

SOUTH BOULDER CREEK MITIGATION PLANS SUMMARY

Note: Red font demarcates areas of possible relation to the OSBT request

EXECUTIVE SUMMARY

South Boulder Creek Flood mitigation is a high priority because of the identified flood risk to life and property, flood benefits from the project, damage experienced during the 2013 flood and direction from City Council. On June 16, 2020, city council instructed staff to,

“...adopt the Variant 1 100-yr flood protection alternative as the basis of design and permitting for the South Boulder Creek Flood Mitigation Project; and ... to, in parallel, analyze whether the upstream model identified by the Open Space Board of Trustees at its meeting on June three would improve flood mitigation effectiveness, reduce costs, decrease environmental impacts or increase the likelihood of receiving applicable permits and permissions as compared to the Variant 1 100-yr model and report these findings to council in the next few months provided that any such analysis of the upstream model by city staff not delay or otherwise impede staff’s work in furtherance of the Variant 1 100-yr model....”

This document provides a summary of past floodplain planning efforts and alternatives analysis for the South Boulder Creek drainageway. This summary highlights alternatives that included flood detention or other solutions upstream of US36, and for the purposes of this document, “upstream” indicates any conceptual design with elements located upstream of US36. A tabulation of all the conceptual alternatives is included as **Attachment A**, and a location map is included as **Attachment B**.

MAJOR DRAINAGEWAY PLANNING, SOUTH BOULDER CREEK (1973)

The first flood mitigation planning effort for South Boulder Creek was prepared in 1973 by R.W. Beck on behalf of Boulder County, the City of Boulder and the Urban Drainage and Flood Control District. The study divided South Boulder Creek into four reaches. Reach 1 included the area from Eldorado Springs to SH93. Reach 2 was located from SH93 to South Boulder Road. Reach 3 included South Boulder Road to Baseline Road. The fourth and final reach was from Baseline Road to the C&S (now BSNF Railroad). Nineteen total alternatives were considered across the four reaches with seven alternatives, including non-structural approaches, considered in upstream reaches 1 and 2. The two alternatives proposed in Reach 2 included flood detention basins between Marshall Road and US36 or levees that extended to US36 through this upstream reach.

This report did not recognize potential flooding across US36 into the West Valley area, but instead identified it as a possible stormwater issue that could cause shallow flooding. To address this issue, a levee in the area of the current CU South property was recommended to contain this shallow flooding and direct it towards the main South Boulder Creek channel under US36. The 1973 plan and recommendations were not formally adopted by the city but did provide background information for future planning efforts.

SOUTH BOULDER CREEK DRAINAGEWAY PLAN (2001)

In 1996 Love and Associates identified that South Boulder Creek flows could overtop US36 creating a greater flood risk to the neighborhoods north of Foothills Parkway, now known as the West Valley. Following these findings, a floodplain mitigation planning effort for South Boulder Creek was developed in 2001 by Taggart Engineering Associates with sponsorship from the Urban Drainage and Flood Control District, City of Boulder, Boulder County and University of Colorado. This study considered five designated alternatives with additional modifications that could be considered to address potential issues with implementation of the alternatives. All five of the proposed alternatives included improvements located upstream of US36. Four of the five alternatives were considered active floodplain management options and one alternative was considered passive¹.

The four active alternatives in this plan considered storage upstream of US36, at SH93, at Gross Reservoir or some combination of those locations. These locations were chosen because they are existing controlling features that have a significant impact on the floodplain and were considered in combination with drainageway improvements aimed at improving conveyance. All four alternatives included an engineered hydraulic control structure in or across South Boulder Creek to divert flows to off-channel storage along US36 or to contain the 100-yr flood flows to the main South Boulder Creek channel.

The recommended alternative was relocation of residents or property acquisition at SH93, storage at US36 and downstream waterway improvements, called “*US36 Storage and Select Waterway Improvements*.” This alternative included a detention facility on the CU South property upstream of US36 and downstream drainage improvements to increase stream channel capacity. The recommendation was based on environmental benefit in that it eliminated the need to build a large embankment across South Boulder Creek, had the least impact to City of Boulder Open Space, required the fewest private land acquisitions and provided the greatest flexibility for modification at a later date. Significant community opposition to property acquisition and residential relocation in the area of SH93 prevented these two elements of the recommendation from proceeding further.

This master plan effort ultimately recommended additional development of the hydrologic and hydraulic modelling prior to advancing the mitigation planning effort to quantify the West Valley risk. These recommendations included using more detailed and updated topography, updated design hydrology and utilizing two-dimensional hydraulic modeling. Therefore, the mitigation recommendations from this study were not carried forward and the City of Boulder in partnership with Boulder County and the Urban Drainage and Flood Control District instead began the floodplain mapping for South Boulder Creek to formally recognize and quantify the flood risk associated with the overtopping of US36 and the West Valley.

¹ Passive floodplain management consists of working with features within the existing floodplain, while active floodplain management uses physical improvements to resolve flooding problems.

FLOODPLAIN MAPPING (2010)

A significant portion of the South Boulder Creek flood risk to the City of Boulder is when the creek leaves its banks, overtops US36 and enters an area of the city known as the “West Valley” that includes the Keewaydin Meadows, Frasier Meadows and East Boulder neighborhoods. This flood risk was first identified and mapped in 2003 and was formalized as a flood risk by FEMA in 2010 ([FEMA Floodplain Mapping](#)). The 2013 floods validated the 2010 flood mapping when, as predicted, South Boulder Creek flows overtopped US36 and entered the West Valley. 2013 South Boulder Creek flood flows were estimated to be in the range of a 75-yr to 100-yr flood event.

SOUTH BOULDER CREEK MAJOR DRAINAGEWAY PLAN (2015)

The city, in partnership with the Mile High Flood District², developed the [2015 South Boulder Creek Major Drainageway Plan](#) using the 2010 floodplain mapping. This master planning process considered fifteen alternatives, of which nine were preferred. The nine preferred options represented those that might best achieve project objectives, have the best return on investment and the fewest undesirable community impacts. One of these nine included proposed regional detention at US36 and was further refined with seven conceptual layouts. **Three of these seven layouts looked to capture flows that spill out of South Boulder Creek at SH93 in detention upstream of US36 on the CU South property. These alternatives were not recommended as they did not eliminate flooding to the West Valley and required additional infrastructure along US36 to contain flood flows. The master plan ultimately recommended phasing of the flood mitigation plan with regional detention at US36 as a first phase because it minimized impacts to Open Space and Mountain Parks lands, had large downstream benefit and because of the benefit cost ratio associated with the improvement.**

SOUTH BOULDER CREEK REGIONAL DETENTION CONCEPT DESIGN (2018)

Based on the 2015 South Boulder Creek Major Drainageway Plan recommendations, conceptual designs for regional detention at US36 were further developed. Three different design configurations each were considered for 100-yr and 500-yr flood protection levels. Four of these alternatives were modelled with and without the CU levee in place. This provided a total of ten conceptual design alternatives for regional detention at US36. All options included flood detention on CU and city Open Space property and a floodwall along US36. This study includes use of the most current hydrologic and hydraulic modeling information, site specific topography and more recent environmental surveys.

During community engagement on the 2018 conceptual designs, community members proposed a conceptual “Community Upstream Alternative” ([link included below](#)), which proposed eliminating the floodwall along US36 by storing water in the previously mined

² Formerly Urban Drainage and Flood Control District

area of the CU South property. When analyzed more in depth, this design did not eliminate the need for a flood wall and resulted in more total infrastructure and environmental impacts. Even when re-running the analysis and increasing and maximizing the proposed storage on the CU South property³ in the previously mined gravel pits, the design did not eliminate the need for a floodwall along US36 and still required more infrastructure and had greater environmental impacts. Additional detention on the CU South property was not further evaluated after this [information](#) was presented to council.

Of related interest, the “Variant 2” alternative considered eliminating the need for outlet works from the proposed detention pond by instead implementing flow restriction at the US36 bridge over South Boulder Creek. This option required removal of the CU South levee, and it was learned during this analysis that the CU levee did not have a material effect on existing South Boulder Creek floodplain. Therefore, removal of the levee does not help or hurt flood mitigation design except that removal may provide opportunity for greater environmental mitigation potential in offsetting environmental impacts from the project.

City council chose to advance the Variant 1, 500-year flood mitigation option to preliminary design and landowner negotiations after review of the alternatives. The information was presented at the City Council meeting on [August 7, 2018](#) and [August 21, 2018](#). Subsequent landowner negotiations lead to July 2019 city council redirection.

SOUTH BOULDER CREEK REGIONAL DETENTION CONCEPT DESIGN (2020)

In July 2019, City Council directed Utilities staff to further refine the South Boulder Creek Flood mitigation project to evaluate varying levels of flood protection and the respective relationship to the [Boulder Valley Comprehensive Plan 2017 CU South Guiding Principles](#). Previous engineering evaluations had produced mitigation alternatives that addressed flooding impacts associated with the 100-yr flood event and the 500-yr flood event. Based on council’s direction, a conceptual design based on a 200-yr flood event was also developed. Key findings of these analyses suggested that costs and ground disturbance (project footprint) increased considerably as the level of flood protection increased beyond the 100-year flood option, as was presented on [February 25, 2020](#). Additionally, the feasibility of the 500-year option was questionable considering the combination of financial implications, environmental impacts and engineering considerations.

Based on the trade-offs that were presented in at the February 25 study session and the public feedback that was presented at the June 16 public hearing in [June 2020](#), City Council directed the project team to proceed with design of the Variant 1 100-yr alternative while also revisiting the upstream concept noted in the June 3 OSBT recommendation to council.

³ Maximum storage was 1,100 acre-feet

Attachments:

Attachment A: South Boulder Creek Master Plans Summary Table

Attachment B: Map of South Boulder Creek Flood Mitigation Locations

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ATTACHMENT A

Flood Mitigation Study	Mitigation Strategy	Detention		Comments
		Location	Conclusion	
South Boulder Creek Regional Detention Conceptual Design (2020)	Variant 1 - 100 -yr	US36	Least Expensive. Least environmental impacts	Reduce design flood event. No land use change.
	Variant 1 - 200-yr	US36	More Expensive. Most environmental impacts	Reduce design flood event. Land use change.
	Variant 1 - 500-yr	US36	Most Expensive. More environmental impacts	Land use change.
South Boulder Creek Regional Detention Conceptual Design (2018)	Master Plan - 100-yr with CU Levee	US36	Most Expensive compared to Variant 1 and 2	Regional detention on CU South Property. Floodwall, embankment, outlet works and Vielel Channel Siphon.
	Master Plan - 100-yr without CU levee	US36	Most Expensive compared to Variant 1 and 2	Regional detention on CU South Property. Floodwall, embankment, outlet works and Vielel Channel Siphon.
	Master Plan - 500-yr with CU Levee	US36	Most Expensive compared to Variant 1 and 2	Regional detention on CU South Property. Floodwall, embankment, outlet works and Vielel Channel Siphon.
	Master Plan - 500-yr without CU Levee	US36	Most Expensive compared to Variant 1 and 2	Regional detention on CU South Property. Floodwall, embankment, outlet works and Vielel Channel Siphon.
	Variant 1 - 100-yr with CU Levee	US36	Least expensive	Regional detention on CU South Property. Floodwall, embankment and outlet works. Removes Viele Channel siphon.
	Variant 1 - 100-yr without CU levee	US36	Least expensive	Regional detention on CU South Property. Floodwall, embankment and outlet works. Removes Viele Channel siphon.
	Variant 1 - 500-yr with CU Levee	US36	More expensive and less adaptable	Regional detention on CU South Property. Floodwall, embankment and outlet works. Removes Viele Channel siphon.
	Variant 1 - 500-yr without CU Levee	US36	More expensive and less adaptable	Regional detention on CU South Property. Floodwall, embankment and outlet works. Removes Viele Channel siphon.
	Variant 2 - 100-yr without CU levee	US36	Least expensive	Regional detention on OSMP property. Floodwall and embankment. Removes Viele Channel siphon and outlet works.
	Variant 2 - 500-yr without CU Levee	US36	More expensive and more adaptable. Least complex solution.	Regional detention on OSMP property. Floodwall and embankment. Removes Viele Channel siphon and outlet works.
	Community Upstream - 100-yr	US36/OS-O	More environmental impacts. US36 Floodwall needed. More infrastructure.	Regional Detention on OS-O. Floodwall and embankment on OSMP and CU South. Flow restriction at US36 bridge.
	Community Upstream - 500-yr	US36/OS-O	More environmental impacts. US36 Floodwall needed. More infrastructure.	Regional Detention on OS-O. Floodwall and embankment on OSMP and CU South. Flow restriction at US36 bridge.
	Project Team Upstream - 100-yr	US36/OS-O	More environmental impacts. US36 Floodwall needed. More infrastructure.	Regional Detention on OS-O. Floodwall and embankment on OSMP and CU South. Removes flow restriction at US36 bridge.
	Project Team Upstream - 500-yr	US36/OS-O	More environmental impacts. US36 Floodwall needed. More infrastructure.	Regional Detention on OS-O. Floodwall and embankment on OSMP and CU South. Removes flow restriction at US36 bridge.
South Boulder Creek Major	Status Quo	N/A	Did not meet 100-yr flood protection goals in West Valley	No enhanced flood protection
	High Hazard Zone containment with critical structure flood proofing	N/A	Did not meet 100-yr flood protection goals in West Valley	Provides no substantive enhancements to level of flood protection
	Regional Detention at US-36 with downstream storage and conveyance improvements through West Valley and along Dry Creek No. 2 Ditch	US36	Highest BCR lowest environmental impact	Critical facilities and residential properties privately owned and floodproofing costs borne by property owners
	Regional Detention near Hwy-93 with downstream storage and conveyance improvements through West Valley and along Dry Creek No. 2 Ditch	SH93	Parcel needed private property from unwilling sellers. Implementation difficult due to maintain natural flow conditions.	
	Distributed Regional Detention with downstream storage and conveyance improvements through West Valley and along Dry Creek No. 2 Ditch	US36/ South Boulder Rd./ Baseline Rd.	Lower BCR, purchase of privately owned undeveloped property.	
	Mainstem flow containment with local West Valley improvements	Baseline Reservoir	Baseline reservoir usage not feasible as it serves as water supply (Lafayette	

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ATTACHMENT A

Flood Mitigation Study	Mitigation Strategy	Detention		Comments
		Location	Conclusion	
Drainageway Plan (2015)	Dry Creek No. 2 Ditch pipeline	N/A	Significant costs and disruption. No water quality enhancement opportunities. Low BCR.	
	Bear Canyon Creek pipeline	N/A	Significant costs and disruption. No water quality enhancement opportunities. Low BCR.	
	Nuisance – Level Flood Improvement Protection	N/A	Did not meet 100-yr flood protection goals in West Valley	Does not address 100-yr flooding
	US36 Median Wall	US36	Not feasible	Raise median wall on US36
	US-36 Flood Control Alternative A	US36	Impacts to OSMP	Single embankment Ultimate US36 ROW
	US-36 Flood Control Alternative B	US36	Highest BCR. Impacts to OSMP.	Single embankment with excavation Ultimate US36 ROW
	US-36 Flood Control Alternative C	US36	Impacts to OSMP	Single embankment with excavation on east side of CU South Ultimate US36 ROW
	US-36 Flood Control Alternative D	US36	No impacts to OSMP. High BCR.	Single embankment with excavation on east side of CU South Phase 1 US36 ROW
	US-36 Flood Control Alternative E	US36/OS-O	Impacts to OSMP. Low BCR.	Dual berms Ultimate US36 ROW no excavation and no fill
	US-36 Flood Control Alternative F	US36/OS-O	Impacts to OSMP. Low BCR (<1.0).	Dual berms Ultimate US36 ROW includes excavation and fill
US-36 Flood Control Alternative G	US36/OS-O	Impacts to OSMP. Low BCR (<1.0).	Dual berms Ultimate US36 ROW includes excavation and fill east side of CU South	
South Boulder Creek Major Drainageway Plan (2001)	Enhanced Floodplain Management	N/A	Enhanced Floodplain Management, will greatly reduce the loss of life, but only marginally reduce the level of flood damages. The average level of damages may somewhat reduce over time if significantly flooded structures are removed, flood proofed, or residents relocate. This reduction would be enhanced if there is a successful voluntary relocation program.	Passive floodplain management
	Flood Storage at Gross Reservoir Highway 93, and US36	Gross, HWY 93 and US36	It may be more costly than the other active flood control alternatives, but it reduces hazard associated with dams by using two smaller storage facilities in the lower valley. It also largely preserves flood storage below and above the spillway at Gross Reservoir, which is a benefit to the entire watercourse downstream of Gross Reservoir. Because the storage would be accomplished at three sites, it may be more difficult to implement than the other 4 designated alternatives. On the other hand, such storage improvements are smaller than options in the other alternatives, and may be affordable on a phased basis.	
	Large Flood Storage at Highway 93	HWY 93	It is a functional, simple, and reliable plan based on one flood storage at a reasonable site. It has the greatest impact on the residents upstream of Highway 93, including about 25 residents who are not in the existing 100-year floodplain. Alternative 3 has the greatest potential dam safety hazard of the storage options in the lower reach, because it has the largest volume and dam height at a single location. While the Highway 93 Dam would further widen the environmental barrier posed by the existing Highway 93, it would also offer some different and diverse environments, and remove development from a portion of the riparian cottonwood forest ecosystem. It has significant impacts to City of Boulder Open Space upstream of Highway 93.	

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ATTACHMENT A

Flood Mitigation Study	Mitigation Strategy	Detention Location	Conclusion	Comments
	Flood Storage at Gross Reservoir and Highway 93	Gross and HWY 93	It would have less impact on the residents and City of Boulder Open Space above Highway 93, yet nearly the same level of environmental benefits of Alternative 3. Since the bulk of the flood storage is at Gross Reservoir, the hazard posed by dam breach within the detailed study reach is the least of Alternatives 2 through 4. It is a relatively simple, reliable plan based on major retention flood storage upstream (where the water is trapped, then released after the event), and one modest flood detention storage (peak attenuation of the Eldorado Canyon flows) at a reasonable site within the detailed study area. The plan offers substantial benefit to the entire canyon .	
	Relocation at Highway 93, US36 Storage and Select Waterway Improvements	US36	The most sound and offers many benefits from an environmental and open space perspective. It is also flexible for implementation as the components can be constructed in phases, and in varying order. At first glance, it may be more costly than other active flood control alternatives. Cooperation among the agencies, optimization, and possible inclusion of other options can increase the cost effectiveness of this alternative. It offers benefits which the other four designated alternatives cannot provide.	Recommended Alternative
Major Drainageway Planning, South Boulder Creek (1973)	Large Flood Control Dam above Denver Diversion (above State Park)	Upstream Eldorado Springs		Reach 1 (Eldorado Springs to Hwy 93)
	Flood Water Retarding Structures (small dams through this portion of the watershed)			Reach 1 (Eldorado Springs to Hwy 93)
	Floodplain Zoning and Use Restrictions		Recommended Alternative	Reach 1 (Eldorado Springs to Hwy 93)
	Acquisition of Floodplain Lands		Recommended Alternative	Reach 1 (Eldorado Springs to Hwy 93)
	Flood Insurance			Reach 1 (Eldorado Springs to Hwy 93)
	Flood Proofing			Reach 1 (Eldorado Springs to Hwy 93)
	Advanced Flood Warning			Reach 1 (Eldorado Springs to Hwy 93)
	Flood Detention Basins			Reach 2 (HWY 93 to South Boulder Rd)
	Levees	Upstream US36	Recommended Alternative	Reach 2 (HWY 93 to South Boulder Rd)
	Baseline Reservoir Flood Storage of 400 to 800 ac-ft	Baseline Reservoir		Reach 3 (South Boulder Rd to Baseline Rd)
	Diversion of flood to Dry Creek			Reach 3 (South Boulder Rd to Baseline Rd)
	Flood Detention Basins		Recommended Alternative	Reach 3 (South Boulder Rd to Baseline Rd)
	5200 cfs SBC Concrete or Riprap-lined Channel			Reach 4 (Baseline Rd to C&S (now BSNF Railway)
	Underground Conduit in Built Up Areas			Reach 4 (Baseline Rd to C&S (now BSNF Railway)
	Golf Course Grass-lined Bypass Channel			Reach 4 (Baseline Rd to C&S (now BSNF Railway)
	5200 cfs SBC Terraced Combination Channel, Riprap Low Flow and Grass-lined Overflow			Reach 4 (Baseline Rd to C&S (now BSNF Railway)
	1000 cfs SBC Soft Channel for Frequent Events, or combine with storage upstream		Recommended Alternative	Reach 4 (Baseline Rd to C&S (now BSNF Railway)
40000 cfs SBC Terraced Combination Channel, Riprap Low Flow and Grass-lined Overflow			Reach 4 (Baseline Rd to C&S (now BSNF Railway)	
Acquisition of Floodplain Structures			Reach 4 (Baseline Rd to C&S (now BSNF Railway)	

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ATTACHMENT B: Map of South Boulder Creek Flood Mitigation Locations

