to continue irrigation practices. While parts of the berm could continue to be grazed, forage production would also be lower because of lack of irrigation. A berm could not be hayed due to its steep sides and hay production would be eliminated. Some irrigation infrastructure would need to be relocated and rebuilt to move irrigation water across the land efficiently.

- **Weeds:** A berm south of US36 would create good habitat for many weedy species and a difficult surface topographically for most weed treatment strategies. OSMP would likely be committed to long-term herbicide use to control weeds on the berm which would conflict with the City's IPM policies. The berm would be a poor quality island patch that would create a long-term threat to the remaining wet meadow and mesic tallgrass habitat in the adjacent OSMP areas.

- **Scenic Resources:** A detention facility at US36 will have scenic impacts for visitors to OSMP lands. The height of the berm will vary depending on local topography and other factors. This structure will create visual impacts due to its height, shape, linear nature and presence in an otherwise semi-natural setting. Depending on viewing perspective, views of the riparian area, agricultural fields and the mountain backdrop will be affected.

The Open Space and Mountain Parks provisions in the City of Boulder Charter define specific uses for OSMP land. The potential construction of a detention facility and berm at US36 appears to conflict with OSMP charter purposes by impacting land with high ecological, agricultural, scenic and recreational values. The extent, proximity, association and significance of these rare resources are found in very few other places in the world. These potential losses are significant and may not be easily mitigated, replaced or restored.