CITY OF BOULDER

COMPREHENSIVE FLOOD AND STORMWATER MASTER PLAN

TECHNICAL MEMORANDUM 2

POLICY AND PROGRAM EVALUATION

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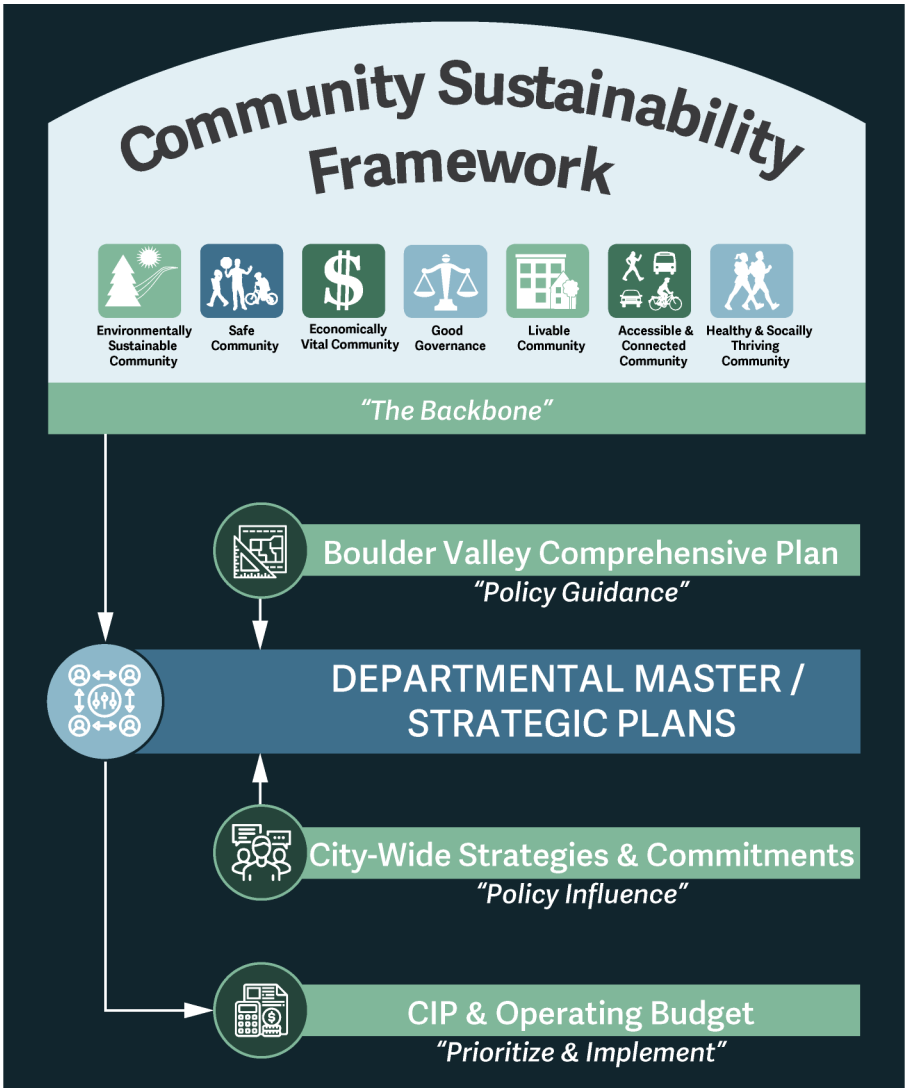
1 Introduction and Purpose

The Comprehensive Flood and Stormwater Master Plan (CFS) is the overarching planning document for the Stormwater and Flood Management Utility (Utility). This document provides a framework for the implementation and evaluation of the various programs and activities within the Utility. A necessary part of the evaluation is to assess both the effectiveness of these programs and activities and to determine if they are in alignment with current city policies.

Within the City of Boulder, the Community Sustainability + Resilience Framework defines community values which help set policies and priorities for the city. This includes the main guiding document, the Boulder Valley Comprehensive Plan (BVCP), which guides decisions about growth, development, and preservation, as well as what services the city provides such as utilities and flood mitigation.



Policies are assessed as to whether the programs and activities within the Utility meet the intent of the policies presented in the BVCP and associated community values based on current implementation. An evaluation of the programs themselves will be completed to identify policy gaps to then assess whether the current policies and guiding documents adequately cover the necessary functions of the Utility.

A framework for evaluation should be established with metrics to determine whether the current programs and activities are adequate to meet the objectives of the Utility. This has not been established to date, and this update to the CFS includes an initial evaluation framework to assess the current programs with the intent that the goals, objectives, and associated metrics will be refined to reflect the forward looking needs of the Utility and public sentiment. A Community Working Group has been assembled to assist with the process and provide input on these items.

Wonderland Creek Greenways Improvements

2 Policy Evaluation

Each of the BVCP policies identified in Technical Memorandum 1 were evaluated to determine whether the programs and activities in the Utility meet the intent of the identified policies. Relevant actions that relate specifically to the Utility were extracted from each policy and grouped under related policy themes to eliminate any redundant actions (reference the Appendix). As part of this exercise, nine themes were identified that relate to specific programs within the Utility; each of these themes are discussed in greater depth below.

BOULDER VALLEY COMPREHENSIVE PLAN POLICY THEMES

Flood Management Program Themes

- Floodplain Preservation and Restoration
- Flood Mitigation

Stormwater Quality Program Themes

- Water Quality Protection
- Groundwater Dewatering
- Wetland Preservation and Restoration

Overarching Utility Themes

- Integrated Planning
- Multi-Objective Planning, Design, and Operation
- Provision of Services
- Public Engagement and Outreach

Floodplain Preservation and Restoration

A large number of policies within the BVCP relate to the preservation and restoration of floodplains, suggesting its importance within the city. In support of floodplain preservation and restoration, the Utility employs multiple approaches that often incorporate floodplain restoration efforts with other floodplain mitigation projects or when partnering with other departments and work groups within the city, including the Greenways Program, Open Space and Mountain Parks, Transportation, and Parks and Recreation. Additionally, properties located in areas prone to flooding are actively purchased by the Utility, especially within the High Hazard Zone, for structure removal and use for floodwater conveyance. Restoration of land following removal of structures on these properties typically occurs as part of larger flood mitigation projects.

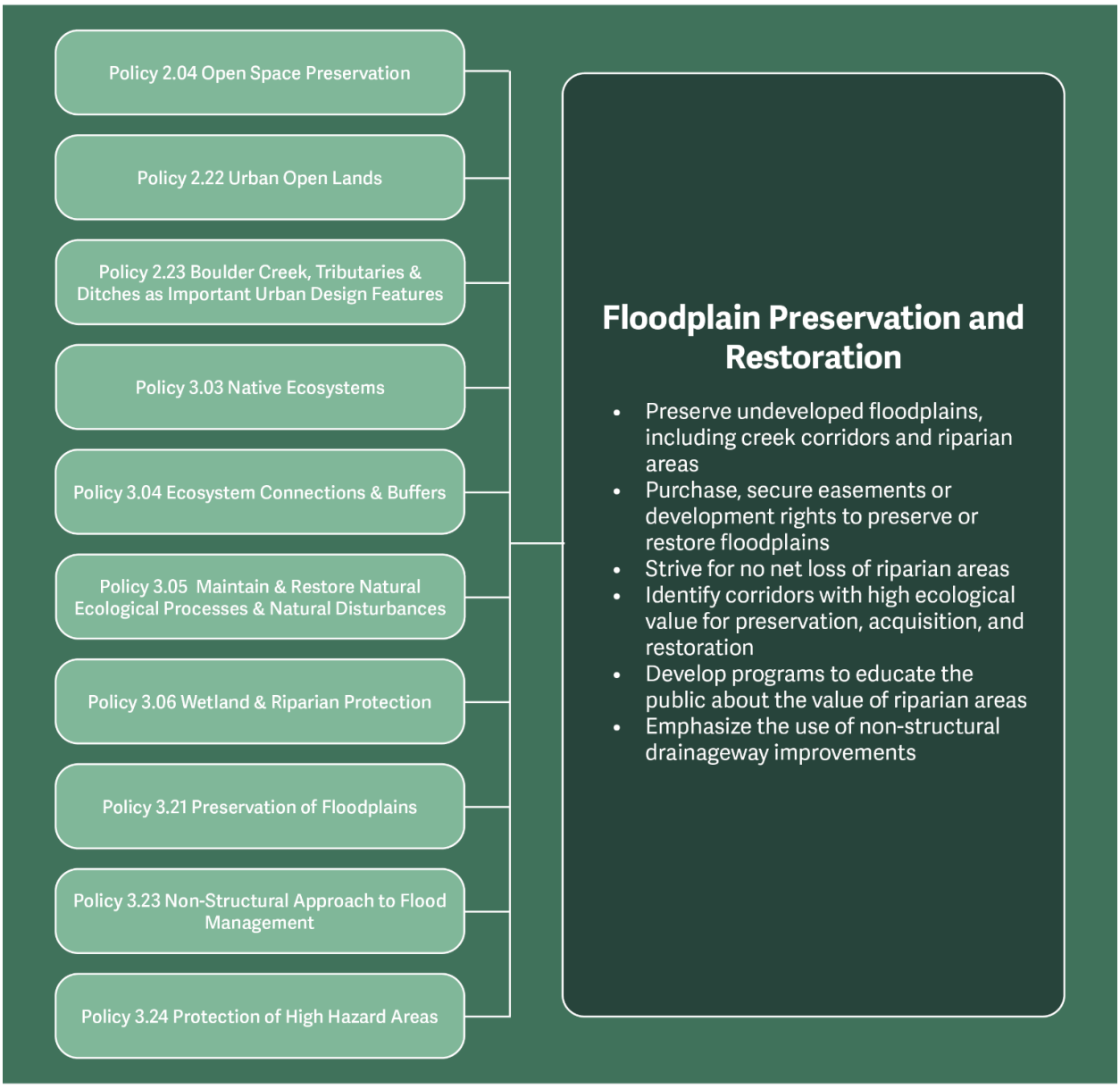


Figure 2.1 – Floodplain Preservation and Restoration as related to BVCP Policies

Elmer's Two Mile Creek Greenway

The Elmer's Two Mile Creek Greenway Project, which was completed in 2010, is an example of the type of floodplain restoration projects constructed by the Utility. This project was a multi-departmental effort, including assistance from the Mile High Flood District to replace an undersized, fenced-in concrete channel.

The improvements included sections with a widened natural channel bottom and an expanded naturalized floodplain in conjunction with structural drainageway improvements that could convey the 100-year flood.

Floodplain Preservation and Development Regulations

The preservation of natural floodplains, including creek corridors and riparian areas is a clear priority within the BVCP for a multitude of social, environmental, and economic reasons. Currently streams, wetlands and water bodies are delineated and mapped with a standard buffer of 25 -ft or 50-ft applied as a wetland buffer. Riparian areas are not delineated or mapped separately. Riparian areas that are located on city-owned property, on private property with conservation easements, or those with purchased development rights are protected, and creek corridors and associated buffers are protected under the Stream, Wetlands, and Water Body Protection regulations in Chapter 9-3 of the Boulder Revised Code. However, there are no protections for riparian areas that extend beyond the regulated buffers. Floodplain regulations are used within the city to regulate land use and the type of development activities that can occur within each of the mapped floodplain zones. Current floodplain regulations in Chapter 9-3 of the Boulder Revised Code make no mention of preserving existing undeveloped floodplains or riparian areas. Instead, these regulations are used to guide development within the floodplains in a manner that primarily protects public safety and limits property damage. Regulations governing the High Hazard Zone are by far the most restrictive on residential development for public safety reasons. However, construction of new structures, additions onto existing structures, and floodplain fill are allowed in at least some form within the mapped floodplain zones.

In an analysis of city GIS data from 2014 to 2018, an additional 117 structures and roughly 1.5 acres of impervious surface area have been permitted within the 100-year floodplain. It was not possible to determine the area of fill permitted within the 100-floodplain from this GIS data.

Table 2.1 – 2014 to 2018 Change in Buildings and Impervious Cover within Mapped Floodplains

Mapped Floodplain Zone	Building Count		Building Footprint		Impervious Cover	
	Number	% Change	sft	% Change	ac	% Change
500-Year Floodplain	+206	+3.9%	+396,790	+2.4%	+10.1	+0.9%
100-Year Floodplain	+117	+3.4%	+6,699	+0.1%	+1.5	+0.3%
Conveyance Zone	+15	+2.3%	-53,934	-4.9%	-2.4	-1.0%
High Hazard Zone	+15	+4.2%	-27,074	-6.8%	-2.2	-1.4%

Notes: The conveyance zone includes the high hazard zone; the 100-year floodplain includes the conveyance zone and the high hazard zone; and the information reported for the 500-year floodplain does not include information within the 100-year floodplain

Use of Non-Structural Drainageway Improvements

Existing policies mention emphasizing the use of non-structural measures over structural methods, such as levees and constructed channels, but there exists no clear guidance within the city as to how non-structural measures are defined and when they should be used. Also, it is not clear whether these types of solutions are emphasized in planning and design or how they are prioritized. Non-structural solutions do not appear within the CIP prioritization goals for mitigation plans used by the city. Since development within these floodplains largely occurred prior to the adoption of regulations, retroactively requiring the use of non-structural drainageway improvements to expand the natural floodplain in fully developed watersheds would be impractical. Because of this, the majority of non-structural practices include floodproofing of existing structures, enhanced warning systems, flood education programs, development of evacuation plans, and flood insurance. Alternatives such as naturalized channels and wide riparian areas where floods are naturally conveyed are often not feasible due to the development within the floodplain or because the required property acquisition is prohibitive.

Stormwater and Flood Management CIP Prioritization Guiding Principles

- Life Safety (High Hazard) Mitigation
- Flood Emergency Response Capability
- Critical Facility (Vulnerable Population) Hazard Mitigation
- Property Damage Mitigation
- Collaboration with other Greenways Program Objectives
- Potential for Operation and Maintenance Cost Savings
- Accommodating New Growth and Development
- Opportunities to Leverage Outside Funding

Flood Mitigation

The flood management program within the Utility is centered on the mitigation of damage caused by floods. The BVCP addresses flood mitigation through four separate policies (reference Figure 2.2). Major activities conducted by the Utility include floodplain mapping, development of flood mitigation plans, design and construction of flood mitigation projects, and review and development of floodplain regulations.

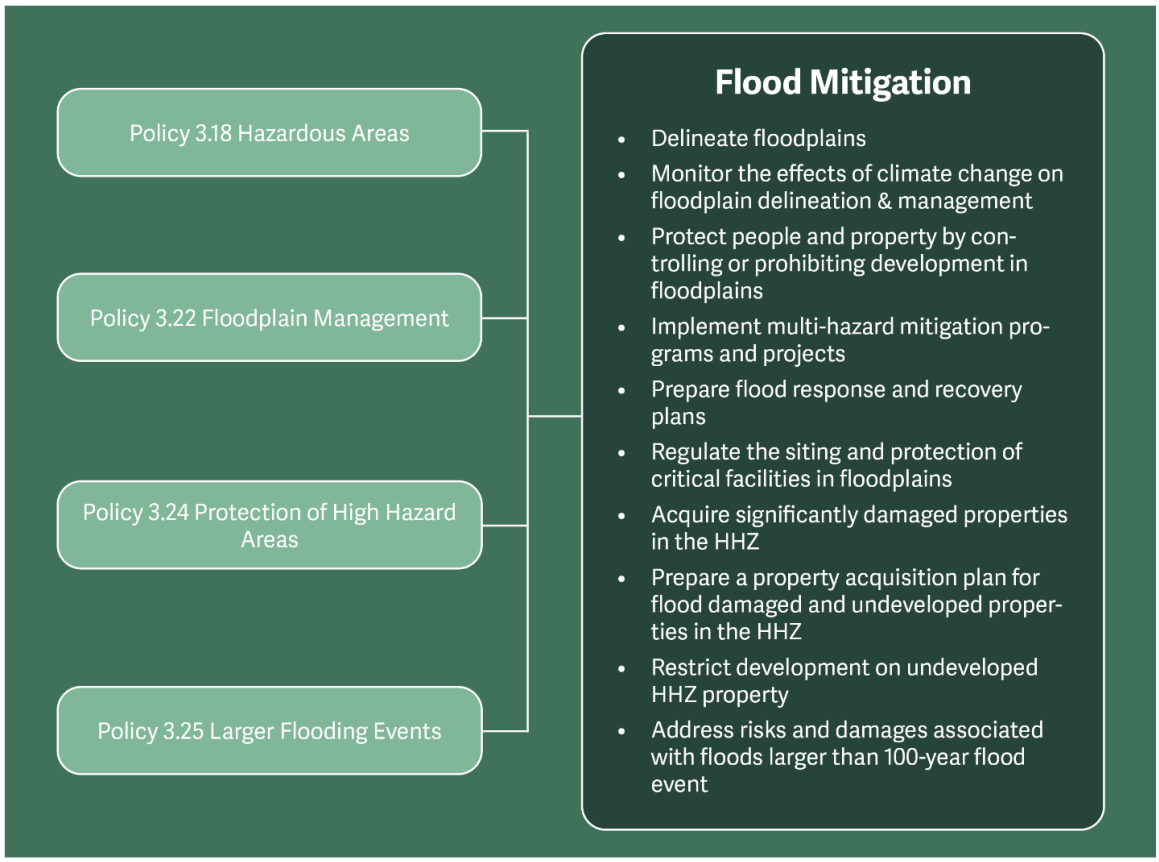


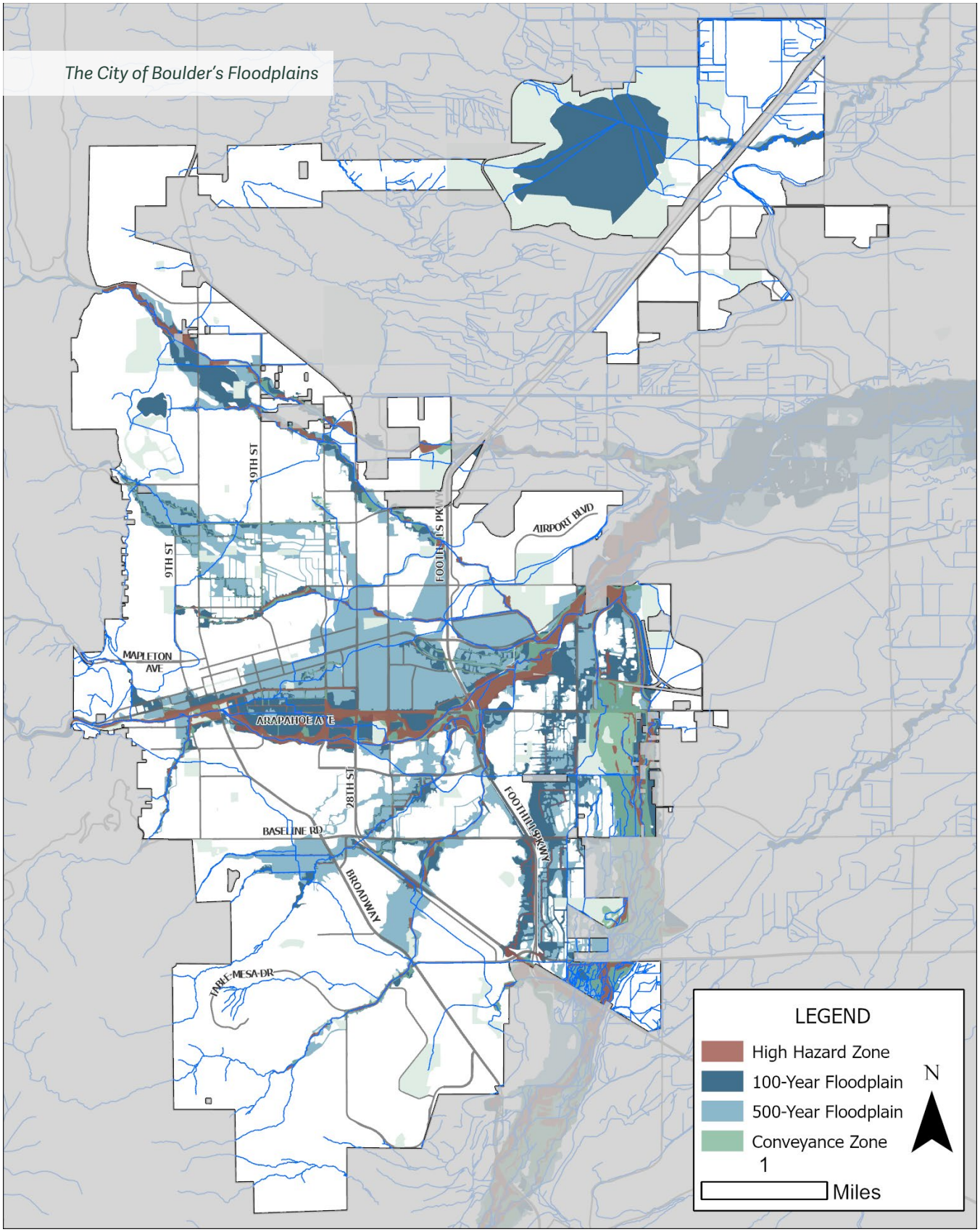
Figure 2.2 – Floodplain Preservation and Restoration as related to BVCP Policies

Floodplain Mapping and Regulations

The city delineates four distinct flood zones as part of floodplain mapping: High Hazard Zone, Conveyance Zone (Floodway), 100-yr floodplain (1% annual chance of occurrence), and 500-yr floodplain (0.2% annual chance of occurrence). These floodplain maps form the basis for the city's floodplain regulations and flood management program.

The city's floodplain regulations are contained in Chapter 9-3 of the Boulder Revised Code and detail land use regulations intended to reduce risk to people and property in areas along drainageways prone to flooding. In 2014, the city enacted new floodplain regulations to require emergency management plans and provide additional flood protection for critical facilities, such as hospitals, police and fire stations, day care facilities, and water treatment facilities in the 500-year floodplain.

The City of Boulder's Floodplains



Development of new structures and additions within the 100-year floodplain are permitted as long as the lowest floor of any residential structure is elevated to the flood protection elevation, which is two feet above the floodwater surface elevation. Residential basements are not permitted on residential structures in the 100-year floodplain.

Non-residential structures may be constructed below the flood protection elevation as long as floodproofing not requiring human activation is installed up to the flood protection elevation. Permitting of new structures requires installation of measures to protect against sanitary sewer backup. Parking lots are allowed in the 100-year floodplain as long as the predicted 100-year flood depths do not exceed 18 inches.

Development within the Conveyance Zone must comply with the 100-year floodplain regulations. Additionally, a private engineering analysis is typically required to ensure that flooding conditions are not worsened (i.e. that the floodplain will not expand or get deeper). Flood mitigation measures may be used to offset these conditions.

Regulations within the High Hazard Zone are the most restrictive due to life safety concerns. No new structures intended for human occupancy are permitted. Additionally, no new parking lots or changes of use from non-residential to residential are allowed. Regulations pertaining to any overlaying zones such as the 100-year floodplain or the Conveyance Zone apply as well.

Property Acquisition

The Utility's Capital Improvement Program provides funding for property acquisition in the amount of about $700,000 annually with an escalation for inflation and rising property costs. This fund allows for the purchase of properties in areas prone to flooding, especially in the city's High Hazard Zone. High-risk properties have been identified and prioritized for purchase along each of the city's major drainageways, and the Mile High Flood District has the ability to partner with the city on high-risk purchases through their Property Acquisition Reserve Fund. The city's property acquisition program has been "opportunity-based" in working with willing sellers and targeting properties that become available on the real estate market. Since 2004, seven properties have been acquired with the most recent purchases along Gregory Canyon Creek. Purchase of these properties serves to accommodate future flood mitigation improvements. Additionally, floodplain regulations for the High Hazard Zone prevent reconstruction of flood damaged properties if the property has incurred damage equal to an amount that is more than 50% of the structure's pre-flood market value.

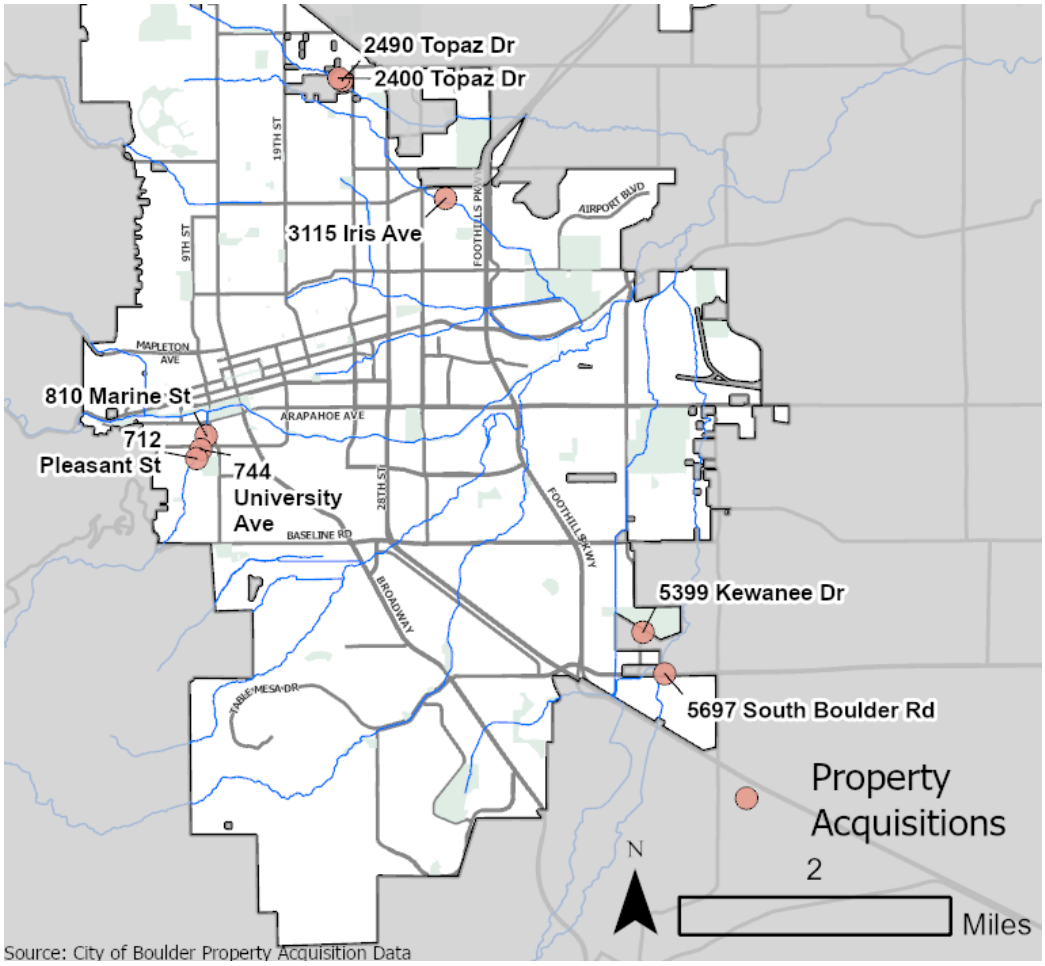
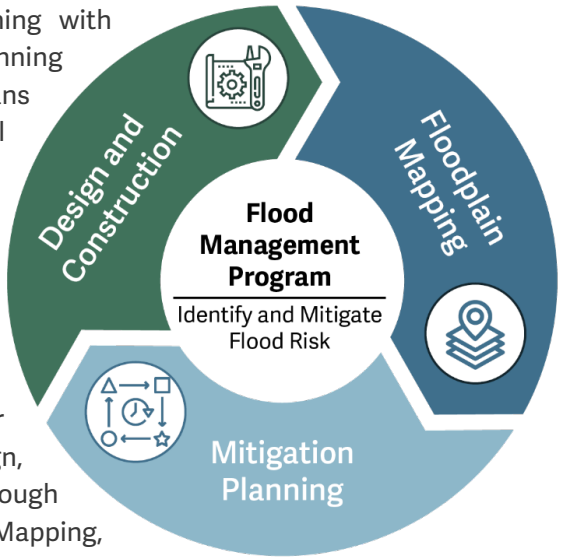


Figure 2.3 – Locations of Properties Purchased Since 2004

Flood Mitigation Planning Process

The flood management process is cyclical in nature, beginning with floodplain mapping to identify flood risk while mitigation planning identifies measures to reduce these risks. Flood mitigation plans identify and evaluate the benefits and costs of potential improvement projects; subsequently projects are placed into the Capital Improvement Program for design and construction. Following significant construction projects, floodplain maps are updated to reflect the changes to the flood area.



Since 2004, floodplain mapping updates have been completed on nearly all of the city's 16 major drainageways with several mitigation plans and construction projects either completed or currently in progress. The flood mapping, mitigation planning, design, and construction process takes years to complete due to a thorough planning and public engagement process (Figure 2.4 – Floodplain Mapping, Mitigation Planning, Design and Construction Project Life Cycle).

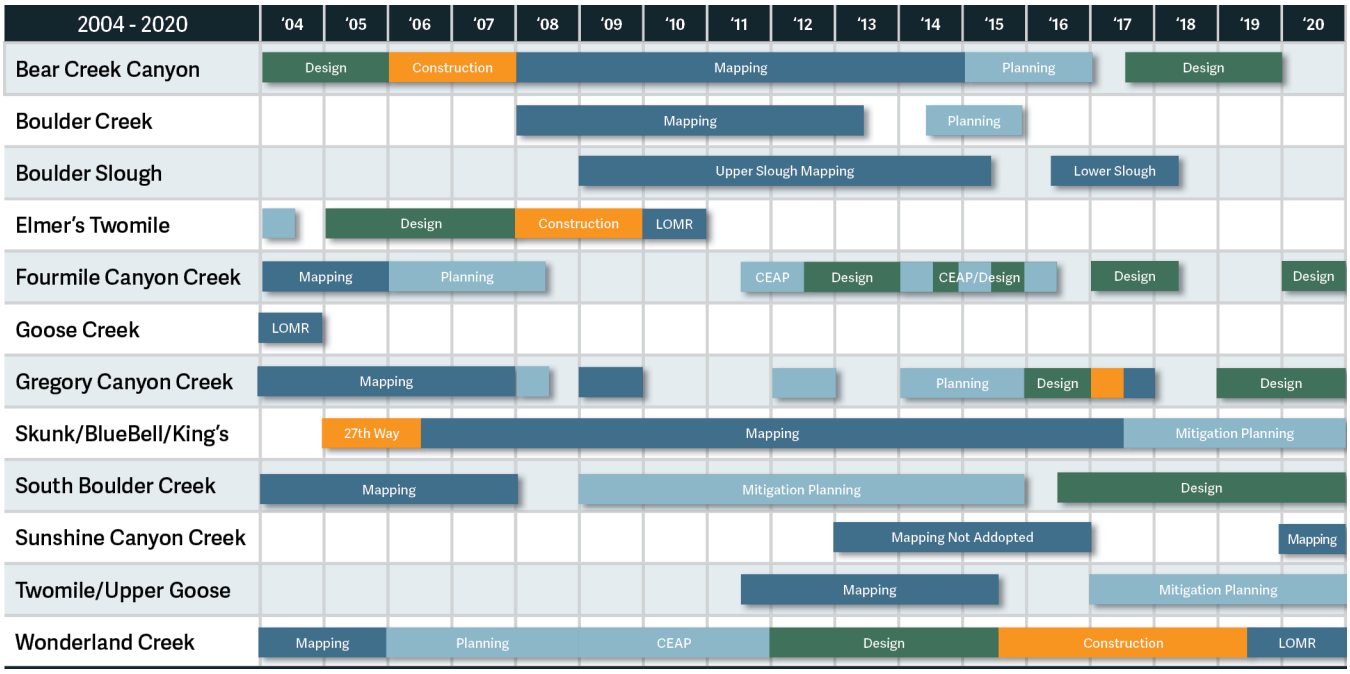


Figure 2.4 – Floodplain Mapping, Mitigation Planning, Design and Construction Project Life Cycle

Flood Response and Recovery Plans

The City of Boulder works with the Boulder Office of Emergency Management (OEM) to provide emergency response and recovery services. As part of this work, OEM maintains an Emergency Operations Plan that covers the City of Boulder and the All-Hazards Recovery Plan.

Water Quality Protection

The City of Boulder holds a Municipal Separate Storm Sewer System (MS4) permit (No. COR090000), and many of the activities to support the protection and improvement of water quality are governed by MS4 permit regulations. The current MS4 permit includes substantial programmatic and technical requirements for the protection of water quality. These minimum MS4 requirements alone likely meet the intent of the existing policies in the BVCP as shown in Figure 2.5.

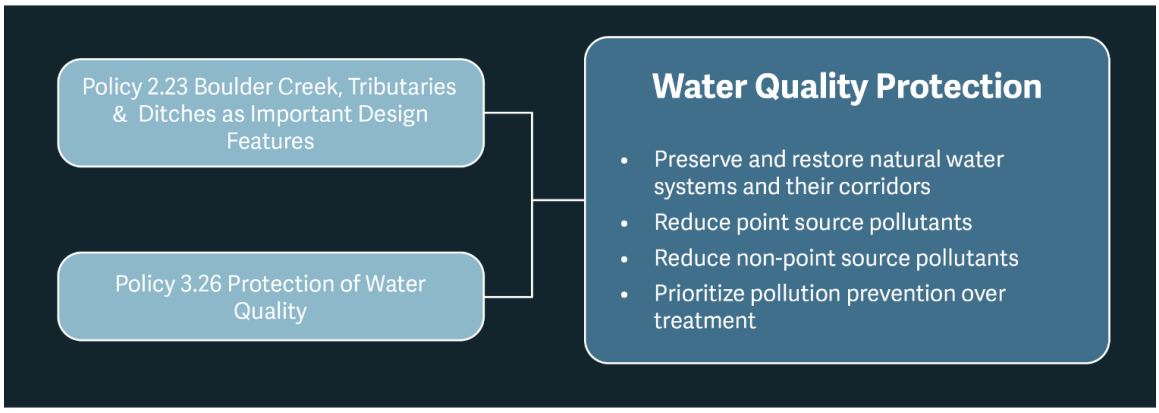


Figure 2.5 – Water Quality Protection as related to BVCP Policies

In addition to the minimum requirements of the MS4 program, the city is actively pursuing efforts to further water quality initiatives by expanding the green infrastructure program, implementing a multi-pronged adaptive management approach to identify and address sources of *E. coli*, and the Boulder Urban Stream Health Program. This program is a framework for collaboratively identifying and implementing projects to improve urban waterways in the city. The goal of this program is to most appropriately use Utility funds and resources to enhance urban stream health and achieve optimal outcomes through studies, projects, education, and collaboration between Utilities staff and other city partners. The program was initiated in 2021.

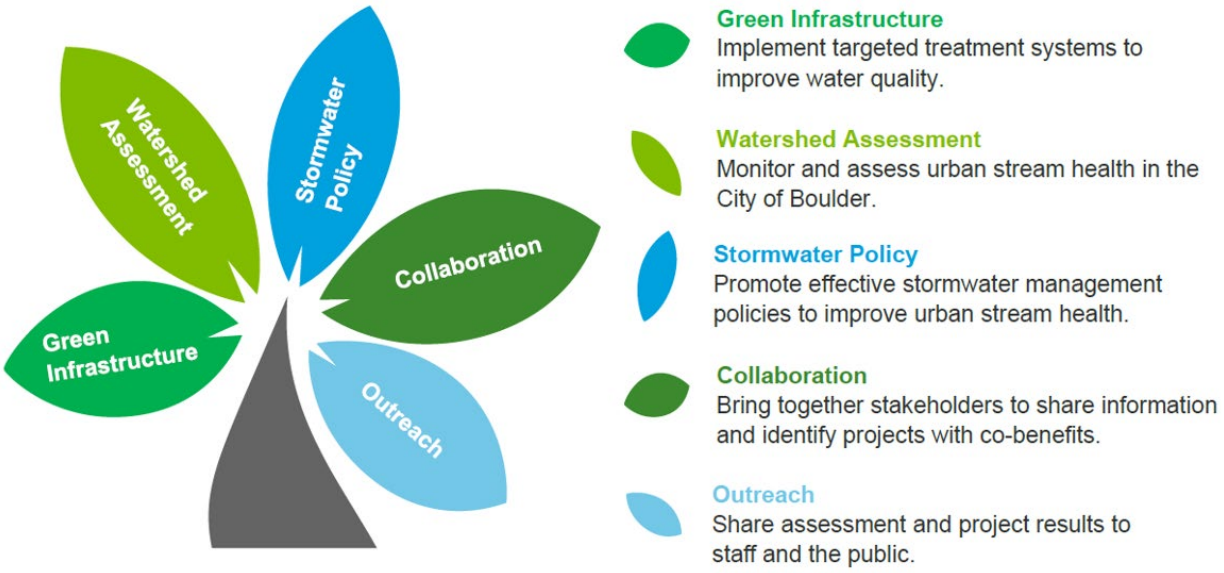


Figure 2.6 – Boulder Urban Stream Health Program

Groundwater Dewatering

Current BVCP policy guidance suggests the need to address and potentially regulate groundwater dewatering activities. Additionally, the last update to the CFS identified recommended actions related to groundwater dewatering and sump systems which have not yet been addressed.

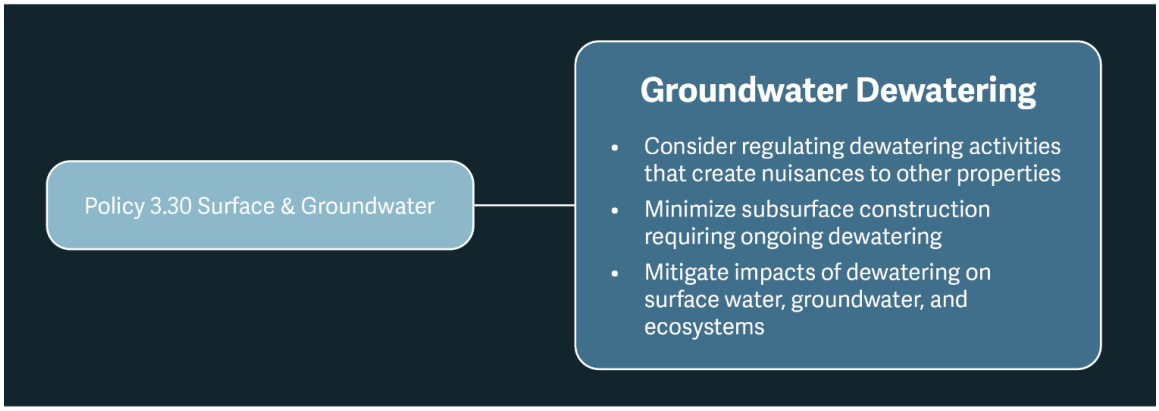


Figure 2.7 – Groundwater Dewatering as related to BVCP Policies

Wetland Preservation and Restoration

Efforts to preserve and restore wetlands are undertaken by the Planning and Development Services Department (through plan reviews), the Greenways Program, Open Space and Mountain Parks Department, and the Parks and Recreation Department. While the functions of wetlands relate to water quality, their preservation and protection is not currently managed within the Stormwater Quality Program.

Existing regulations governing the protection of wetlands are located in 9-3 of the Boulder Revised Code. These regulations seek to find a reasonable balance between a property owner's desire to make reasonable uses of their property and the public's interest in preserving and protecting wetlands. Therefore, development is discouraged but when it is unavoidable the regulations indicate that impacts should be minimized and mitigation provided for losses. Construction of buildings, additions, accessory structures, fences, and detention or retention facilities are prohibited within regulated wetlands. Additional regulations apply to inner and outer buffer areas based on whether the wetland is considered high functioning. Wetlands less than 400 square feet are exempt from the regulations unless a plant, animal, or other wildlife species is listed as rare, threatened, endangered, or as a species of special concern in the BVCP or by a government agency.

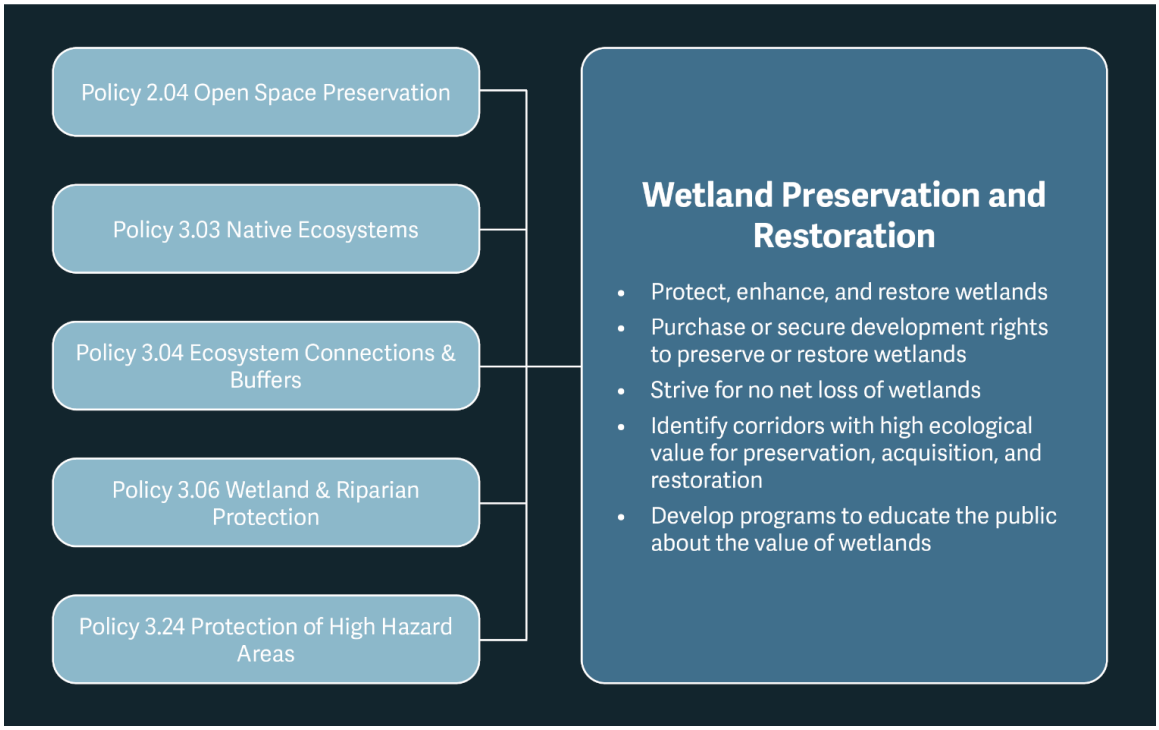
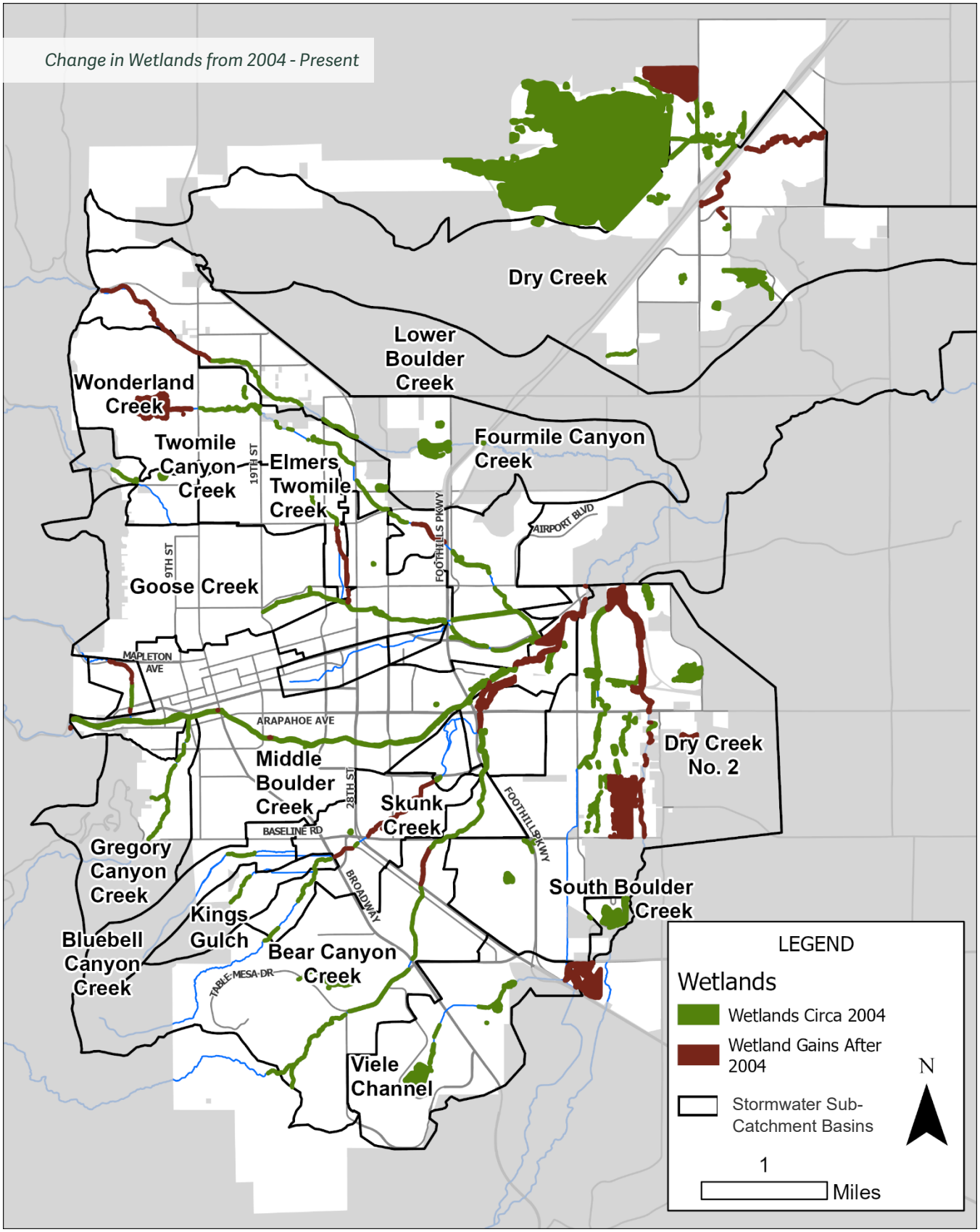


Figure 2.8 – Wetland Preservation and Restoration as related to BVCP Policies

In 2004, wetlands within the city were mapped and evaluated. Since then, the GIS database has only included records of wetlands that have either been restored or enhanced, and does not include wetlands that have been lost. Because of this, the current data show a 25% increase in wetlands since 2004. However, using an impervious cover dataset from 2018, a roughly 3.5-acre increase of impervious cover in wetlands has occurred. Due to these discrepancies in the data, it cannot readily be determined whether there is a net loss of wetlands.


Change in Wetlands from 2004 - Present
Dry Creek
Lower Boulder Creek
Wonderland Creek
Twomile Canyon Creek
19TH ST
Elmers Twomile Creek
Fourmile Canyon Creek
FOOTHILLS PKWY
AIRPORT BLVD
9TH ST
Goose Creek
MAPLETON AVE
ARAPAHOE AVE
Middle Boulder Creek
28TH ST
Skunk Creek
BASELINE RD
FOOTHILLS PKWY
Dry Creek No. 2
Gregory Canyon Creek
BROADWAY
South Boulder Creek
Kings Gulch
Bluebell Canyon Creek
Bear Canyon Creek
TABLE MESA DR
Viele Channel
LEGEND
Wetlands
Wetlands Circa 2004
Wetland Gains After 2004
Stormwater Sub-Catchment Basins
N
1
Miles

Integrated Planning

The City of Boulder actively works with multiple regional and state organizations to effectively engage on flood management and water quality issues such as the Colorado Department of Transportation, Boulder County and Keep it Clean Partnership, among others. Additionally, the city is a part of the Mile High Flood District (MHFD), which assists local governments with multi-jurisdictional drainage and flood management issues. The Utility works closely with MHFD on flood mitigation planning, design, construction, maintenance of drainageways, stormwater quality criteria for MS4 Permit requirements, and the Information Services and Flood Warning program. The Keep it Clean Partnership is an organization of seven partner communities within Boulder County that coordinates on stormwater quality activities, including education, outreach, and monitoring to provide an integration of data and studies to analyze long-term water quality trends.

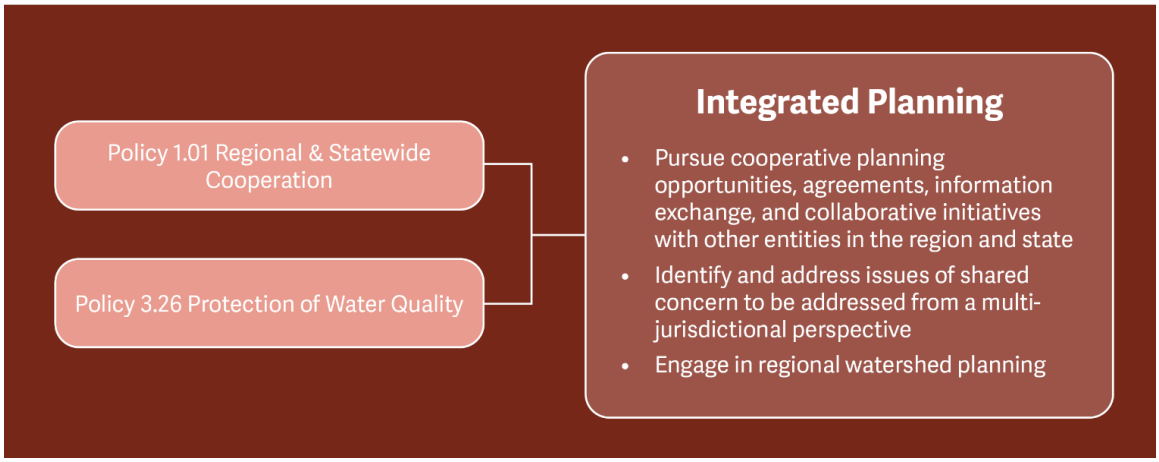


Figure 2.9 – Integrated Planning activities as related to BVCP Policies

Wonderland Creek Greenways Improvements

Multi-Objective Planning, Design, and Operation

Programs within the Utility often partner with other city departments, regional and state organizations in the design and construction of projects to achieve multiple objectives. A typical example is combining stormwater and flood improvements, stream restoration, and/or trail linkages with transportation projects. Additionally, the Greenways Program is comprised of an interdisciplinary staff work group to integrate multiple objectives along the city's major drainageways. Planning and design for projects along the greenways incorporates objectives such as habitat protection, water quality enhancement, storm drainage and flood mitigation, integration of trails and recreation, and preservation of cultural resources. Additionally, maintenance along the greenways is coordinated between multiple city departments and property managers such as the Boulder Valley School District, University of Colorado, and Boulder County Transportation Department.

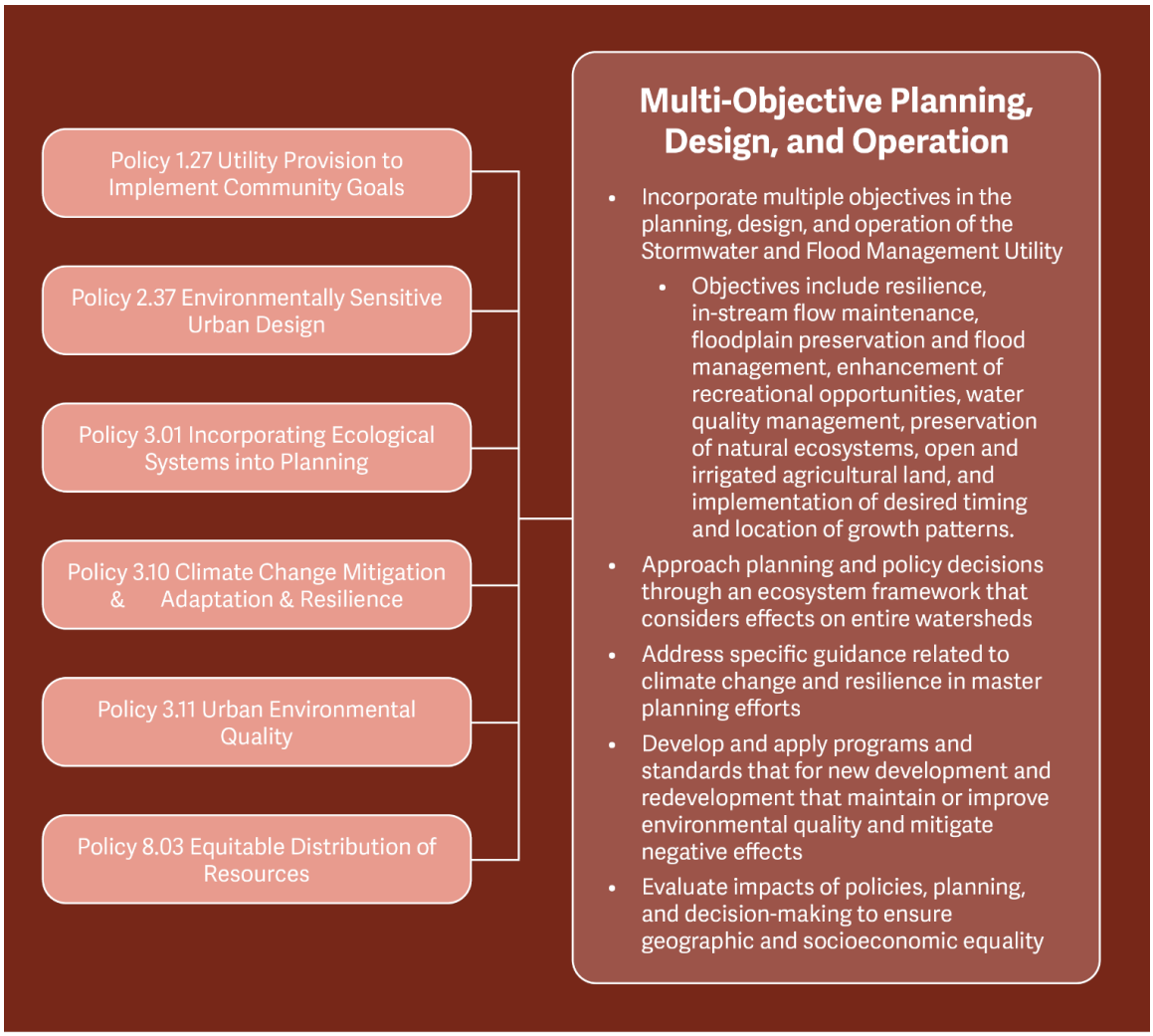


Figure 2.10 – Multi-Objective Planning, Design and Operation as related to BVCP Policies

Climate change, resilience, and the application of an ecosystem framework are objectives identified in the BVCP (Figure 2.10). It is not clear whether addressing these items and applying an ecosystem framework that considers effects on entire watersheds has been applied in the past, other than following MHFD guidance on floodplain mapping and construction of urban drainage improvements in a way that provides an additional level of conservatism. The Utility has not previously conducted an evaluation of current policies, planning and decision-making through the lens of geographic and socioeconomic equality. The following section on program evaluation incorporates the use of this lens where applicable. This approach is in alignment with the Racial Equity Plan recently adopted by the city and meets the intent of the policies within the BVCP.

Provision of Services

When it comes to the provision of stormwater and flood management services, BVCP policies largely relate to new urban development. However, because the majority of development within the city consists of infill or redevelopment, the construction of stormwater and flood management services for what would be considered new development rarely occurs.

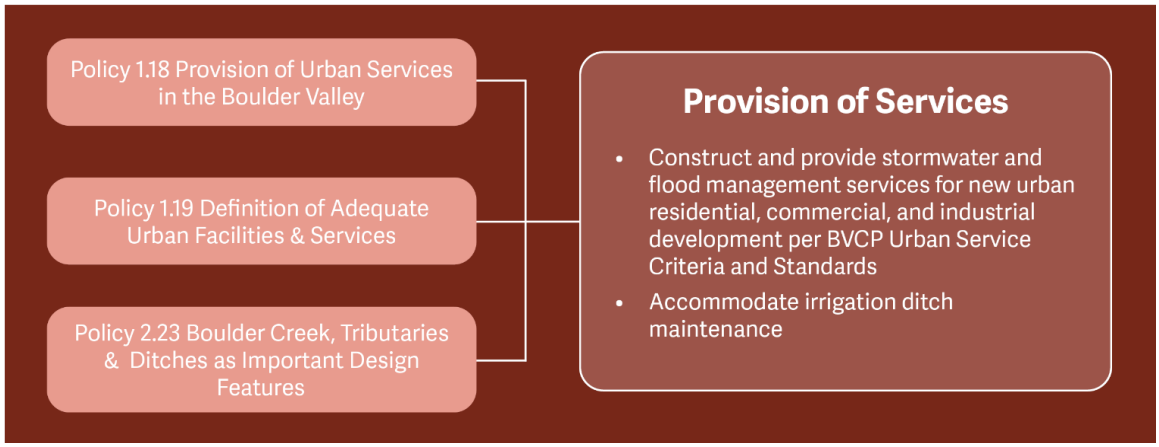


Figure 2.11 – Floodplain Preservation and Restoration as related to BVCP Policies

Public Engagement and Outreach

Activities related to public engagement and outreach are discussed in Policy 3.22 Floodplain Management that states: "Developing public awareness to flood risks and encouraging the public to proactively implement protective measures that reduce the risk to themselves and their property."

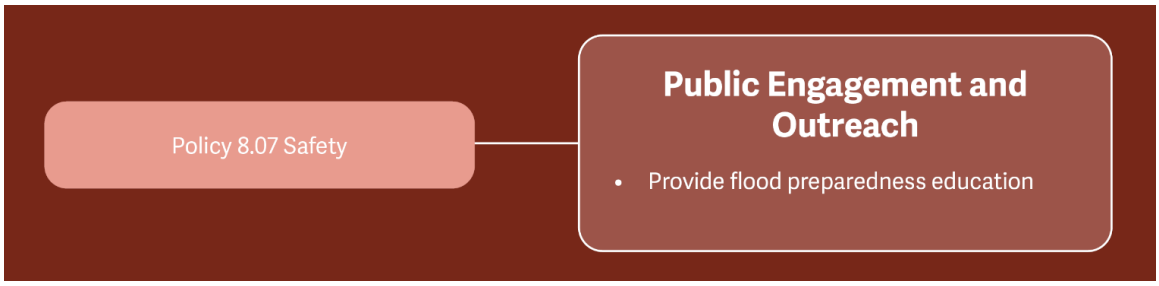


Figure 2.12 – Floodplain Preservation and Restoration as related to BVCP Policies

The Utility reaches out to community members, boards, commissions, and elected officials in a variety of ways to educate and raise awareness of flood risk and provides resources to help prepare for floods. The table below provides examples of typical education and outreach tools that are often used.

Table 2.2 – Typical Education and Outreach Tools

Community Guide to Flood Safety	www.boulderfloodinfo.net
Direct mailings to properties in the 100-year floodplain	Flood safety classroom programs for elementary school teachers
Door hangers to University of Colorado off campus housing neighborhoods and high hazard residential properties	Temporary and permanent signage located on underpasses and along creeks
Annual utility bill inserts	Water Festival Flood Safety Presentation
Public events, open houses, workshops	Flood safety sheets for elementary students
Social media posts (Facebook, NextDoor, etc.)	Daily Camera ads
USB devices with flood safety material	Brochures and programs for stormwater outreach

Twomile Canyon Creek Flooding in 2013

3 Program Evaluation

Program evaluation requires systematic methods to investigate the effectiveness of actions that are aimed at ameliorating stormwater and flooding problems. Unlike the previous master plan, which did not endeavor to evaluate the programs within the Utility, an initial assessment of the Utility's work was conducted to inform the Plan going forward and identify areas where additional information and data would be useful to city staff in the goal of continuous improvement. In order to conduct this evaluation, goals and objectives were created based on existing policy language, recommendations from other reference documents reviewed as part of Technical Memo #1, and conversations with city staff. These goals and objectives were assembled together with associated evaluation metrics in a logic model for each program. Current metrics were selected based on the presence of quantitative data and actions that had been completed in support of each objective were recorded.

Recognizing that resources to identify flood risk, mitigate flood damage, and maintain flood and stormwater facilities are scarce in comparison with the need, an overarching objective of the evaluation was to assess program outcomes and impact through the following lenses:

- What are the program goals and objectives (as largely outlined in the BVCP)?
- Which program actions drive results?
- Where are the biggest areas of concern, and do the current actions move the needle to solve them?
- What data are available to ascertain effectiveness?

This evaluation included participation by a cross section of city departments and staff, the Boulder County Office of Emergency Management, and the Community Working Group (CWG). The CWG provided valuable input regarding community perceptions, values, and program elements of interest including project prioritization; funding; flood warning, response and recovery; public education and outreach; drainage system maintenance; and setting goals that are specific and measurable.

Flood Management Program Evaluation

The City of Boulder has significant flood risk, primarily due to its location at the mouth of the Boulder Creek and its tributaries. With 16 major drainageways, approximately 13 percent of the city — including around 2,000 structures — are located within the regulatory 100-year floodplain. The flood management program is responsible for all programs and activities related to local flooding and the floodplain, including floodplain mapping, risk assessments, regulations, flood information and insurance, emergency preparedness, property acquisition, and flood mitigation capital improvements. This work is managed with two full-time staff dedicated to both flood management and stormwater drainage engineering. The Utilities Maintenance work group is responsible for maintenance of the floodways with four full-time staff and four part-time staff. The following sections identify the goals and objectives of the existing flood management program that were used as evaluation criteria and to identify program efficacy and opportunities.

Floodplain & Fluvial Hazard Mapping

Floodplain mapping provides the basis for flood management by identifying the areas subject to the greatest risk of flooding. This information is essential for determining areas where life safety is threatened and property damage is most likely. Floodplain mapping forms the basis for the city's floodplain regulations and the National Flood Insurance Program.

GOAL: Provide floodplain mapping throughout the city in order to inform land use decisions

Objective:	Comply with current FEMA and city standards for updating and adopting floodplain maps
Objective:	Identify areas subject to the greatest risk of flooding within the city
Objective:	Identify areas prone to fluvial hazards

All 16 floodplains have been mapped within the city. Since the previous CFS update, ten floodplain mapping projects have been completed and have provided revised and updated maps for 80% of the major drainageways by drainageway length. Current floodplain mapping standards meet all current FEMA and city standards. An area for policy analysis includes modeling methods that might better determine flood risk as well as fluvial hazard mapping.

The Fluvial Hazard Zone is the area a stream has occupied in recent history, may occupy, or may physically influence as it stores and transports water, sediment, and debris.

Flood Preparedness, Response & Recovery

Planning and preparation can make a big difference in flood safety and continuing operations after a disaster. The more prepared the community is with pre-flood readiness, ongoing monitoring, effective warning systems, trained response, and post-flood recovery, the better the chances are for management and mitigation of flooding impacts.

GOAL: Provide resources to help people prepare for floods and to recover in the event of a flood

Objective:	**Ensure p**eople are aware of their flood risk and flood preparation measures
Objective:	Maintain a response team within the Utility
Objective:	Ensure that adequate resources are provided to socially underrepresented populations for preparedness and response

The Utility currently maintains a robust education and outreach program, and annually performs multiple activities as listed in Table 2.1 above to provide information in a variety of forms to the community. Since the City of Boulder has the highest flash flood risk of any municipality in the State, the Utility places significant importance on flood education and outreach programs.

GOAL: Provide resources immediately before, during, and after flood emergencies to promote safety and infrastructure resiliency

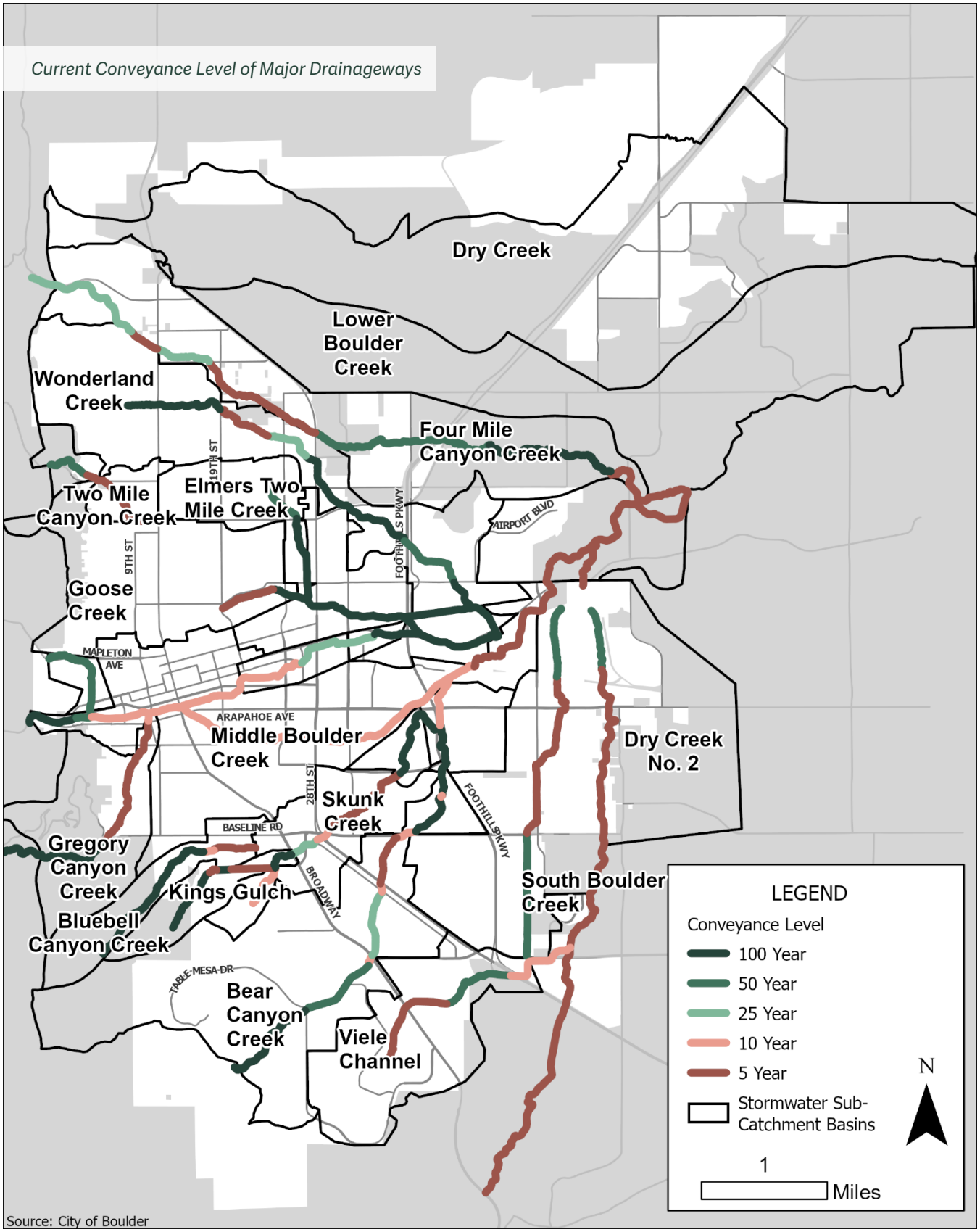
Objective:	Ensure adequate and resilient outdoor emergency warning systems are provided throughout the city
Objective:	Maintain a current operations plan for response and recovery related to flood emergencies

As its name implies, the purpose of the outdoor warning system is to alert persons of flood risk if they are outside, and as such, systems are evaluated for coverage using distance-based buffers in GIS. This method does not account for persons who are indoors, or impacts caused by physical or environmental factors, such as building obstructions or noise caused by hail or high winds. Additionally, Public Works maintains a Continuity of Operations Plan in the event of emergencies. Program capacity would be enhanced by routine communication and closer coordination with the Boulder County OEM, who have resources to support preparedness, response (i.e. the Incident Management Team, Incident Command) and recovery. For greatest impact, it is recommended that City leadership work more closely with the OEM to build capacity.

Flood Mitigation

Most work completed by the Flood Management Program is related to the mitigation of damages to property caused by floods and the reduction of risks to people during flood events. This includes identifying measures for reduced risk through mitigation planning, construction of mitigation projects, regulating development in areas prone to flooding, and ensuring that major drainageways are maintained to accommodate floodwaters.

Current Conveyance Level of Major Drainageways



Source: City of Boulder

GOAL: Identify, evaluate, design, and construct improvements within the floodplain to mitigate damages to property and protect the public.

Objective:	Develop flood mitigation for major drainageways in the city
Objective:	Provide standardized guidance for the creation of mitigation plans
Objective:	Prioritize flood mitigation improvement projects with an emphasis on the use of non-structural approaches whenever possible
Objective:	Select, design and construct flood mitigation projects to remove people and property from the floodplain

The Utility is developing mitigation plans for all major drainageways, but it is a lengthy process that often takes many years to fully complete. Since publishing the 2004 CFS Master Plan, mitigation plans have been updated, created, or are in progress for 80% of the major drainageways in the city. These mitigation plans follow general guidance provided by the city to individual consultants. While the hydrologic and hydraulic methodologies used must be based on FEMA approved methods, there is no standardization between the mitigation plans for this or for the development and prioritization of alternatives. Because of this, there are many variations in the methods used, non-structural approaches are sometimes discussed, but do not appear to be prioritized, and conveyance of the 100-year flood event is not always evaluated. These discrepencies between mitigation studies makes it difficult to adequately and equitably prioritize projects on a city-wide basis. These items are each being considered and addressed as part of the Policy Analysis Technical Memoranda as part of this master plan.

After completing mitigation plans, projects are then selected for design and construction as part of the city's CIP process. Since 2004, seven mitigation projects have been completed to increase flood conveyances from less than 10-year event flood capacity to 100-year event flood capacity in some cases. In additon to those seven projects, another seven more are currently in the design or construction phases.

GOAL: Remove structures and acquire privately owned properties in areas prone to flooding, especially within the city's high hazard zone, for the purposes of flood mitigation

Objective:	Develop a prioritized list of high-risk properties to inform property acquisitions
Objective:	Prevent reconstruction of structures that have sustained significant flood damage
Objective:	Retain undeveloped high hazard flood areas in their natural state whenever possible

A prioritized list of high-risk structures has been created to inform property acquisitions. Additionally, current floodplain regulations prohibit the redevelopment of flood-damaged structures that are damaged more than 50% of pre-flood market value. They also prohibit construction of parking lots or residential structures in the high hazard zone. Review of GIS data from 2014 to 2018 showed that there has been a 6.8% reduction of structures (in square feet) in the high hazard zone and a 1.4% reduction of overall impervious cover.

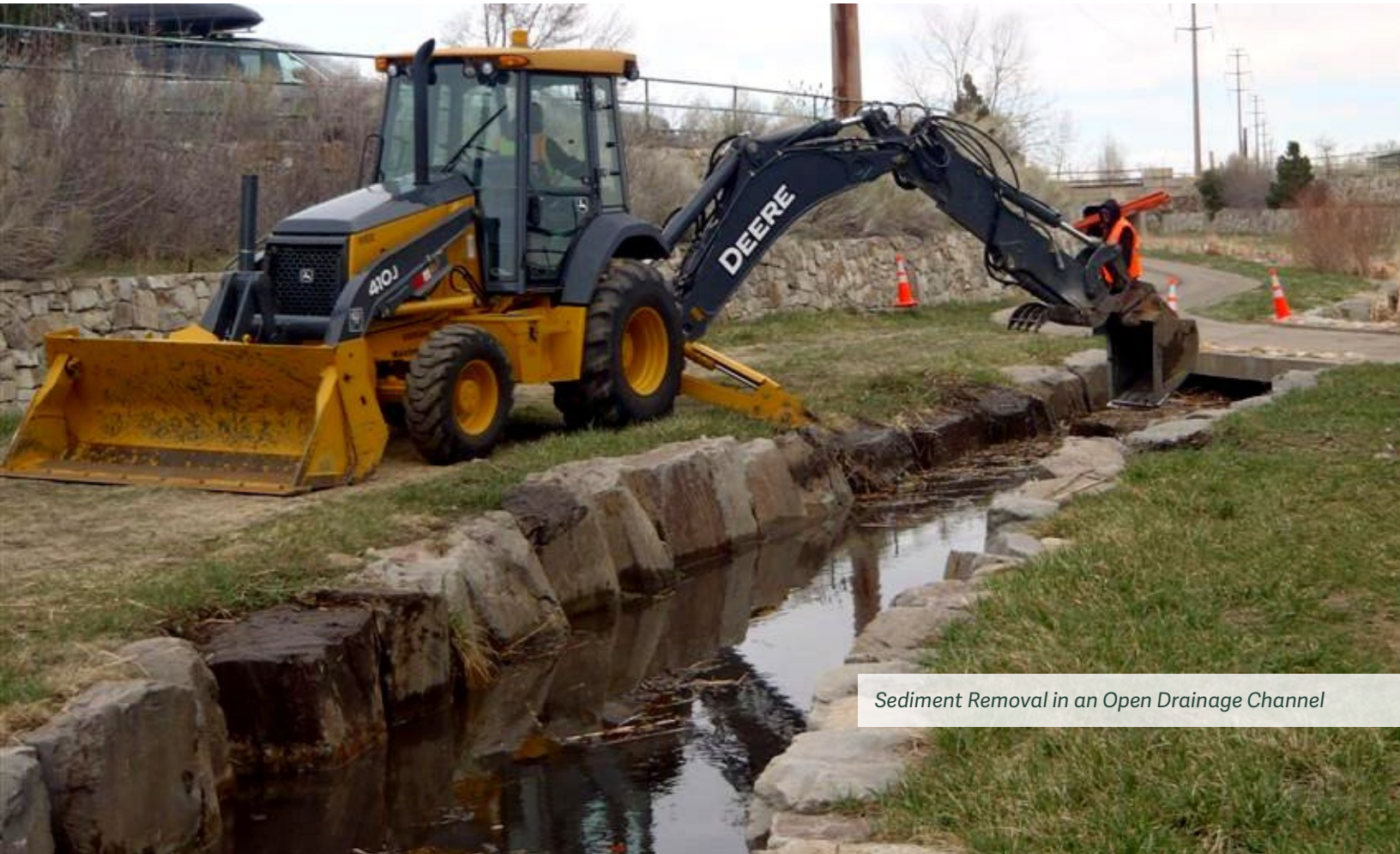
GOAL: Ensure that major drainageways are maintained to accommodate the passage of floodwaters

Objective:	Routinely clear nuisance vegetation from channels and debris buildup from culverts and bridges
Objective:	Provide satisfactory maintenance access and public access easements or rights-of-way for the purposes of maintenance activities

The Utilities Maintenance work group is responsible for the maintenance of 36.5 linear miles of open drainage channels that make up part of the major drainageways. Maintenance also includes associated structures and floodways, as well as irrigation ditch maintenance where maintenance agreements are in place with private ditch companies. This work is supplemented through the use of contractors and by maintenance projects overseen by the Mile High Flood District. In past years flood maintenance activities have been dominated by reactive, emergency maintenance needs, known problematic areas, and irrigation ditches with maintenance agreements. Irrigation ditch maintenance is not a function of the Flood Management Program, but since the activities and required resources are similar, the staff maintaining floodways also maintain irrigation ditches, as required. A complete maintenance cycle of city flood facilities has not been completed in recent decades. An asset management system was recently employed to track time and equipment for required tasks. To better address the maintenance needs of the major drainageways, in 2021 the Utilities Maintenance work group was split into a stormwater group and a flood and greenways group and additional staff have been hired to proactively address maintenance needs of the flood and greenways infrastructure. It is the goal of the Utilities Maintenance work group to complete future maintenance cycles in 10-12 years.

Irrigation Ditches

Since the 1860s, development has occurred near existing private irrigation ditches. As such, ditches located within the City of Boulder have been opportunistically used as default stormwater drainage systems, although not designed for this purpose. This legacy issue, while beneficial in many aspects for stormwater conveyance, also mandates ongoing city maintenance.



Sediment Removal in an Open Drainage Channel

GOAL: Reduce risks to people and property by regulating land use in areas along drainageways that are prone to flooding

Objective:	Regulate development within the 100-year floodplain to mitigate risk of property loss or damage
Objective:	Reduce impacts to critical facilities and services in the 500-year floodplain
Objective:	Evaluate policies intended to address damages caused by floods larger than the 100-year event

Floodplain regulations are in place to meet the intent of the above objectives; however, further review should be undertaken to determine if the regulations and program activities achieve the floodplain management goals listed below. Additionally, these policies have not been evaluated to address damages caused by larger flood events.

Floodplain Management

In addition to protecting people and property from damaging floods, there is a strong community desire to protect the floodplains themselves due to the many social, environmental, and flood mitigation benefits they provide. As part of the community engagement process linked with this master plan update, it is clear that public sentiment is aligned with the policies in the BVCP to preserve and protect these floodplains.

GOAL: Preserve and protect the natural resources and beneficial functions of floodplains

Objective:	Define and implement non-structural measures within floodplains
Objective:	Preserve undeveloped floodplains where possible through public land acquisition, private land dedications and multiple program coordination

Non-structural measures have not been defined by the Utility, so it is unclear whether the intent is to incorporate naturalized floodplains or if floodproofed structures and enhanced flood warning systems meet this intent. Regardless, non-structural measures are currently incorporated as part of mitigation projects on an opportunistic basis.

Floodplain preservation efforts are primarily conducted by Open Space and Mountain Parks (OSMP) through open space acquisitions of floodplains, which primarily occur outside of the city limits. While the Utility supports these initiatives, the level of involvement in this activity has not been clearly defined.

GOAL: Reclaim and restore floodplains and their functions

Objective:	Incorporate floodplain restoration measures into flood mitigation projects
Objective:	Restore habitat for native species

Floodplain restoration is often included as part of mitigation projects whenever feasible. Of the mitigation projects that have been constructed since 2004, only the projects involving simple replacements of bridges or culverts did not include some form of habitat or floodplain restoration work. Similar levels of restoration efforts are also proposed in the projects that are still in design and construction phases.

GOAL: Protect cultural and recreational resources associated with stream corridors and floodplains

Objective:	Identify and protect historic resources within the floodplain
Objective:	Limit open space development to trails and trail linkages

Many of the actions completed to achieve these objectives are carried out by the Greenways Program and OSMP. Cultural resources within floodplains were identified in the 2011 Greenways Program Master Plan update. OSMP limits development within the floodplains they manage to trails and similar recreational features. However, these limitations on open space development do not currently extend to privately owned properties.

Public Education and Flood Insurance

The City of Boulder participates in the National Flood Insurance Program (NFIP) by adopting and enforcing floodplain management ordinances and providing public education to reduce future flood damage. In exchange, the NFIP makes federal government-backed flood insurance available to homeowners, renters, and business owners whether they are in the floodplain or not. The NFIP also has a voluntary incentive program called the Community Rating System (CRS), which allows communities to obtain discounts on flood insurance premiums if the community floodplain management activities exceed minimum NFIP standards.

GOAL: Increase public awareness of flood risk and safety measures

Objective:	Provide bilingual public education events and materials through a variety of platforms to inform the public of flood risks and available community resources
Objective:	Seek to broaden outreach efforts as community needs and habits change

In 2021, the City Council adopted a Racial Equity Plan and hired a language access program manager who is responsible for developing the city's language access plan. Work is ongoing on these efforts to continue to reach as many community members as possible. These efforts were hindered by the COVID-19 pandemic, highlighting the need to provide continuity during times of disruption.

GOAL: Reduce associated flood risks and related insurance costs by participating in the NFIP CRS Program

Objective:	Engage in community floodplain management activities that exceed the minimum National Flood Insurance Program requirements to obtain discounted rates on flood insurance premiums for homeowners, renters and business owners
Objective:	Maintain the lowest feasible CRS class

The city has an active floodplain management program and its progressive approach to managing flood risk is well recognized with a CRS Class 5 rating. Since the last CFS Master Plan update, the Utility has lowered its CRS rating from a Class 8 in 2004 (providing a 10% discount to community members on flood insurance) to a Class 5 (providing a 25% discount to community members).

Stormwater Drainage Program Evaluation

As urbanization and impervious surfaces increase, less stormwater infiltrates into the ground, resulting in increased runoff. This increased stormwater runoff can produce localized and downstream flooding as well as channel erosion and increased non-point source pollution. The Stormwater Drainage Program is responsible for the network of underground pipes, structures, and channels that convey stormwater or surface runoff to major drainageways within the city. Activities necessary to ensure the management of this infrastructure include master planning to guide upgrades and expansion of the system, inspections, maintenance, repairs, regulations, and stormwater collection and conveyance system capital improvements. At the time of this publishing, the breadth of this work is managed with two full-time equivalent (FTE) staff dedicated to both flood management and stormwater drainage engineering, and nine full-time staff in the Utilities Maintenance work group dedicated to stormwater infrastructure maintenance.

Stormwater Collection System

The city currently operates a stormwater collection and conveyance system to minimize impacts of localized and downstream flooding caused by stormwater runoff. Per the 2016 Stormwater Master Plan, this system consists of 713 detention ponds and approximately 160 miles of storm sewer, including associated structures and outfalls as part of the conveyance system. Additionally, the system is periodically assessed to identify areas within the system that lack sufficient capacity for existing and future needs.

GOAL: Provide an adequate stormwater collection and conveyance system for existing and future development within the city

Objective: Size the storm sewer system to convey the runoff from 2-year storm events in residential areas, and from 5-year storm events for collector and arterial roadways and in commercial areas

Objective: Focus on problem areas created by smaller storms to address localized flooding

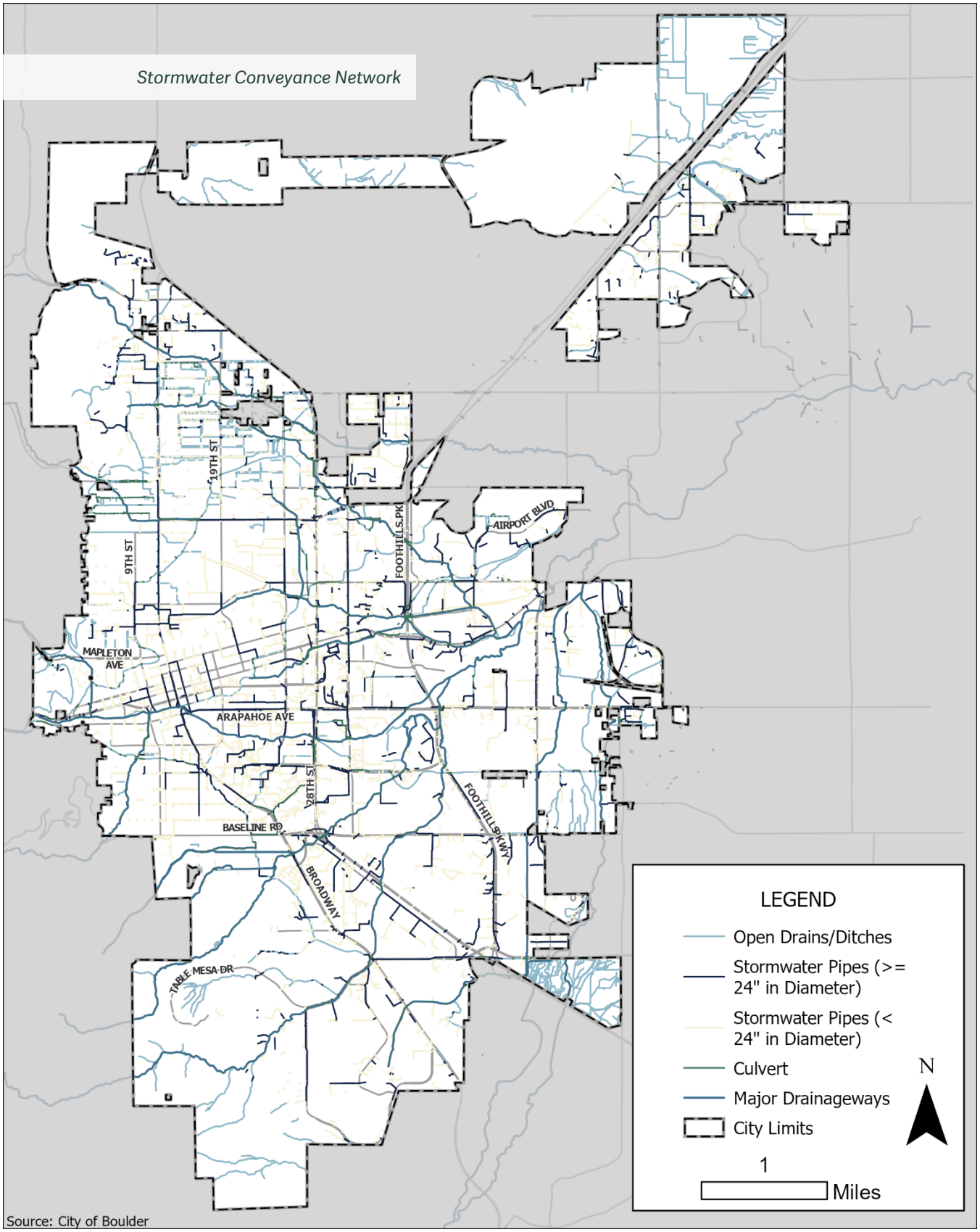
Per the city's Design and Construction Standards, the minimum pipe size for stormwater conveyance is 15 inches, and over 30% of the system consists of pipes smaller than this. There are significant areas within the city that do not have any stormwater conveyance pipelines. Other areas contain pipes that cannot adequately convey flows from the design storm, which results in localized flooding from these smaller storm events. The 2016 Stormwater Master Plan identified 35 areas within the local drainage system having insufficient service. Priority areas and recommended improvements were identified, but the number of people affected or area extent within these deficient service areas were not quantified.

GOAL: Minimize impacts of localized and downstream flooding, stream bank and channel erosion within the open channel stormwater drainage system by controlling the rate and volume of stormwater runoff from development and redevelopment projects

Objective: Limit post-development peak flow conditions to match pre-development peak flow conditions

Detention is required on all development projects where peak flow rates are increased per the city's Design and Construction Standards; however, the current stormwater detention policy has gaps that should be addressed.

Stormwater Conveyance Network



Source: City of Boulder

GOAL: Provide a connected and continuous stormwater drainage system that does not discharge into irrigation ditches, where practical.

Objective: Identify stormwater connections into irrigation ditches
Objective: Identify irrigation ditches having insufficient capacity for stormwater conveyance

It is the policy of the Mile High Flood District and also recommended by the Colorado Water Conservation Board to disconnect all stormwater discharges from irrigation ditches. However, the situation in the City of Boulder is more nuanced and disconnection of all stormwater discharges is not feasible. The Utility recognizes the limitations of using irrigation ditches for stormwater conveyance and has opted to identify whether irrigation ditches have capacity for stormwater conveyance prior to deciding whether to disconnect the stormwater conveyance. As part of the 2016 Stormwater Master Plan update, stormwater connections to irrigation ditches were identified, but capacity of the receiving ditches has yet to be assessed.

Operations and Maintenance

The Utilities Maintenance work group is responsible for inspection and maintenance of about 160 miles of stormwater pipe, ranging from 10" to 72" in diameter, 2,771 manholes, 5,623 inlets, and 1,993 stormwater outfalls. Maintenance consists of cleaning, repairing, jetting, and inspecting stormwater infrastructure.

GOAL: Ensure the stormwater collection and conveyance system functions properly and yields expected capacity to protect public safety and the city's investment in the system

Objective: Provide routine inspections and assessments of the entire system
Objective: Provide routine maintenance of pipes, structures, natural and man-made channels including irrigation ditches, and public detention facilities
Objective: **Provide minor** repairs to existing pipes and structures

In past years, the Utilities Maintenance work group activities were primarily reactive without having staff dedicated to stormwater maintenance. Because they provided emergency maintenance in the stormwater and floodway systems, along with irrigation ditch maintenance required by maintenance agreements, routine maintenance tasks required for the stormwater collection and conveyance system were often neglected due to more urgent maintenance needs. Recently, an asset management system was employed to track time and equipment for tasks. It was found that the inspection cycle for the stormwater conveyance system occurs on an estimated 11-year cycle and cleaning activities are completed on an estimated 31.5-year cycle. To proactively address the maintenance needs of the stormwater system, the Utilities Maintenance work group was split into two groups — a stormwater group and a flood and greenways group — and additional staff were added to reduce the time between routine maintenance of the entire stormwater conveyance system and increase the level of service.

Figure 3.1 – Beehive Asset Management System Benchmarking and Data Collection

GOAL: Provide maintenance accessibility to the entire stormwater collection and conveyance system

Objective:	**Identify reaches of the stormwater conveyance system lacking adequate maintenance access**
Objective:	**Provide permanent access to reaches of the stormwater conveyance system, detention facilities, and other drainage facilities for routine and major maintenance activities**

Information and data input into the Utility's asset management system is an ongoing process that will take time to complete. Identification of insufficient maintenance accessibility will be included as part of this process.

GOAL: Provide irrigation ditch maintenance per existing maintenance agreements with irrigation ditch companies

Objective:	**Identify tasks for irrigation ditch maintenance in current asset management system to develop a predictive maintenance plan**

Maintenance responsibilities associated with irrigation ditches can vary significantly between individual maintenance agreements. As with the other operations and maintenance tasks, these responsibilities are being entered into the Utility's asset management system and are not expected to be fully complete until at least 2022. Once this process is completed, the Utilities Maintenance work group will have greater capacity to predict and plan for maintenance needs to increase efficiency.

GOAL: Ensure resources are available to provide emergency maintenance on the stormwater conveyance system

Objective:	**Identify resources required to provide emergency maintenance during and after storm events**

Currently, on-call construction contracts are in place to handle emergency maintenance beyond what the current operations and maintenance work group staff and equipment can provide. This system was put in place following

the 2013 flood and, while its efficacy has not been tested in large storm events, it has shown to work well in smaller storm events. Additionally, Mile High Flood District is also available as a resource for this work.

Groundwater

Groundwater and sump systems can create nuisance drainage in the public rights-of-way and across adjacent private properties. Also, groundwater dewatering systems can affect local water wells and wetlands by lowering the groundwater table. Requirements for groundwater extraction and release are loosely defined in current city regulations.

GOAL: Mitigate impacts of dewatering on groundwater or surface water quantity and quality, groundwater recharge, local water wells, wetlands, and ecosystems

Objective:	Identify areas within the city where groundwater issues may arise including naturally high groundwater locations, seasonally high groundwater locations, and groundwater pollutants
Objective:	Require the identification of mitigation and remediation measures prior to dewatering
Objective:	Minimize subsurface construction that requires ongoing dewatering

Policy recommendations to evaluate a proactive approach to dealing with the extraction and discharge of groundwater as overland flow and into surface waters was included in the previous CFS Master Plan and also in the BVCP. To date, groundwater issues have not been addressed by the Utility. The City of Boulder stopped issuing groundwater permits in 2019, as it was largely duplicative of the State's general permit for discharges from subterranean dewatering activities focusing on discharged volume and water quality.

GOAL: Prevent nuisances to other properties created by dewatering activities

Objective:	Require dewatering mitigation for residential basements and other ongoing dewatering

Groundwater dewatering mitigation is not currently required for residential basements or for ongoing dewatering. The determination of whether to require mitigation measures has not yet been addressed.

Stormwater Quality Program Evaluation

The built urban environment has negative impacts on the water quality in Boulder's streams and drainageways in the forms of polluted runoff, spills, and excess sediment. The city's Stormwater Quality Program is responsible for managing local activities to preserve, protect, and enhance water quality affecting Boulder's surface waters. The program not only seeks to comply with state water quality regulations, but to educate the public and improve water quality through better understanding of issues and enhanced stewardship. Currently this work is being performed by four full time staff in the Stormwater Quality Program with assistance from other Utilities Department staff and partnerships with regional organizations for outreach, education, and water quality data reporting.

Stormwater Regulatory Compliance

The city holds a permit for discharge from its storm sewer system to waters of the state. This stormwater permit has requirements related to a number of city activities, including operations and maintenance, development, and

education and outreach. Other water quality regulations include Total Maximum Daily Load (TMDL) requirements for *E. coli* in Boulder Creek.

GOAL: Maintain compliance with current MS4 permit requirements

Objective: Provide effective and engaging education and outreach on the importance of water quality and its protection
Objective: Provide appropriate response, cleanup, and documentation for spills and other illicit discharges in the city
Objective: Conduct construction stormwater program oversight with appropriate inspections and follow-up enforcement
Objective: Require the installation and proper maintenance of permit required post-construction stormwater control measures
Objective: Conduct municipal operations in a manner that promotes pollution prevention and good housekeeping

The city is currently in compliance with their MS4 permit. As part of the Program's efforts to comply with permit requirements and meet the needs of the broader community, there are specific areas where the activities of the Utility go well above and beyond minimum permit requirements. For example, the MS4 permit requires that a combination of four different types of education and outreach activities be completed annually, whereas the Utility reports that they conduct at least fifteen activities annually. The Utility is also in the process of expanding their construction and post-construction stormwater quality programs to meet community needs.

GOAL: Reduce sources of *E. coli* in Boulder Creek to meet TMDL requirements

Objective: Work to identify potential *E. coli* sources and determine controllability
Objective: Identify and implement strategies to reduce controllable sources of *E. coli* in stormwater runoff entering Boulder Creek

It is well known in the stormwater quality community that identification and control of *E. coli* sources is notoriously difficult. The City of Boulder has been extensively involved in evaluating and researching *E. coli* sources that extend well beyond regulatory requirements. The city also voluntarily completed an update to the TMDL Implementation Plan in 2019 that highlights a tiered and methodical approach to identifying and addressing *E. coli* sources.

GOAL: Develop compliance strategies in anticipation of future MS4 regulatory requirements

Objective: Closely track the MS4 permit renewal process and provide appropriate input and feedback as a partner with CDPHE

The city brings a unique perspective to many areas of permit implementation. Presenting this perspective to the State has proven valuable to ensure reasonable and achievable regulatory requirements for the city. It is the intent of the Utility to continue participation and fostering these relationships in the future.

Enhancement of Urban Stream Health

In addition to meeting permit requirements, the Stormwater Quality Program is dedicated to addressing broader stormwater quality concerns and critical aquatic habitats in ways that protect and enhance urban stream health. This approach requires the implementation of projects and programs above and beyond stormwater quality permit requirements.

GOAL: Protect and enhance water quality and urban stream health through strategic collaboration, data collection, programmatic planning, and implementation of water quality projects

Objective:	Implement the Boulder Urban Stream Health (BUSH) program through internal city collaboration and the funding of water quality related projects
Objective:	Implement data collection and assessment projects that further understanding of local watershed conditions
Objective:	Develop and implement municipal policies related to urban runoff or stream health
Objective:	Design and construct water quality projects to improve urban stream conditions or mitigate the effects of urban runoff

In conjunction with current MS4 Permit requirements, the Stormwater Quality Program has increased efforts related to the control of stormwater pollutants through the use of stormwater control measures on construction sites and for post-construction stormwater management. Post-construction stormwater control measures are not required on development sites less than an acre in size or on residential properties.

Bioswale Installation in Parking Lot

Recently, the Boulder Urban Stream Health (BUSH) program was initiated to create a project implementation framework to address water quality concerns. Additionally, the Stormwater Quality Program has taken a more focused approach to water quality data collection based on specific concerns and plans to track stream health function ratings in 2022 to support these efforts.

GOAL: Support the preservation, restoration, and maintenance of greenways, creek corridors, and wetlands for the protection and improvement of water quality

Objective:	Manage the greenways program to provide appropriate understanding, oversight, maintenance, planning, and projects for the preservation and enhancement of the riparian corridor
Objective:	Strive for no net loss of wetlands

In recent years, the Stormwater Quality Program has shifted from mostly focusing on MS4 Permit compliance to building larger programs to enhance water quality and stream health which incorporate permit compliance measures. Additionally, the Greenways Program was historically under the purview of the Flood Management

Program until it recently became a part of the Stormwater Quality Program. Because of these factors, greater support for preservation and restoration of natural water systems and their ecosystems beyond what is required for permit compliance has not been a focus of this program. However, efforts are already underway to incorporate this moving forward.

Water Quality Regulation and Monitoring

The city's Stormwater Quality Program conducts various water quality monitoring and special studies along the creek including implementing studies related to the *E. coli* TMDL Implementation Plan.

GOAL: Support compliance related to surface water permitting and regulations

Objective: Continue the ongoing water quality monitoring program in support of surface water permits and regulations

The Stormwater Quality Program monitors for temperature variations, nutrients, metals, sediments, *E. coli*, periphyton/chlorophyll-a, and benthic macroinvertebrates in multiple locations to meet routine monitoring and sampling requirements for State permits and regulations.

GOAL: Seek to better understand surface water quality, dynamics, and impacts related to stream health and regulations

Objective: Implement projects and studies to inform regulatory decisions related to city surface water permits

Special studies are conducted on an as-needed basis to support focused project implementation and regulatory decisions. Since 2015, four special studies were conducted to: evaluate watershed conditions; monitor for neonicotinoids; evaluate temperature thresholds; and identify connections between nutrient concentrations and macroinvertebrates.

Routine Stream Monitoring

4 Findings and Gap Analysis

This section summarizes the main findings from the policy and program evaluations to underscore areas where the Utility is performing well and supporting the intent of the BVCP policies. Additionally, the evaluation also found opportunities where the Utility might improve processes or policy to address current and future community needs.

This information will be further analyzed and form the basis for policy and procedure recommendations contained in the master plan.

Policy Evaluation

Because the Boulder Valley Comprehensive Plan provides overarching guidance for the entire city, it is not surprising that many of the policies contained therein provide overlapping direction as they relate to the functions of the Utility. Their overarching nature often does not provide tangible objectives that are typically defined at the utility master plan level. Therefore, qualitative and semi-quantitative discussions, versus strict qualitative analyses are presented below on the major program themes.

Flood Management Program Themes

Within the Flood Management Program, themes related to floodplain preservation and restoration are supported by ten policies in the BVCP, however floodplain preservation efforts tend to be underrepresented in flood mitigation projects that seek to remove people and property from floodplains by reducing floodplain size. This conflicts with restoration efforts intended to support critical ecological processes associated with the flooding of riparian areas and wider floodplains. Improved definition and/or description of non-structural drainageway improvements or protection of riparian areas may support future implementation of these concepts.

The city has delineated floodplains for the entire city per FEMA mapping standards and has developed regulations to control or prohibit development in these areas to protect people and property as identified in BVCP policies. These floodplain regulations may benefit from further evaluation to determine whether they have unintended consequences, such as continued encroachment into the floodplain which could eventually result in negative cumulative effects of flood damage. Additional recommended policy actions such as addressing risk and damage associated with larger flooding events and how to best incorporate climate change may also be considered.

A city-wide Multi-Hazard Mitigation Plan is in place that is routinely updated to implement projects and programs that mitigate risk from defined hazards such as floods. The Utility may want to enhance its internal emergency preparedness and response processes aside from those in the MHMP to conform to the structure and processes specific to the Utility to avoid overreliance on Boulder County OEM for response and recovery efforts. Further specifics regarding what should be addressed by the Utility related to emergency response and recovery will require further definition during subsequent master planning phases.

Stormwater Quality Program Themes

Between the functions of the Greenways Program, OSMP, and MS4 Permit requirements, the Stormwater Quality Program is meeting or exceeding the intent of the stormwater quality policy themes. While groundwater dewatering can affect surface water quality, this can most likely be addressed from a program standpoint with the Stormwater Drainage Program. BVCP policy guidance supports consideration of, but does not require, policies and regulations related to groundwater dewatering.

Five separate policies in the BVCP address wetland preservation and restoration. Efforts to preserve wetlands are addressed by other departments and programs within the city; however, it is not currently a priority of the Stormwater Quality Program. Given that wetlands perform many services that are directly related to the enhancement of water quality, it has been noted that preservation and restoration of wetlands should be a bigger focus for the Program going forward.

Overarching Utility Themes

The Utility actively engages in integrated planning efforts with external regional and State entities to address multi-jurisdictional concerns. Within the city, Utilities partners with other departments in the design and construction of projects to achieve multiple objectives. Improving upon these internal coordination efforts by developing a streamlined approach may help avoid missed opportunities. The Utility has recently created a project management office (PMO) to share resources in an organized way and further develop project management knowledge and skill. Implementation of this PMO will likely enhance project execution and planning efforts across the Utility.

The Utility has begun to but has not yet fully integrated planning for the effects of climate change, resiliency, ecosystem frameworks, and racial equity into planning and policy decisions.

Guiding Principles

The guiding principles found in the previous CFS Master Plan lack supporting definitions (Table 4.1), which makes it difficult to determine whether the activities of the Utility support their intent. These guiding principles should be evaluated for current relevancy and revised as necessary.

Table 4.1 – Current Guiding Principles

Floodplain Management	Stormwater Quality	Stormwater Drainage
1. Preserve floodplains 2. Preparation for floods 3. Help people protect themselves from flood hazards 4. Prevent unwise uses and adverse impacts in the floodplain 5. Seek to accommodate floods, not control them	1. Preserve our streams 2. Prevent adverse impacts from stormwater 3. Protect and enhance stream corridors	1. Maintain and preserve existing and natural drainage systems 2. Reduce and manage developed runoff 3. Eliminate drainage problems and nuisances

Program Evaluation

A qualitative assessment of whether minimal preconditions for program evaluation were met preceded the undertaking. Three primary activities were undertaken:

- Description of the program model with particular attention to, and consensus around, the program goals and objectives
- Assessment of how well defined and evaluable the model is, and
- Identification of public, community working group, and staff interest in the evaluation and a determination of how the results are to be used.

Logic models were developed to understand the sequence of steps and Utility staff activities, going from program services to outcomes. Further, efforts were made to codify what visible, measurable, or tangible results are or might be present as evidence that the objective has been met.

Policies in the BVCP did not provide complete coverage of the necessary functions required by the Utility. Existing information was gathered through data collection and review, information provided by city staff, GIS-information, and staff interviews in order to evaluate the program efficacy.

Limitations of the evaluation included: quantitative data could not be obtained in many instances for the evaluation; and the stated goals lacked specific and measurable objectives. It is recommended that the goals and objectives be refined to better reflect the needs of Utility moving forward and defined metrics be developed to track whether activities produce desired outcomes, and to evaluate the Utility more easily in future master plan updates.

Finally, all programs are constrained by the available resources — funding, personnel, and tacit community and organizational support.

- **Funding.** The 2021 budget for the Stormwater and Flood Management Utility is $17M, of which $9M is reserved for CIP/debt service and $6M is the annual operating budget. At the funding rate, when compared with the backlog of project and maintenance needs, it will take several decades to implement the identified needs.
- **Staff.** Within the Stormwater and Flood Management Utility, five FTEs are assigned to stormwater quality and only two FTEs are in place to manage the mapping, engineering and construction components for both flood management and stormwater drainage. Additional staff within the Utilities Department also provide support with maintenance, communications, finance, outreach, and management. However, these staff are dedicated across the City of Boulder Utilities Department, and as such, also support work plans for the Water and Wastewater Utilities.
- **Support.** As documented in the 2019 city-commissioned Tipton report, Boulder Utilities staff expressed concern regarding the ability to implement program work plans with a perceived lack of support from senior officials and the city council. Numerous personnel and structural changes have been made since that time; however, some staff continue to express concern regarding public perceptions and overall support for the Stormwater and Flood Management Utility.

Flood Management Program

The Utility follows floodplain mapping procedures required by FEMA, but consideration should be given to mapping additional floodplain hazards (i.e. fluvial hazard zones) and to evaluate mapping approaches such as when a map should be scheduled for remapping and what technology should be employed (e.g. 1D vs 2D models). Flood mitigation studies lack consistency between procedures used for hydraulic and hydrologic analyses along with alternatives prioritization and flood protection levels that should be addressed.

The Utility has an active flood education and outreach program that produces collateral and outreach materials and conducts engagement and education events on an annual basis. In discussions with the CWG, however, there was a perception that the city does not provide adequate education and outreach. To bridge this gap, methods for evaluating the success of education and outreach efforts, along with an annual communications plan to address changing outreach needs and bilingual communications, should be further developed.

There is a clear need to strike a balance between floodplain management that focuses on the preservation and restoration of floodplains — due to the many environmental and social benefits floodplains can provide — with individual property rights and flood mitigation that seeks to reduce floodplain extents to protect people and property from floods.

Stormwater Drainage Program

The 2016 Stormwater Master Plan update provided a hydraulic analysis of the local drainage network to identify deficiencies in stormwater conveyance capacity. Development of metrics would assist with CIP prioritization, and should include racial equity and climate change considerations.

There were some inconsistencies noted between existing regulations, design standards, and recommendations made by the MHFD Urban Storm Drainage Criteria Manual related to hydrologic calculations, storm sewer sizing and detention pond design that should be further addressed.

The Utilities Maintenance work group has recently undergone a restructuring process to better address both flood and stormwater drainage maintenance needs, along with irrigation ditch maintenance required through contractual obligations. This process should be monitored, with the incorporation of recommendations to enhance routine maintenance on existing infrastructure. Additionally, irrigation ditches should be evaluated for capacity and recommendations for stormwater disconnection identified where applicable.

Stormwater Quality Program

Meeting MS4 Permit requirements is a significant task for any municipality to undertake. The City of Boulder's Stormwater Quality Program has completed a substantial amount of work to both comply with, and exceed, minimum permit requirements in many cases. This includes a robust water quality outreach program with help from regional partners and extensive *E. coli* source identification and elimination efforts. Because of this, the Stormwater Quality Program has been undertaking water quality initiatives that reach beyond state required actions. Many of these initiatives are still in their infancy and will require continued evaluation and adaptive management.

Evaluation of Racial Equity and Social Vulnerability

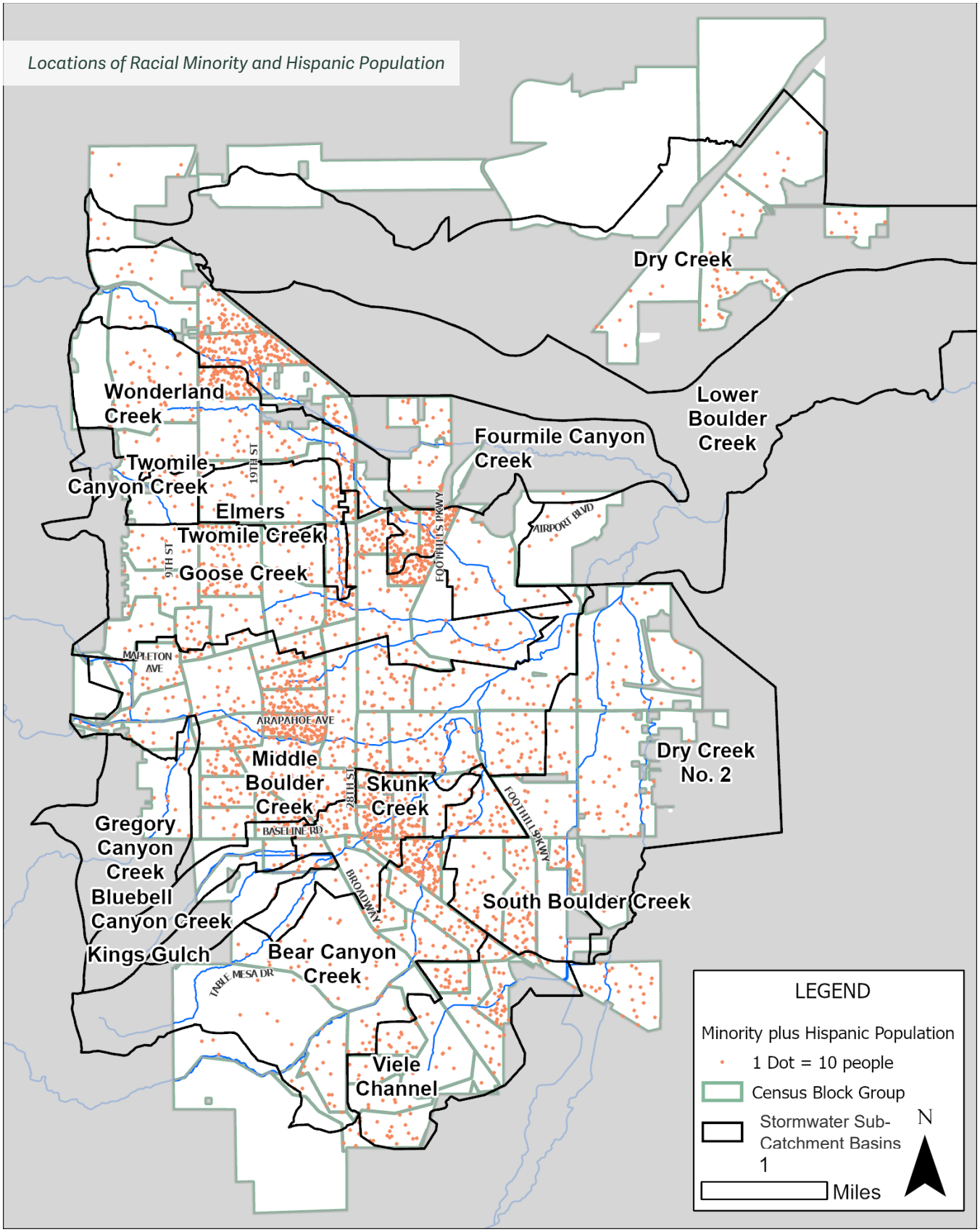
As part of the city's master planning process, the city employs Community Connectors to engage underrepresented communities, bridge cultural and language barriers, help develop effective engagement opportunities and support activities related to master planning efforts with city staff and partners. Additionally, education and outreach related to flood preparedness, response, and recovery have not uniformly been published or presented in both English and Spanish. To address this, the city hired a language access program manager who is responsible for developing the city's language access plans.

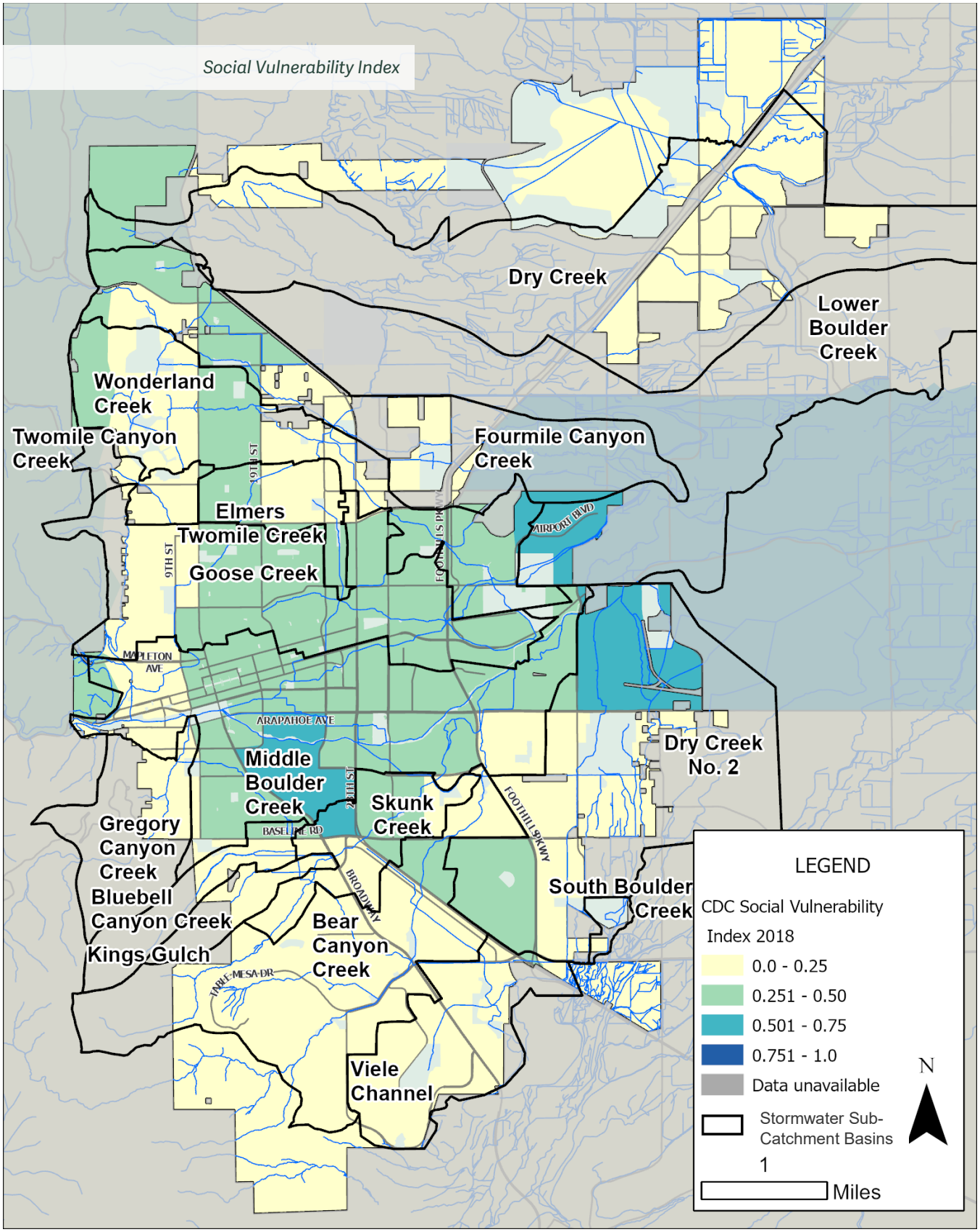
The Utility strives to incorporate racial equity into its operations by first evaluating whether undue burdens may have inadvertently been created by existing regulations, policies, or procedures and then to identify corrections that can be made moving forward. In a review of current floodplain regulations, properties located in the high hazard zone that sustain flood damage equal to or greater than 50% of their pre-flood market value are not allowed to be rebuilt. This regulation places undue burden on low income communities where property values are lower. For example, a $200,000 home that sustains $110,000 in damage cannot be rebuilt; whereas a $2,000,000 home that sustains up to $1,000,000 in damage can be reconstructed.

Tracking of specific data like: value of structures removed from floodplains or rebuilt in floodplains; location of floodplain permits rejected or accepted as it relates to neighborhood demographics; median value of structures removed from the floodplain due to mitigation projects; and percent of minority residents removed from floodplains due to mitigation projects might help to identify further inequities in practices within the Utility.

Racial equity has not previously been a factor in project prioritization for the Utility's programs or for CIP projects. Additionally, some flood mitigation projects are currently being proposed to provide flood mitigation solutions that provide less than 100-year flood conveyance to protect the redevelopment potential of the site, where other projects located in the same watershed have relocated mobile home residents from a site so that 100-year flood mitigation could be provided. In addition to looking at racial equity, social vulnerability is another well-accepted index developed by the Centers for Disease Control and Prevention (CDC) to predict a community's ability to respond to, and recover from, natural disasters based on a number of social and economic factors. Lower indices indicate lower social vulnerability. By integrating social vulnerability into flood mitigation planning and emergency response and recovery plans, the most vulnerable populations can be prioritized for resource allocation during and after emergencies or prioritized for removal from the floodplain all together.

Locations of Racial Minority and Hispanic Population




Social Vulnerability Index
Dry Creek
Lower Boulder Creek
Wonderland Creek
Twomile Canyon Creek
Fourmile Canyon Creek
Elmers Twomile Creek
Goose Creek
Middle Boulder Creek
Skunk Creek
Dry Creek No. 2
Gregory Canyon Creek
Bluebell Canyon Creek
Kings Gulch
Bear Canyon Creek
South Boulder Creek
Viele Channel
19TH ST
9TH ST
28TH ST
FOURMILE CANYON DR
AIRPORT BLVD
MAPLETON AVE
ARAPAHOE AVE
BASELINE RD
BROADWAY
FOOTHILLS PKWY
APPLE MESA DR
LEGEND
CDC Social Vulnerability Index 2018
0.0 - 0.25
0.251 - 0.50
0.501 - 0.75
0.751 - 1.0
Data unavailable
Stormwater Sub-Catchment Basins
1
Miles
N

Evaluation Summary

Table 4.2 represents a summary of actions that have been identified for improvement as part of the policy and program evaluation efforts. Improvement actions that are bolded will be further addressed in subsequent technical memoranda as part of the master planning analysis process.

Table 4.2 – Identified Improvement Actions

Program	Identified Policy Improvement Actions	Identified Program Improvement Actions
Overarching Utility	• Incorporate multiple objectives in the planning, design, and operation of the Utility • Approach planning and policy decisions through an ecosystem framework • Address specific guidance related to climate change and resilience • Evaluate impacts of policies, planning, and decision making to ensure geographic and socioeconomic equality	• Identify metrics needed for tracking progress and future evaluation • Review existing Guiding Principles and define terms like unwise uses in the floodplain and non-structural practices • Develop prioritization criteria for CIP projects and establish a framework for prioritization • Address coordination between Programs within the Utility and with other city departments like Transportation • Develop standards and requirements for annual work plans • Address racial equity in regulations, planning, and project prioritization
Flood Management Program	• Proactively preserve and restore floodplains • Define and map riparian areas • Define and prioritize use of non-structural drainageway improvements • Monitor effects of climate change on floodplain delineation and management • Prepare flood response and recovery plans • Restrict development on undeveloped high hazard zone properties • Address risks and damages associated with floods larger than the 100-year flood event	• Review floodplain mapping standards to include increased risk and evaluate mapping approaches • Identify how to evaluate success with flood education and outreach efforts • Provide resources to socially underrepresented populations for preparedness and response • Update emergency response plan for Utility • Develop standardized guidance for flood mitigation plans and address flood protection levels based on drainageway • Address future floodway maintenance needs • Review existing floodplain regulations to determine what the balance should be between environmental, social, and individual property rights • Explore effort required to further reduce CRS rating

Program	Identified Policy Improvement Actions	Identified Program Improvement Actions
Stormwater Drainage Program		• Evaluate current level of service being provided • Evaluate current detention pond design standards • Identify irrigation ditches with insufficient capacity to receive stormwater runoff • Address routine maintenance needs • Discuss whether groundwater should be addressed by the Utility
Stormwater Quality Program	• Consider regulating groundwater dewatering activities to mitigate impacts • Minimize subsurface construction requiring ongoing dewatering • Proactively preserve and restore wetlands	• Incorporate BUSH program implementation into master plan • Track stream health function ratings • Evaluate success of green infrastructure plan • Address management of greenways program • Incorporate wetlands into water quality planning efforts