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

MEETING DATE: March 17, 2014

AGENDA TITLE: Informational Item –Stormwater and Flood Management Utility Capital Improvement Program (CIP) Preview

PRESENTERS:
Jeff Arthur, Director of Public Works for Utilities
Robert Harberg, Principal Engineer-Utilities
Annie Noble, Flood and Greenways Engineering Coordinator
Douglas Sullivan, Engineering Project Manager
Kurt Bauer, Engineering Project Manager
Katie Knapp, Engineering Project Manager
Pieter Beyer, Civil Engineer II
Ken Baird, Financial Manager for Utilities

EXECUTIVE SUMMARY

This information item is intended to provide an update regarding the Stormwater and Flood Management Utility (Utility) Capital Improvement Program (CIP) issues ahead of the formal budget process by providing:

- Background information
- Flood update
- Project updates
- Schedule of key milestones

The formal CIP budget discussion will begin in April with a WRAB recommendation scheduled in June. Therefore, no formal action by the WRAB is requested at this time.

BACKGROUND

The Utilities Division's mission is to provide quality water services, as desired by the community, in a manner which emphasizes efficient management of fiscal and natural resources, and protects human and environmental health.

The city's Stormwater and Flood Management Utility (Utility) was created in 1973 as an enterprise utility and funded by a service charge and connections fees which provides approximately $6,000,000 of revenue each year.

The Comprehensive Flood and Stormwater (CFS) Master Plan is an overarching document that is intended to present key issues, programs, projects, and associated budgets for the Utility. Unlike other city master plans, CFS does not identify specific Capital Improvement Projects. Rather it sets the agenda for implementing programs and activities and provides guiding principles, program elements and action items as summarized in the Executive Summary – see **Attachment A**. The CFS Master Plan was accepted by City Council in November 2004.

Stormwater management focuses primarily on what is called the minor (2-5 year) storm events, whereas flood management focuses on major (100-500 year) storm events. In the past, most CIP funds have been allocated to flood management projects because of the significant life safety and property damage risk in Boulder. **Attachment B** presents a summary of Utility CIP project expenditures from 1990-2012.

The CFS Master Plan is organized and focuses on the following programs:

MAJOR DRAINAGEWAYS

The city has a comprehensive floodplain management program designed to identify flood risks, mitigate the risks of flooding, minimize loss of life and property damage and support recovery following a major flood event. Major components of the city's floodplain program include: mapping, mitigation master planning and construction, property acquisition and flood protection through land use regulations and flood preparedness. The flood management program is focused on flood hazards associated with major drainageways that pose the highest risk to life safety and property damage. Major drainageways within the City of Boulder are depicted in **Attachment C**. Because of the significant risk to life safety and property damage in Boulder, a focus of this program is on emergency preparedness, flood warning, public awareness and self help techniques.

Floodplain mapping provides the basis for the city's floodplain management program by identifying the areas subject to flooding. Flood mitigation master planning typically follows each mapping study update. During the mitigation master planning process, potential flood mitigation improvement projects are identified and evaluated based on a benefit to cost review using a Federal Emergency Management Agency method of analysis prior to investing public funds in such improvements. Flood mitigation projects are prioritized based on the life safety threat.

The primary guiding documents for this program are:

- Major Drainageway Planning, Boulder and Adjacent County Drainageways – Phase B (1987)
- Fourmile Canyon and Wonderland Creek Flood Mitigation Plan (2009)

The highest priority projects identified in the 1987 document have been completed. Other projects identified in this document are being reviewed based on new flood modeling information. Because of the increased complexity of hydraulic modeling, mapping, hazard identification, benefit/cost analysis, environmental regulations and public involvement, subsequent studies have been focused on individual drainageways. An example is the South Boulder Creek flood mitigation planning effort that is currently in progress. These planning studies typically take many years to complete.

The Fourmile Canyon and Wonderland Creek flood mitigation planning encompassed nearly a decade. The progression of study typically starts with base mapping and hydraulic modeling leading to an updated floodplain mapping study that is submitted to FEMA for review and approval. FEMA review can take several years to complete and effective mitigation planning is generally not feasible until mapping changes have been finalized.

Major drainageway improvement projects are generally multi-year projects and often require phasing to fund the significant costs. A single culvert can range from several hundred thousand dollars for a two-lane roadway crossing to multiple million dollars for a major arterial roadway crossing. In most cases, significant property acquisition is required, including the demolition and removal of existing private structures. Refer to **Attachment B** for more detailed information about the historic cost of major drainageway and other improvement projects.

STORMWATER MANAGEMENT

Stormwater Management refers to the city's stormwater collection system that conveys rainfall and runoff to the major drainageways. The stormwater collection system is comprised of storm sewers, culverts and ditches that convey stormwater away from developed property and roadways to the major drainageways. There are approximately 160 miles of city owned and maintained stormwater pipe. Most of this pipe was installed after 1960 and large areas of the city were developed with no storm drainage features other than paved streets that convey rain water runoff.

The city developed a stormwater management program to meet USEPA requirements regarding non-agricultural stormwater discharges under the National Pollutant Discharge Elimination System (NPDES) Stormwater Program. The program is designed to prevent harmful pollutants from being discharged into local water bodies. The City of Boulder is a Municipal Separate Storm Sewer System (MS4), and has an MS4 permit to meet NPDES Stormwater Program permit requirements.

The primary guiding document for stormwater management is the Stormwater Master Plan (SMP) which was completed in 2007. The SMP is a comprehensive evaluation of the city's stormwater collection and stormwater quality system. The goal of the Boulder SMP is to proactively manage stormwater runoff to protect water quality and to minimize impacts of localized and downstream flooding by identifying infrastructure improvements for the collection, conveyance and treatment of stormwater runoff from within the City. The SMP Executive Summary is presented as **Attachment D**.

FLOOD UPDATE

As a result of the recent flood, there is an increased interest by the public in flood mitigation improvements. Assessing flooding impacts and analyzing the benefits and costs associated with stormwater and flood mitigation, in addition to the public engagement process will take years to complete for the stormwater system and all major drainageways. It may be desirable to accelerate mitigation improvements. Additional funding in the form of Stormwater and Flood Management Utility rate increases would need to be considered.

ANALYSIS

Attachment E presents a list of CIP projects and potential funding amounts being considered as discussed below.

MAJOR DRAINAGEWAYS

The Greenways and Flood 2014-2019 CIPs focused on projects along Wonderland Creek between Foothills Highway and Winding Trail Drive and Fourmile Canyon Creek between 22nd Street and Violet Avenue. Funding was also shown for South Boulder Creek. The 2013 flood event resulted in varying flood extents along Boulder Creek and the 14 tributaries. Documentation of the flood event revealed discrepancies between the FEMA regulatory floodplain limits and the extent of actual flooding in the Fourmile and Wonderland Creek drainages. In particular, Fourmile Canyon Creek deposited significant amounts of sediment in and along the historic drainageway. This caused water to flow in other adjacent areas.

The city has commissioned an engineering consulting firm to revisit the floodplain mapping for the spill area along Fourmile Canyon Creek. The design of the projects along Fourmile Canyon Creek has been put on hold pending updated 100-year flow data from this evaluation.

Typically flood mitigation projects are identified as part of a flood mitigation planning study, which usually follows a flood mapping update and approval by FEMA. An overall schedule for major draingeway CIP planning is presented as **Attachment F**.

Capital improvements required to mitigate flood hazards require multi-year funding or the issuance of bonds. **Attachment G** presents representative historic cost information about various projects as well as ballpark estimated costs for 100-year flood mitigation improvements for various drainageways.

Prior to the September 2013 flood disaster, the city had several mapping and mitigation projects underway. The schedules of those projects are being adjusted to allow consideration of new LiDAR data and new information from the flood event and are listed below:

Current Mapping Updates

- Upper Goose Creek and Two-Mile Canyon Creek
- Skunk Creek, Bluebell Canyon Creek and King's Gulch

  These mapping study updates should be completed later this year based on the new LiDAR derived topographic base mapping and analysis of the extent of flooding from the September 2013 flood disaster. Flood mitigation studies for these drainageways are anticipated to begin in 2016 and funding is shown in the CIP in 2017 and 2018.

- Boulder Slough from Broadway to downstream of 30th St. The construction of improvements along the Boulder Slough between 30th St. and Foothills Parkway is underway in conjunction with the Boulder Junction project and a Letter of Map Revision (LOMR) will be done following the construction.

Current Flood Mitigation Planning

- Boulder Creek, Gregory Canyon Creek and Bear Canyon Creek.

  The floodplain mapping for these areas was more recently updated and appears to accurately reflect actual 2013 flood disaster conditions, but this will be confirmed. This study will identify opportunities for mitigation and help prioritize future work. This study will not only consider 100-year flood improvements, but will also look at improvements for more frequent storm events. This study will begin in early 2014. Funding is shown in the CIP in 2015 and 2016 for Bear Canyon Creek, Gregory Creek and Boulder Creek, with additional funding in 2017 for Boulder Creek.

- South Boulder Creek

  This mitigation study will be completed this year. The proposed improvements will be taken through an extensive public process prior to final design and construction. Additional funding is shown in this year's CIP in 2015 and 2016, in addition to the bond funds that were shown in previous CIPs. Phase two of the South Boulder Creek Flood Mitigation Improvements was listed as unfunded in previous CIPs, but was included in 2020 in this CIP. As a result of the recent flood disaster, the city may be eligible for post-disaster grant funding for improvements along South Boulder Creek.

On-going Capital Improvements

- Fourmile Canyon Creek

  Funding continues to be shown in the CIP for Fourmile Canyon Creek as in last year's CIP, with additional funding shown in 2020. Once the information from the September 2013 flood disaster is reconciled with existing hydrologic and hydraulic modeling, we will adjust and move forward with the projects identified in the Fourmile Canyon Creek Mitigation Plan. Additional mitigation projects may be identified as a result of the 2013 flood.

Flood Recovery

Flood recovery work is well underway including debris and sediment removal from the city maintained drainageways to restore capacity. Bids have been received for permanent restoration of drainageway features and a contract will be issued in the near future. The total cost of flood recovery work associated with the major drainageways is approximately $6-8 million and previously appropriated funds intended for the Wonderland Creek flood mitigation project are being used to cover these expenses.

It is estimated that 75% of the "eligible" costs will be reimbursed by FEMA with reimbursement payment expected in late 2014 or early 2015. FEMA provides reimbursement only for restoration of facilities maintained by the city prior to the flood and only for restoration to pre-flood conditions. There is the possibility that the State of Colorado may appropriate money to provide an

additional 12.5% reimbursement of expenses to local governments. The city will need to determine the best approach for funding the unreimbursed costs.

STORMWATER MANAGEMENT

The 2014-2019 Utility CIP includes major drainageways projects and stormwater management projects. The major drainageway section was discussed above. This section provides an overview of the stormwater management programs and projects. The stormwater management program currently includes the following four projects/components: Upper Goose Creek, Stormwater Quality Improvements, Storm Sewer Rehabilitation, and Transportation Coordination. The CIP funding allocations are based in part on the Stormwater Utility Master Plan (SMP) recommendations - completed in 2007. The SMP included a comprehensive list of CIP recommendations organized accordingly to three Tier levels of prioritization. City staff is in the process of reviewing the various flood data available from the September 2013 flood event. Staff is in the process of reconciling the flood information with the master plan recommendations and developing an updated set of stormwater quality and drainage CIP project priorities.

Following the September 2013 flooding disaster, city staff is recommending increased funding in two of the four areas, and creating a fifth area to specifically address localized drainage improvement projects. This recommendation is based on the need to address the extensive flooding that occurred in numerous areas throughout the City.

Flood Recovery
Flood recovery work is well underway including debris and sediment removal from inlets, catch basins, manholes, culverts and stormsewers. It is anticipated that a construction bid will be awarded for additional work in the 2nd quarter of 2014. The total cost of flood recovery work associated with the stormwater management system is estimated to be approximately $1-2 million and will need to be made available in 2014. It is estimated that 75% of this cost will be reimbursed by FEMA. Payment is expected in late 2014 or early 2015.

Upper Goose Creek
The Upper Goose Creek drainage improvements project was identified as the top stormwater drainage priority in the SMP. This project was identified to include pipe replacement, new storm drains, and channel improvements. This project area is bounded on the west by 9th Street, on the east by 19th Street , on the south by North Street and on the north by Evergreen. This area has experienced flooding on numerous occasions in the past. The priority of the Upper Goose Creek project will be re-evaluated in light of the September 2013 flood disaster.

Stormwater Quality
The Stormwater Quality Improvements program is becoming a higher priority because of stormwater quality regulations and the impact of stormater discharged to Boulder Creek and its tributaries through numerous outfalls. This program has been historically funded at $100,000 year. Staff has identified additional water quality projects that would require increased funding in the future and is considering a recommendation that this funding be increased to $150,000 annually.

Storm Sewer Rehabilitation
Post-flood inspections have revealed several storm collection system assets which require repair due to normal wear and tear. Many of these include corrugated metal pipes which have severe corrosion. Currently the city funds storm sewer rehabilitation at a rate of approximately $250,000 per year.

Transportation Coordination
The community has recently supported additional funding for transportation projects through a voter approved bond measure. The additional projects have resulted in a corresponding increase in the associated stormwater infrastructure needed. The current funding to coordinate with and support transportation projects is $250,000 per year but this may need to be increased to support the additional transportation projects.

Local Drainage Improvements
The September 2013 flood disaster made it clear that there are significant localized stormwater conveyance issues throughout the City. To begin the process of evaluating and prioritizing improvement alternatives and funding certain improvements additional funding is being considered.

FINANCIAL CONSIDERATIONS

The Utility operates as an enterprise utility as defined in State law under the Taxpayer Bill of Rights (TABOR.) An enterprise is a government owned business authorized to issue its own revenue bonds and receiving less than 10% of its annual revenue in grants from all Colorado state and local governments. Total operating and transfer expenses are about $3.5M, and the 6-year CIP approved in the 2014 budget and debt payments averages $5M per year. In 2013, customer billings accounted for approximately $5.5M in revenue, and plant investment fees contributed about $600,000. In some years, another significant source of funding is federal grants and/or Urban Drainage Flood Control District funds.

The 2014 rate for a single-family residential customer with up to a 15,000 square foot lot is $7.69 per month and those with lots between 15,000 and 30,000 square feet paying $9.61, and those over 30,000 square feet paying $11.54. All other properties pay a fee based on a runoff calculation. For example, a grocery store in town pays about $880 per month, and a local hotel pays $224 per month. Compared to 15 other utilities in the Front Range, the single-family residential rate in Boulder is the 5th highest. Ft. Collins and Longmont are currently the highest in the survey at around $13 per month. Fort Collins implemented several years of double digit rate increases after the 1997 Spring Creek flood, including a 45% increase in 2002 following master plan updates. Their rate has remained the same since 2004. They have been working to build for 100-year flood protection in their 12 drainage basins within a 35 year timeframe.

Following the September 2013 flood, Longmont increased Storm Drainage fees from $7.77 to $13.05 for residential customers. They are working to make improvements for a 100-year flood, and anticipate needing to bond for an additional $20M.

The financial plan adopted for 2014 for the Utility anticipated annual rate increases of 3%. Continuing this level of funding would not allow for the additional mitigation improvements

outlined in this memo, and depending on the level of FEMA reimbursement for flood costs, may require projects or operations to have reduced funding. If Boulder's stormwater fee were increased to an amount similar to Longmont and Ft. Collins, this would bring in approximately $3.8M in additional revenue annually at a cost of a little over five dollars per month on a single-family residential bill. This increase, along with ongoing inflationary increases, would provide sufficient revenue to fund the additional projects highlighted in **Attachment D** based on preliminary estimates. The ballpark estimate in **Attachment G** shows potential costs for providing 100-year flood mitigation costs. To provide the bond capacity to fund the estimated cost of over $300M, rates would have to increase over 500%.

SCHEDULE OF KEY MILESTONES

Budget Schedule

The current schedule of major budget milestones is provided below. Elements involving the WRAB are highlighted in bold italics.

WRAB Preliminary CIP Budget Discussion - April 21, 2014
Budget Guidelines to Departments - April 2014
WRAB Draft CIP Review - May 19, 2014
Proposed Budget Submittal to City Manager - May 2014
WRAB Recommendation on CIP/Budget - June 16, 2014
Departmental Budget Review by City Manager - May/June 2014
Planning Board Recommendation on CIP - August 2014
City Council Study Session on CIP - August 2014
City Council Study Session on Budget - September 2014
City Council Consideration/Adoption of Budget – October/November 2014

ATTACHMENTS:
Attachment A: Comprehensive Flood and Stormwater Master Plan Executive Summary
Attachment B: Historic Flood Project Expenditures (1990-2012)
Attachment B: Map of Major Draiangeways
Attachment D: Stormwater Master Plan Executive Summary
Attachment E: List of CIP Project Funding Considerations
Attachment F: Major Draingeway CIP Planning Schedule
Attachment G: 100-year Flood Mitigation Costs

EXECUTIVE SUMMARY

INTRODUCTION

The Comprehensive Flood and Stormwater Utility Master Plan (CFS) provides a framework for evaluating, developing, and implementing various programs and activities in the Utility within the scope of the available budget. The CFS replaces the 1989 Comprehensive Drainage Utility Master Plan (CDUMP).

The CFS is the result of the periodic need to update programs and activities to satisfy current local interests, accommodate changing trends, philosophies, regulations and standards, ensure maximum effectiveness and cost efficiency, and meet evolving community goals and objectives.

The Stormwater and Flood Management Utility (Utility) is responsible for the administration of the City's flood management, stormwater quality, and stormwater drainage programs. Its responsibilities include:

- Administration and Operations.
- Utility Rates and Finance.
- Program Development and Management.
- System Maintenance and Restoration.
- Flood and Stormwater Regulation and Compliance.
- System Master Planning and Design.
- Public Education and Community Outreach.
- Flood Prediction.
- Stormwater Quality Management.
- Emergency Preparedness and Day-to-Day Operations.
- Capital Improvements and Land Management.

The CFS Utility Plan's main objectives are to address: (1) flash flood hazards; (2) stormwater quality; (3) stormwater drainage; (4) program integration and implementation; and (5) financial considerations.

AREA DESCRIPTION

The Boulder Creek Watershed encompasses some 440 square miles and extends from the Continental Divide to the high plains east of the City. There are 15 major drainageways (or creeks) in Boulder, within which a total of 17 sub-basins have been delineated. The tributary drainageways all eventually feed to Boulder Creek north of the Valmont Reservoir.

The study area itself is nearly "built out" resulting in a highly urbanized drainage setting. The natural hazards related to stormwater and flood management are particularly complicated by the fact that space is at a premium and that so many structures are within the floodplain.

PUBLIC PROCESS

A Community-Review Group (CRG) was used to provide "real-time" input to the analysis and draft recommendations for the CFS Master Plan. The CRG was created based on the key interests affected by the CFS.

The Independent Review Panel (IRP), a panel of flood hazard experts, also participated in the CFS development process.

The Water Resource Advisory Board (WRAB) met twice in 2003 and discussed key issues and the master plan process.

FLOOD MANAGEMENT

The Flood Management Program is responsible for all programs and activities related to local flooding and the floodplain.

The City of Boulder is extremely vulnerable to flash flooding due to its geographical location at the base of the Rocky Mountains. Within the City of Boulder's 100-year floodplain there are thousands of people and approximately 3,600 structures with an assessed valuation of almost $1 billion.

The City continues to grow through a combination of new development and redevelopment activity. Within the floodplain, these activities pose additional potential for hazards due to flash floods.

Recent projections indicate that almost 5 percent of the parcels of land designated with redevelopment potential have greater than 50 percent of their land area within the high hazard or conveyance flood zones. Current City regulations would significantly restrict redevelopment of these parcels. Almost 20 percent of the parcels of land designated with redevelopment potential have greater than 50 percent of their land area within the 100-year floodplain. Current City regulations do not restrict redevelopment of these properties but require suitable flood protection measures. However, these properties would still be subject to flood damage from larger flood events. Many of these parcels are located in the Boulder Valley Regional Center and the downtown business area which will be impacted by Boulder Creek flooding.

Boulder floodplain policies have not been updated since adoption of the CDUMP. As a result, our local floodplain management program has fallen behind the progression of national and regional trends and philosophies, and the nonstructural floodplain policy objectives outlined in the early years of our floodplain management program have never been fully realized.

Current Program Elements

Current flood management program elements include floodplain mapping, risk assessments, regulations, flood information and insurance, emergency preparedness, property acquisition, and flood mitigation capital improvements.

Guiding Principles

Using national and regional trends and philosophies, current and past local policies, and recommendations from the IRP and CRG as a backdrop for updating Boulder's flood management program, staff is recommending five guiding principles:

1. "Preserve Floodplains."
2. "Be Prepared for Floods."
3. "Help People Protect Themselves from Flood Hazards."
4. "Prevent Adverse Impacts and Unwise Uses in the Floodplain."
5. "Seek to Accommodate Floods, Not Control Them."

Recommended Flood Management Program Elements

Floodplain Mapping Studies Program

Floodplain mapping studies are essential in determining areas where life safety is threatened and damage to property is likely.

A 10-year update cycle coincides with the City's average timeline for updating new citywide topographic, planimetric, and aerial base mapping used for the study purposes.

In-depth analysis of floodplain mapping results can offer insights into the associated risks and levels of hazard inside the floodplain. The expanded hazard information is valuable for enhancing non-structural flood management program activities supported by the community.

Recommendations include:

- Adopt a 10-year update cycle for local floodplain mapping studies.
- Include floodplain risk assessments in all floodplain mapping updates.

Public Education and Flood Insurance

The guiding principle to "help people protect themselves from flood hazards" focuses on educating the public about flooding and providing information and resources the public may access to reduce their own exposure to flooding. Given that Boulder is nearing "build-out," this approach allows the flood management program to reach out and benefit the community at large.

There has been a strong community interest in offering a greater balance of non-structural flood management program activities as part of the overall Stormwater and Flood Management Utility program. These recommendations will serve to help achieve this balance:

- Create a flood management program resource center and program manager.
- Allocate $125,000 annual funding and staff resources for program support.
- Enhance the flood management Web site.
- Pursue an improved Community Rating System (CRS) rating given available resources.
- Research a local flood proofing program.

Flood Preparedness

The guiding principle to "be prepared for floods" focuses on floodplain emergency preparedness. Flood preparedness is a critical element in the City's floodplain management program, considering that more than 15 percent of the community is impacted by floodplains.

The more prepared a community can be with pre-flood preparedness, ongoing monitoring, effective warning systems, trained response, and post-flood recovery, the better chance the risks of flooding may be managed.

Recommendations include:

- Enhance coordination between the Office of Emergency Management and the City of

Boulder by taking a more active role in emergency management.

- Continue to enhance flood monitoring and prediction, early warning, and multiple notification measures by implementing the findings in the University of Colorado and recent system evaluations.
- Update and improve the flood response and flood recovery plans to address actions by public officials and actions by residents and members of the public.
- Develop innovative user friendly information materials for the public and residents to follow in the event of a flood.

Floodplain Regulations

Floodplain regulations are land use regulations intended to regulate activities and development in the 100-year floodplain, conveyance zone (or floodway), and high hazard zone. They are designed to provide a mechanism to address life safety and property damage impacts by restricting certain activities and improvements in the floodplain.

The floodplain regulatory revisions include recommendations intended to better address issues of life safety and structural safety:

- Assess the adequacy of *life safety measures.*
- Address *floodplain mapping uncertainties.*
- Develop options for *mitigating new floodplain* encroachments.
- Develop *500-year protection standards for critical facilities.*
- Evaluate the adequacy of the *flood protection elevation for flood proofed structures.*
- Develop *hazard analysis standards.*
- Seek FEMA approval of engineered foundation standards for crawlspaces.
- Research limited residential flood-proofing options for structures located in lower-risk shallow flooding areas.
- Evaluate the Association of State Floodplain Managers "no adverse impact" approach to floodplain management.
- Seek FEMA and UDFCD acceptance of the City conveyance zone (floodway).
- Seek Boulder County/City of Boulder regulatory consistency.

Property Acquisition and Floodplain Mitigation

The floodplain risk assessments will provide a more detailed framework for evaluating floodplain management and/or mitigation alternatives.

The property acquisition and constructed flood mitigation program has been very successful over the years. However, modern community interests and national trends away from structural drainageway construction have raised questions regarding previous structurally oriented projects that involve significant costs and raise environmental and aesthetic issues. The following recommendations offer approaches to balance structural and non-structural alternatives:

- Floodplain risk assessments, developed in conjunction with floodplain mapping updates, should be used to identify and quantify life safety and property damage risks to determine appropriate measures for property acquisition and floodplain mitigation.

- A balance of constructed flood mitigation projects (based on risks to life safety and of property damage) and acquisition of property (including removal of associated structures) should be applied to long-term floodplain management and preservation.

- Non-structural alternatives shall be considered and balanced with structural measures for floodplain planning and mitigation activities.

STORMWATER QUALITY

The City's Stormwater Quality Program is responsible for managing local activities to preserve, protect, and enhance water quality affecting Boulder's streams and drainages. The current program has four main components:

- Public Education
- Water Quality Monitoring
- Regulatory Compliance
- Source Control

In 2001, in response to Clean Water Act requirements, Colorado Department of Public Health and the Environment (CDPHE) expanded its regulations to include regulations for discharges from municipal storm sewer systems for cities with populations less than 100,000 and more than 10,000. Stormwater permit compliance is based on implementation of stormwater management programs intended to reduce pollutant loading from urbanized areas.

Water quality in Boulder Creek and its tributaries is a significant concern. The CDPHE is considering listing Boulder Creek as an impaired water body for E. coli bacteria contamination.

Currently, Best Management Practices (BMPs) identified as options in the City's Design and Construction Standards (DCS) are geared more toward new development than toward re-development. Boulder is predominantly "built-out", and guidelines focused toward new development have limited applicability in denser, redeveloping areas such as the Boulder Valley Regional Center and the downtown business center. Therefore, more innovative solutions need to be applied. Examples of these BMPs include porous pavements, subsurface detention, vegetated landscape filters and hydrodynamic separator devices.

Current Program Elements

Current stormwater quality program elements include water quality regulations, sub-basin management and stream enhancement.

Guiding Principles

Recommended stormwater quality guiding principles, based on national trends and current local policies, include:

1. "Preserve Our Streams"
2. " Prevent Adverse Impacts from Stormwater"

3. "Protect and Enhance Our Stream Corridors"

Recommended Stormwater Quality Program Elements

Water Quality Regulations

Implementation of a common approach results in consistency throughout the Boulder Creek watershed and provides more comprehensive, regional protection of water quality.

Continued water quality monitoring of the main stem of Boulder Creek will provide information needed to evaluate the impact of existing and new regulatory requirements such as the Total Maximum Daily Limit (TMDL) and sediment/aquatic life standards.

Recommendations include:

- Update City codes and development standards to meet applicable federal and state regulations. Update City standards to exceed federal and state requirements where appropriate to meet local water quality protection needs.
- Ensure adequate funding for the continued participation in the WASH program and the City's individual requirements for compliance with the City's Stormwater Permit.
- Continue to pursue opportunities to collaborate with other communities to address water quality issues.
- Track upcoming regulatory changes to develop the most cost effective approach to compliance.
- Enhance water quality monitoring program to improve data analysis, program evaluation and compliance tracking.

Sub-basin Management

Sub-basin management focuses on reducing the impact of runoff by focusing on preventive measures to minimize pollution at the source. Recommendations include:

- Research BMPs oriented to redevelopment and existing development in highly urbanized areas such as the Boulder Valley Regional Center and the downtown business center and incorporate appropriate BMPs into City Ordinances and Standards.
- Integrate water quality objectives into the City master planning process, such as updates to the Boulder Valley Comprehensive Plan (BVCP) and the update to the Stormwater Management Plan.
- Examine the stormwater utility rate structure to promote innovative BMPs and investment in public regional BMPs.
- Develop incentive programs to promote BMPs in both residential landscapes and commercial development that are innovative and exceed City requirements.
- Explore the use of subsidies, public-private partnerships, and grant-funding to implement innovative urban BMPs. Consider special improvement districts for targeted areas, such as the Boulder Valley Regional Center and downtown business center.

- Increase the water quality benefits derived from the City's urban forest through support of the City's Urban Forest Program and tree planting programs for parks and other City owned properties. Consider updating regulations and standards to increase tree planting requirements for new development and re-development projects.

- Integrate multiple objectives including water quality enhancement on City-owned land and in decisions regarding future property acquisition.

- Develop GIS tool to prioritize water quality improvement projects for sub-basins using data such as potential pollutant loading, land-use, impervious surface, groundwater recharge and other data, some of which has been developed in the *2000 Boulder Creek Watershed Study*.

- Update development and re-development regulations and standards to expand runoff reduction and water conservation requirements.

Stream Enhancement

Stream enhancement focuses on the stream corridor itself. Stable stream environments are necessary for fish and other aquatic species to survive. Riparian habitat provides a number of water quality and ecosystem functions.

Recommendations include:

- Protect and preserve the watershed's most critical and fragile areas – floodplains. Provide ample flood capacity and freeboard, allowing for increase in riparian vegetation and roughness. Integrate floodplains protection with stream channel enhancement through the major drainageway planning process.

- Expand the *Greenways Master Plan* principals to all tributaries beyond Boulder Creek and the six tributaries currently studied.

- Use balanced approaches to drainage solutions that provide multiple benefits, including the water quality/quantity benefits of preserving the stream corridor and its natural character.

- Avoid hydrologic disconnect between groundwater and surface water in stream channels.

- Implement sub-basin water quality management practices and projects in conjunction with Greenways project implementation.

- Update the *Greenways Design Guidelines* to include measures to stabilize channel erosion and sedimentation, support fish and other aquatic species movement, protect riparian habitat, and other measures to promote stream stability.

STORMWATER DRAINAGE

The City's stormwater collection system consists of a variety of storm sewers and open drainage ditches that collect water and divert the water to major drainageways.

Irrigation ditches collect stormwater in many places in the City. Depending on the amount of rainfall, stormwater flows may exceed the capacity of the ditch and spill from the ditch in an uncontrolled manner.

In the past, the Utility's emphasis has been to provide structural solutions, such as drainageways and storm sewer facilities, to resolve stormwater and flood management issues. Now, the overall guiding principles are in place to develop a balance of structural and non-structural solutions to these critical programs and activities.

Current Program Elements

Current stormwater drainage program elements include stormwater collection system and planning; design and construction standards; maintenance; detention and groundwater extraction and release.

Guiding Principles

Guiding principles for the stormwater drainage program component based on national trends and current local policies, are proposed as follows:

1. Maintain and Preserve Existing and Natural Drainage Systems."
2. "Reduce and Manage Developed Runoff."
3. "Eliminate Drainage Problems and Nuisances."

Recommended Stormwater Drainage Program Elements

Stormwater Collection System and Planning

The existing Stormwater Collection System Master Plan provides the City of Boulder with a guide for minor storm (2-year frequency for residential areas and 5-year frequency for commercial/ industrial areas) drainage related Capital Improvement Projects (CIP). This 20-year old plan should be updated to include drainage, detention, groundwater and stormwater quality issues. Land use has changed significantly and the plan should consider planned development and redevelopment activities. Stormwater quality permitting requirements and BMPs should be further assessed and applied to individual sub-basins. The following issues should be considered:

- Assess current and future land use and associated imperviousness.
- Update hydrology/hydraulic models.
- Consider groundwater flows when evaluating existing capacity.
- Consider peak flows for the minor and major storm events.
- Limit the post development peak discharge rate to the pre-development discharge rate for single design two-year storm events.
- Separate stormwater drainage from the irrigation ditches.
- Focus on known problem and future development areas.
- Integrate water quality and other multi-objective issues in the updated plan.
- Re-evaluate detention including the possibility of regional detention and increasing existing detention.
- Locate (estimate) the water table throughout the City.

- Re-evaluate remaining projects for necessity and community objectives.
- Re-prioritize recommended projects.
- Review and revise the City's criteria for prioritization.

Design and Construction Standards

The City's Design and Construction Standards (DCS) regulate the design and construction of public infrastructure, improvements, and landscaping within the City's public rights-of-way and public easements. The current standards were last updated November 16, 2000, and need to be consistent with the most current versions of the Urban Drainage and Flood Control District (UDFCD) standards. Stormwater drainage and stormwater quality standards also need to be integrated.

Maintenance

The recommended action items will address the current maintenance issues of frequency and tracking of maintenance activities.

- Integrate above grade facility information associated with the major drainageways into the City's maintenance management system.
- Integrate maintenance performed by the UDFCD into the City's maintenance management system.
- Include project management personnel in the Call-Log database.
- Inspect and remove excessive vegetation and debris along open drainageways on a yearly cycle or as needed based on requests.
- Remove debris from inlets on a 2-year cycle or as needed based on requests.
- Remove silt and sand deposits from manholes and open channels on a 2-year cycle or as needed based on requests.
- Inspect and repair storm sewer pipe on a 2-year cycle or as needed based on requests.
- Clean excessive deposits of sediment within storm sewers on a 2-year cycle or as needed based on requests.

Detention

The City has required on-site detention for new developments since the early 1970s. On-site detention storage is required for all developments other than individual single-family lots that are not part of a larger development. Most of these facilities are privately owned and maintained. The design of these facilities is reviewed by City staff at the time of application. The facilities are inspected and as-built drawings are now required to be submitted. However, there is currently no follow-up City inspection to assure these facilities are functioning as originally intended.

Recommendations for on-site detention include:

- Review each development plan to look for opportunities to increase detention greater than the minimum currently required.
- Integrate water quality BMPs into on-site detention requirements.
- The amount of detention should be based on the degree of redevelopment proposed

or an incentive plan, where going above and beyond decreases fees.

Recommendations for existing detention facilities include:

- Determine if additional inspection and maintenance is needed based on the condition assessment of a random sampling of the existing facilities. On-going inspection and maintenance could be accomplished by either the City or private property owners.
- Require property owners to periodically submit an inspection report to the City once every 5 years to certify that the detention facility is functioning as originally designed or there is a plan for improvements.

Groundwater

Groundwater and sump systems create nuisance drainage in the public rights-of-way and potential hazards due to build-up of slime and ice. Also, groundwater de-watering 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.

The recommended action items will allow for a proactive, rather than reactive, approach to dealing with groundwater issues:

- Identify problem areas and require more precise water table information that considers seasonal fluctuations.
- If the City believes or knows of a problem area, then a mitigation plan should be required prior to permitting.
- If groundwater is not expected but is encountered during construction then a mitigation plan should be required prior to issuing the certificate of occupancy.
- Evaluate the implications of groundwater contamination and further explore existing available soils information.
- Consider groundwater discharge as part of the update to the *Stormwater Collection System Master Plan*.
- Identify problem areas and issues including the effect of groundwater de-watering on local water wells and wetlands.
- Develop mitigation options for specific problem areas based on estimates of additional groundwater flow.

Program Integration and Implementation Opportunities

The Stormwater and Flood Management Utility is part of the City's Public Works Department. The organizational structure of the Department provides both opportunities for and challenges to integrating various program interests and other multi-objectives.

Current Program Elements

The following institutional opportunities for integration are currently defined:

- Annual Budget Process

- Greenways Master Plan and Program
- Project Planning and Approval Process (PPAP)
- Community and Environmental Assessment Process (CEAP)
- Design and Construction Standards (DCS)

Recommendations

Program Integration

This master plan recommends maintaining existing coordination and integration processes. In addition to these existing processes for program integration, this master plan has identified additional opportunities for coordination:

- Board and Council Review and Discussion of CFS Utility Master Plan
- Interactive Web Site
- Stormwater Management Plan
- Major Drainageway Planning
- Design and Construction Standards
- Flood Management Program
- Greenways Program (including update to Greenways Design Guidelines)
- Boulder Valley Comprehensive Plan
- Water Quality Master Plan
- Maintenance Program
- Annual Budget Process

A significant opportunity for integration with other City objectives is the 2005 update to the Boulder Valley Comprehensive Plan. The update process will provide an opportunity to review land use and zoning designations from the perspective of flood hazard, water quality and drainage issues.

A Flood Management Program office will be established to enhance and integrate various program functions and provide a more focused point of contact for other staff and the public. This office will work closely with Planning and Development Services - Floodplain and Wetland Management, which will continue to be the focal point for interactions with the development community.

In addition it is recommended that the Greenways program be expanded to all 15 of the City's major drainageways to provide for better integration of multiple objectives.

These additional opportunities provide a way to integrate various program interests and other multi-objectives.

Program Implementation

To assure integration with various program interests and other multi-objectives the City will use a multi-disciplined approach and involve staff from appropriate workgroups.

FINANCIAL CONSIDERATIONS

The Utility is an enterprise funded primarily by monthly utility fees. The Utility today receives annual revenues of over $4 million that are applied to operating activities, emergency

preparedness, stormwater quality, stormwater maintenance and capital improvements.

In general, existing programs are adequately funded. However, several increases to existing program funding are presented. To support these increases in funding, money will need to be reallocated from the existing budget or a rate increase will be required as follows. The following proposed financial plan will be considered as part of the City's on-going budget process.

Flood Management

It is proposed that annual funding for the on-going flood management program increased from $100,000 to $350,000 per year. This represents a shift to balance structural and non-structural solutions for flood management.

Stormwater Management

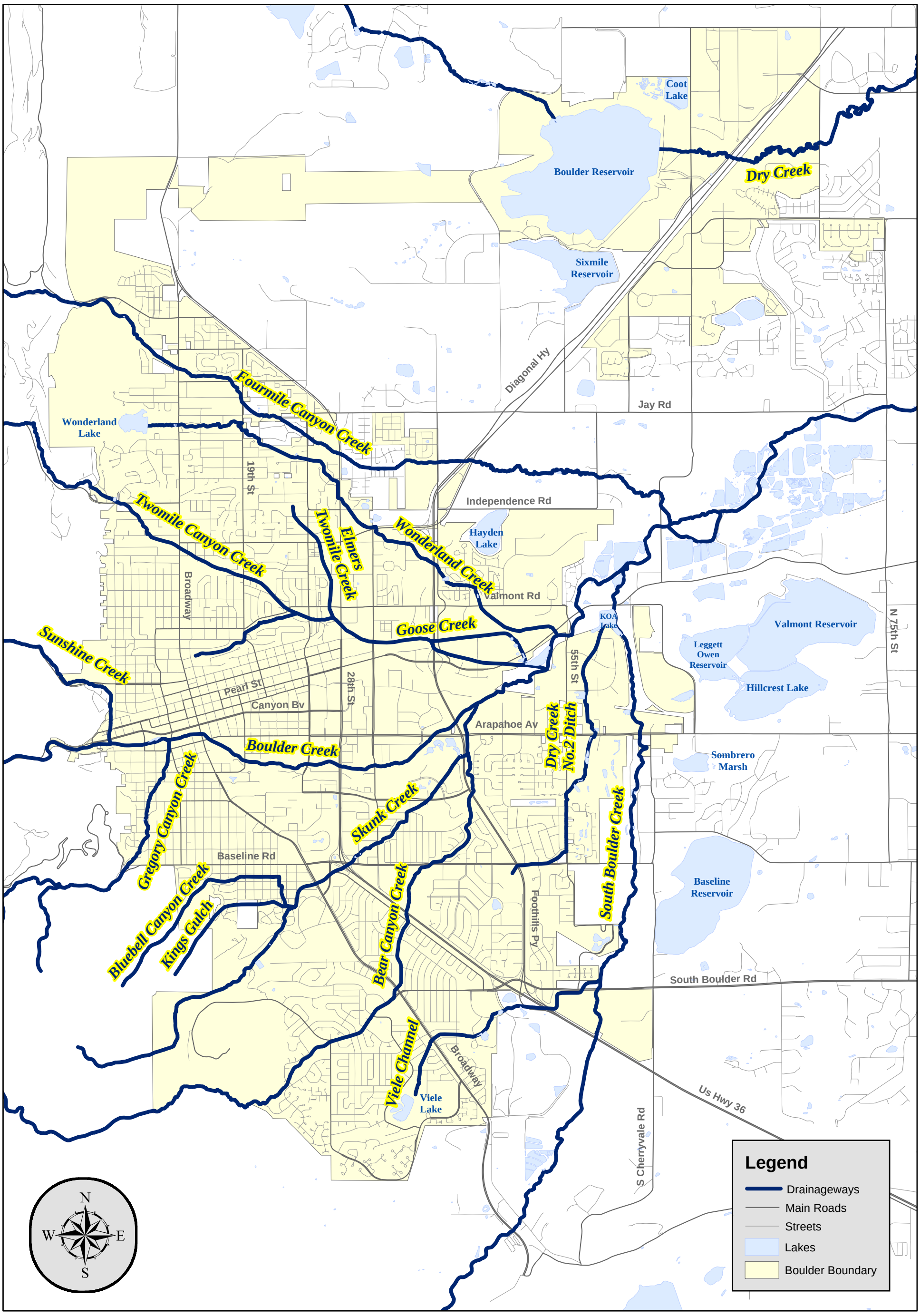
It is proposed that:

- A one-time additional funding allocation of $250,000 should be made in the 2005 budget to update the Stormwater Collection System Master Plan.
- Additional annual funding of $50,000 should be allocated to begin an inspection and maintenance program for stormwater quality and existing private on-site detention facilities.
- Additional annual funding of $50,000 should be allocated to GIS tools development and support.

At proposed funding levels it will take many years to achieve the goals of this master plan. The financial approach recommended in this plan considers evolving regulations, technology and development characteristics. A slower, methodical approach will allow for planning and adapting to these anticipated changes.

ATTACHMENT B
FLOOD CONTROL AND DRAINAGE UTILITY
PROJECT EXPENDITURES (1990-2012)
2013 Dollars

	TOTAL	PERCENT
Property Acquisition		
Pre-Flood Acquisitions	**$15,636,477**	
Branding Iron Mobile Home Park	**$1,734,187**	
Boulder Creek Property Acquisition	**$2,824,039**	
Mapleton Mobile Home Park	**$2,387,096**	
Fowler Property Acquisition	**$3,297,809**	
Tebo Property Acquisition	**$1,898,474**	
Crouch Property Acquisition	**$480,700**	
Subtotal Property Acquisition	**$28,258,781**	**35%**
Major Drainageway Improvements		
Goose Creek	**$22,757,526**	
Bear Canyon Creek through Martin Park	**$1,105,715**	
Gregory Canyon Creek Drainageway	**$1,272,530**	
Elmer's Two-Mile Creek	**$8,267,750**	
Wonderland Creek-Valmont to Goose Creek	**$475,356**	
Wonderland Creek at Boulder White Rock Ditch	**$380,886**	
Wonderland Creek- Diagonal Highway	**$1,195,750**	
Bear Creek Arapahoe to Foothills	**$380,968**	
Bear Canyon Broadway Grd Sep	**$578,104**	
Boulder Creek / Broadway Bridge	**$756,823**	
South Boulder Creek Improvements	**$2,082,780**	
Accelerated Tributary Projects	**$329,226**	
Four Mile Creek	**$1,600,653**	
Subtotal Major Drainageway Improvements	**$41,184,066**	**51%**
Subtotal Storm Sewers	**$11,244,187**	**14%**
Total	**$80,687,035**	**100%**



0 0.5 1 2 3 Miles

City Of Boulder

Major Drainageways

Figure 3-1

Executive Summary

The original 1984 City of Boulder Storm Water Collection System Master Plan is being updated to reflect changes in land use, infrastructure and the regulatory climate as well as anticipated redevelopment within the community. The revised Stormwater Master Plan (SMP) provides the City of Boulder with the necessary planning tools and capital improvement projects to address flood management and water quality within the collector portion of the storm drainage system for the next decade.

The Boulder SMP was developed to replace the 1984 plan with a document that is more inline with present-day problems and opportunities and the City's overarching environmental, economic and social goals. The goal of the Boulder SMP is to proactively manage stormwater runoff to protect water quality and to minimize impacts of localized and downstream flooding by identifying infrastructure improvements for the collection, conveyance and treatment of stormwater runoff from within the City. The SMP prioritizes storm drain and water quality improvements within the City and provides an implementation plan for the construction of conveyance and water quality improvements

Major activities undertaken in the development of the plan include the following:

- Develop system analysis and problem identification criteria,
- Develop hydrologic, hydraulic and water quality models,
- Evaluate the system and rank problem areas,
- Perform alternatives analysis and develop a recommended plan,
- Prepare a capital improvement plan.

Study Area Characterization

The City of Boulder, with a population of approximately 100,000 and an area of nearly 25.5 square miles, is located along the front range of the Rocky Mountains, northwest of Denver, Colorado. Within the City, there are 12 subbasin and 15 major creeks (a.k.a. major drainageways) that generally flow from west to east as they converge on Boulder Creek, which is the main tributary flowing through the City. Runoff from within the City is conveyed to these major drainageways by the City's collector storm drain system and the irrigation canal system.

At present, Boulder is nearly fully built-out with much of the future development expected to occur as site redevelopment. Collectively, the current impervious percentage, assuming 2006 land use conditions, is 32% and is projected to be 34% under the Boulder Valley Comprehensive Plan. However, considering the City's Design and Construction Standards (DCS), the net future condition imperviousness used for this analysis was determined to be 33%,

Planning and Analysis Criteria

A master planning analysis was performed to identify potential collector system stormwater and associated water quality improvements within the City of Boulder. The evaluation was guided by a set of system analysis criteria used to identify conveyance and water quality problem areas and to evaluate potential improvements. These criteria included quantitative assessments of storm drain surcharging, culvert overtopping, channel/canal flooding, structure flooding (buildings, etc) and pollutant loadings. Other system analysis criteria used to support the study

included design storms (2-year, 5-year and water quality), landuse (existing and future conditions) and model boundary conditions.

Analysis Approach

A key element in the master planning process is the development of a hydrologic, hydraulic and water quality model of the natural and man-made stormwater system within the City. The model should be capable of analyzing runoff conditions; predicting flooding risk; estimating comparative pollutant loadings; evaluating existing facilities and infrastructure; and designing proposed improvements. To these ends, the primary objectives of the stormwater analysis were to:

- Construct a model that accurately represents the existing stormwater system within the City's collector system.
- Validate the model to previous studies and regional rainfall-runoff statistics.
- Utilize a land use-based method to estimate runoff under current conditions and incorporate the Boulder Valley Comprehensive Plan to represent future development conditions within the City.
- Evaluate the existing stormwater infrastructure with respect to the system analysis criteria and rank each problem in terms of severity.
- Locate, size and assess the performance of new stormwater management facilities including pipes, detention ponds, surface channel and irrigation canals.
- Locate, size and assess the performance of new water quality facilities based on areas identified in the model that exhibit elevated pollutant concentrations and/or loads.

Limits of Analysis

The focus of the Boulder SMP is the collector storm drainage system, which includes pipe 18" in diameter and larger and primary open channel systems that are not part of the City's major drainageways. To further refine the stormwater conveyance system, two levels of service are provided based on landuse and roadway category. For areas that are mainly residential in land use, the 2-year recurrence interval design storm was used to identify problems in the downstream conveyance system. For areas draining mainly commercial, industrial and collector and arterial roadways, the 5-year event was used. Areas within the city that experience localized flooding (e.g., undersized pipes that are less than 18 inches in diameter; roadside ditches; and clogged catch basins) were not considered as part of this study unless they have been identified by the City as known flooding locations.

Modeling Approach

The modeling approach for the Boulder SMP integrated GIS as a pre- and post-processing tool with an EPA-based Storm Water Management Model (SWMM) as the hydrologic, hydraulic and water quality analysis tool. The analysis software used for the project was XPSWMM which is a proprietary version of EPA-SWMM software that provided an efficient GIS interface that EPA-SWMM does not have at this date. Workflow began in GIS, where the input parameters for the SWMM model were developed. This data was transferred out of GIS to SWMM, for the evaluation of the system hydraulics and water quality. Model results were ultimately brought back into GIS for post processing and storage for future reference by the City.

Landuse and City Development Criteria

Land use is a key factor in assessing stormwater runoff because it affects both the quantity (volume and peak) and quality of water being routed through the stormwater system and natural channels. The effect land use has on water quantity can be generally linked to the amount of

impervious area for a particular land use category. The more impervious the area, the faster the water will be routed to the storm water collection system due to the lower surface roughness of the ground. It will also have an increase in volume since infiltration can not occur through impervious surfaces. Consequently, an area with a higher percentage of impervious surfaces will produce higher peak flows over a shorter period of time than will a similar area with a lower percentage of impervious surfaces.

The future conditions scenario represents a fully developed urban area according to the Boulder Valley Comprehensive Plan, 2006 (BVCP). This scenario represents a worst case scenario from a stormwater perspective because it encompasses the highest level of imperviousness. However, this scenario has also incorporated the City's DCS, which require detention and water quality treatment for all new impervious areas associated with new and re-development projects. As discussed in later sections of this report, the City performed an inventory of existing detention and treatment facilities and it was identified that roughly 78% of all current facilities are adequately functioning (22% have failed). Consequently, to incorporate the DCS, this same facility performance level (78%) was also assumed to occur under future development conditions. To accomplish this, the change in impervious percentage between existing and future conditions was reduced by 78% to account for the detention and treatment facilities that will collectively be built as the city develops and/or re-develops.

Problem Identification

Utilizing the verified SWMM model, runoff, hydraulic, and water quality calculations were completed for two different land use scenarios: existing conditions and future conditions, and three different design storms: the 2- and 5-yr events and the water quality storm. These results were then evaluated with respect the previously noted system analysis criteria to identify specific system deficiencies within the City's collector storm drain system.

Hydraulic Problem Areas and Ranking

Model results for existing conditions indicate that 572 nodes out of 1635 nodes within the model violate one or more of the noted criteria. To better understand the cause and affect of each problem area, a number of these deficient nodes and links were combined together into individual problem locations. This resulted in a total of 51 hydraulic problem locations. Irrigation canal segments were also added to the problem identification list if the corresponding design storm causes the channel to overtop its banks and flood the surrounding area.

Due to the relatively large number of problem locations identified through the modeling and GIS analysis, and due to limitations within the City's capital budget, a ranking was performed on the problem areas to prioritize the conveyance problems. This process resulted in identifying three problem priority levels; Tier 1, Tier 2 and Tier 3 indicating severe, major or minor problem areas, respectively. The process of ranking system problems into tiers utilized a point-based matrix using a weighted criteria approach. Six criteria were used to rank the problem areas. These criteria include: 1) the extent of the problem, 2) the flooded volume, 3) the impact to neighboring structures, 4) the length of under capacity pipe, 5) the confidence in the underlying data and 6) the proximately of the hydraulic problem to water quality areas of concern. The problem prioritization process resulted in five Tier 1 problem areas, 17 Tier 2 problem areas, and 31 Tier 3 problem areas. These problem locations are shown on Figure ES-1.

Water Quality Analysis and Problem Areas

The water quality analysis included two separate approaches to identify problem locations within the collector system: 1) a buildup-washoff analysis using the XPSWMM model to identify water quality areas of concern that produce high pollutant loads and 2) targeted outfall approach focusing on the collector system outfalls to Boulder Creek. The water quality area of concern

approach used the XPSWMM model to identify areas within the City having comparatively higher pollutant concentrations and/or loads. This approach identified 12 locations within the City that were characterized as water quality areas of concern. The Boulder Creek outfall approach identified 17 collector system outfalls that do not currently receive pollution reduction through regional water quality facilities. The water quality areas of concern and Boulder Creek outfall sites are shown on Figure ES-2.

System Improvement Alternatives and Recommendations

Improvement alternatives were developed for the Tier 1 and Tier 2 problem areas and a qualitative assessment identified the preferred alternative for each problem area. The Tier 3 problem areas did not receive an evaluation of different alternatives due to the limited severity of the conveyance problems. Instead, improvements to resolve the Tier 3 problem areas consisted of pipe replacement to increase the system capacity and resolve the conveyance problem.

For the water quality area of concern sites, improvement alternatives were developed to evaluate the optimum improvement for a give site or location. Improvements for the Boulder Creek outfall sites were developed based on the use of proprietary BMPs (a.k.a. water quality manholes) since these types of facilities are best suited for highly urbanized areas as typically found near the collector system outfall top Boulder Creek. A cost/benefit analysis was performed for the improvement water quality improvements at each of the water quality area of concern and Boulder Creek outfall sites. This process identified 18 water quality improvement projects to address the address the water quality area of concern site and the Boulder Creek outfall sites that favorable cost/benefit ratios or that did not rely on future development for project implementation.

The recommended plan for addressing the conveyance and water quality problem areas is a compilation of all hydraulic and water quality improvements developed in this study. Figure ES-3 provides an overview of the recommended plan improvements with corresponding improvement projects IDs. In some instances, the recommended water quality improvements were in close proximity to a hydraulic improvement location and were combined into a single project. Other recommended improvements consist of improvements that separately address water quality or conveyance problems.

Capital Improvement Plan

The goal for this master plan is to manage stormwater, by minimizing impacts on localized and downstream flooding and improving water quality. To these ends, the recommended system improvements were categorized as 1) Hydraulic and Combined Hydraulic/Water Quality projects or 2) Water Quality Improvement projects. These two project categories form the collector system Capital Improvement Plan (CIP).

The implementation plan for the Hydraulic and Combined Hydraulic/Water Quality CIP projects follows the Tier 1, 2 and 3 problem areas. Tier 1 CIP projects are considered high priority improvements as they resolve severe conveyance system problems and in some instances address stormwater quality problems. Tier 1 projects areas are anticipated to a) have a high social benefit by resolving street and property flooding issues, b) have a high economic benefit by reducing flooding risk and property damage, and c) provide an environmental benefit by addressing stormwater quality issues at identified problem locations. Note that not all Tier 1 locations included a water quality problem site and that the overriding criterion for prioritization was resolving flooding issues. Table ES-1 identifies the Tier 1 CIP projects; Tier 2 and 3 projects are identified in Sections 5 and 6 of the main report.

Table ES-1: Tier 1 Hydraulic and Combined Hydraulic/Water Quality CIP Projects

Ranking	Improvement ID	Location	Improvement Type	Capital Cost
1	GC_02	Upper Goose Creek	Pipe Replacement New Storm Drain Channel Improvement	$10,701,000
2	MBC_10	18th and Spruce Street	Pipe Replacement Storm Drain Re-Routing/Extension	$1,577,000
3	MBC_14	Arapahoe and 28th Street	Pipe Replacement Storm Drain Re-Routing/Extension Proprietary BMP	$1,659,000
4	DC_01	Gunbarrel – Spine Road, Lookout and 63rd Systems	Pipe Replacement Storm Drain Re-Routing/Extension Constructed Wetland	$5,694,000

The implementation plan for the Water Quality Improvement (WQIMP) projects were prioritized based on problem severity as identified by pollutant load. The WQIMP category was developed since many of the water quality project sites were not adjacent to hydraulic problem and improvement locations. In addition, many of these WQIMP projects could be defined as a small capital projects since the estimated construction costs are less than $100,000.

Table ES-2: Water Quality Improvement CIP Projects

Improvement ID	Annual TSS Load (pounds)	Location	Capital Cost
WQIMP 2	61,900	Boulder Creek 1,400' East of 75th Street	$104,000
WQIMP 3	56,500	Boulder Creek & 28th Street	$81,000
WQIMP 5	46,200	Boulder Creek & 75th Street	$76,000
WQIMP 6 & WQIMP 9	45,700 & 38,400	Boulder Creek & East Broadway Street & Arapahoe Avenue	$157,000
WQIMP 8	41,500	Boulder Creek 200' West of Folsom Street	$84,000
WQIMP 12	29,000	Boulder Creek & Folsom Street	$78,000
WQIMP 14	24,200	Boulder Creek & 9th Street	$73,000
WQIMP 15	22,800	Broadway & Skunk Creek	$73,000
WQIMP 16	20,300	Boulder Creek & 13th Street	$81,000
WQIMP 18	15,000	Boulder Creek & 11th Street	$51,000

Estimates of capital construction costs included in this plan are considered planning level estimates to be used in developing stormwater capital budget requirements.

Attachment G

	A	B	C	F	G	H	I	J	K	L	M
1				CITY OF BOULDER				28-Feb-14			
2				2015-2020 CAPITAL IMPROVEMENT PROGRAM				*- Draft -*			
3				STORMWATER AND FLOOD MANAGEMENT UTILITY FUND							
4											
5											
6	**Assumed Inflation Rate**	**4.00%**	**ESTIMATED**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
7	**PROJECT NAME**		**2013 COST**	**REVISED**	**PROJECTED**	**PROJECTED**	**PROJECTED**	**PROJECTED**	**PROJECTED**	**PROJECTED**	**PROJECTED**
8											
9	**Major Drainageways**										
10	Elmer's Twomile Creek	431332		$0	$0	$0	$0	$0	$0	$0	$0
11	Goose Creek	431710		$0	$0	$0	$0	$0	$0	$0	$0
12	South Boulder Creek	431202		$74,967	$230,518	$250,000	$750,000	$0	$0	$0	$0
13	South Boulder Creek - Bond Proceeds			$0	$0	$0	$0	$4,500,000	$0	$0	$30,000,000
14	Bond Issuance Costs			$0	$0	$0	$0	$75,000	$0	$0	$0
15	Skunk Canyon Creek			$0	$0	$0	$0	$100,000	$500,000	$0	$0
16	Sunshine Creek			$0	$0	$0	$0	$0	$0	$0	$0
17	Twomile Canyon / Upper Goose Creeks			$0	$0	$0	$0	$100,000	$500,000	$0	$0
18	Bluebell Canyon Creek - King's Gulch			$0	$0	$0	$0	$100,000	$500,000	$0	$0
19	Viele Channel			$0	$0	$0	$0	$0	$0	$0	$0
20	Four Mile Canyon Creek		$3,500,000	$0	$0	$0	$0	$0	$0	$500,000	$2,500,000
21	Four Mile Canyon Creek - Upland to Violet	431729		$0	$0	$0	$500,000	$500,000	$500,000	$250,000	$0
22	Four Mile Canyon Creek - 19th to 22nd	431730		$85,882	$1,284,106	$0	$0	$0	$0	$0	$0
23	Bear Canyon Creek	431010		$0	$0	$100,000	$500,000	$0	$0	$0	$0
24	Gregory Canyon Creek	431702		$0	$0	$100,000	$500,000	$0	$0	$0	$0
25	Boulder Creek	431015		$0	$100,000	$500,000	$2,500,000	$2,500,000	$0	$0	$0
26	Boulder Slough	431016		$869,616	($369,616)	$0	$0	$0	$0	$0	$0
27	Wonderland Creek	431003	$7,500,000	$0	$0	$0	$0	$0	$0	$0	$0
28	Wonderland Creek - Foothills to 30th	431011		$598,793	$6,906,690	$0	$0	$0	$0	$0	$0
29	Wonderland Creek at 28th St.	431012		$265,216	$5,084,784	$0	$0	$0	$0	$0	$0
30	Preflood Acquisition	431622		$7,875	$3,151,011	$500,000	$500,000	$550,000	$600,000	$632,660	$657,966
31	Greenways Program Transfer	431630		$24,527	$613,860	$97,500	$97,500	$97,500	$97,500	$97,500	128,303
32	**Subtotal - Major Drainageway Improvements**			$1,926,875	$17,001,353	$1,547,500	$5,347,500	$8,522,500	$2,697,500	$1,480,160	$33,286,269
33											
34	**Miscellaneous**										
35	Yards Master Plan Implementation	431039		$0	$50,000	$0	$0	$0	$0	$0	$0
36	CU Bike/Ped Bridge Replacement I	431054		$0	$200,000	$0	$0	$0	$0	$0	$0
37	2013 Flood	431913		$443,458	$556,542	$0	$0	$0	$0	$0	$0
38	Utility Billing Computer System Replacemen	431453		$0	$9,707	$0	$0	$250,000	$0	$0	$0
39	**Subtotal - Miscellaneous Drainage Improvements**			$443,458	$816,249	$0	$0	$250,000	$0	$0	$0
40											
41	**Stormwater Management**										
42	Upper Goose Creek	431459	$10,700,000	$0	$0	$175,000	$750,000	$750,000	$750,000	$1,000,000	$1,165,547
43	Local Drainage Improvements		$1,000,000	$0	$0	$1,040,000	$1,081,600	$1,124,864	$1,169,859	$1,216,653	$1,265,319
44	Stormwater Quality Improvements	431775		$159,995	$94,005	$156,000	$162,240	$168,730	$175,479	$182,498	$189,798
45	Storm Sewer Rehabilitation	431760		$12,804	$388,266	$260,000	$270,400	$281,216	$292,465	$304,163	$632,660
46	Transportation Coordination	431780		$443,458	$260,203	$312,000	$324,480	$337,459	$350,958	$364,996	$632,660
47	**Subtotal - Localized Drainage Improvements**			$616,257	$742,474	$1,943,000	$2,588,720	$2,662,269	$2,738,760	$3,068,310	$3,885,983
48											
49	**TOTAL CAPITAL USES OF FUNDS**			$2,986,590	$18,560,076	$3,490,500	$7,936,220	$11,434,769	$5,436,260	$4,548,469	$37,172,252

Floodplain Mapping, Mitigation Planning and Capital Improvements (not including property acquisitions)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fourmile Canyon and Wonderland																					
Mapping Study	Mapping Study						FEMA Approval														
Mitigation Planning	Mitigation Study																				
Capital Improvements																					
Wonderland Valmont Rd to Goose	Construction		LOMR																		
Wonderland Underpass at 30th St				Design		Construction			LOMR												
Wonderland Foothills to 30th											CEAP	Design				Construction		LOMR			
Wonderland 30th to Winding Trail													CEAP	Design		Construction		LOMR			
Fourmile 22nd St to Upland Ave													CEAP	Design on hold due to remapping							
Fourmile Upland to Broadway															CEAP	Design on hold due to remapping					
South Boulder Creek																					
Mapping Study			Mapping Study						FEMA Approval												
Mitigation Planning										Mitigation Study											
Capital Improvements															CEAP	Grant App/Design					
Upper Goose and Twomile																					
Mapping Study												Mapping Study									
Mitigation Planning																					
Skunk, King's Gulch, Bluebell																					
Mapping Study											Mapping Study										
Mitigation Planning																					
Capital Improvements																					
Broadway to Moorhead		CEAP	Design/Construction						remap												
Gregory																					
Mapping Study					Mapping Study						FEMA										
Mitigation Planning																					
Mini-mitigation Plans										BCW			WH Pacific								
Capital Improvements																					
Boulder Creek																					
Mapping Study								Mapping Study						FEMA Approval							
Mitigation Planning																					
Capital Improvements																					
Broadway Bridge		Design/Construction			remap																
Boulder Slough																					
Mapping Study (Broadway to 30th St)								Mapping Study													
Mapping study (30th St to Foothills)								Mapping Study													
Capital Improvements																					
30th to Foothills												Design/Construciton									
Bear Canyon Creek																					
Mapping Study (lower Bear and Harrison Ave. Levee)									Mapping Study												
Mitigation Planning																					
Capital Improvements																					
Arapahoe to Foothills & Harrison Ave. levee			CEAP	Design/Construction				remap													
Lower Goose Creek																					
Mapping Study																					
Mitigation Planning																					
Capital Improvements																					
30th Street to Folsom	Design/Construction				LOMR																
Elmer's Twomile																					
Capital Improvements																					
Juniper to Goose Creek			Design/Construction									LOMR									

Attachment G
100-Year Event Flood Mitigation Costs

Historic 100-year Flood Mitigation Costs			
Channel Improvements	**Actual Total Cost (2013 dollars)**	**Lineal Feet**	**Design Flow Rate (cfs)**
Elmers Two Mile Creek	**$ 8,260,243**	2500	900
Goose Creek	**$ 22,401,809**	3500	3000
Underpasses	**Actual Total Cost (2013 dollars)**	**Roadway Lanes**	**Design Flow Rate (cfs)**
Wonderland-Diagonal Underpass	**$ 2,537,987**	6	2200
Broadway/Skunk Creek Grade Seperation	**$ 1,503,495**	6	1350

Ballpark Estimated 100-year Flood Mitigation Costs			
Channel Improvements	**Total Estimated Cost**	**Lineal Feet**	**Design Flow Rate (cfs)**
Fourmile Canyon Creek			
Violet to 28th St.	$35-45 million	6,000	3,600
Twomile Canyon Creek			
Linden to Broadway	$15-20 million	4,000	1,000
Sunshine Canyon Creek			
Mapleton to Canyon	$5-10 million	2,000	1,000
Gregory Canyon Creek			
Flagstaff to Boulder Creek	$30-35 million	6,000	1,800
Bluebell Canyon Creek			
12th St. to Sunnyside Lane	$10-15 million	3,500	700
Upper Goose Creek			
Broadway to Folsom	$40-50 million	7,500	1,600
Wonderland Creek			
19th St. to 26th St.	$15-25 million	5,000	1,000
South Boulder Creek			
West Valley Overflow Mitigation	$35-40 million		
Boulder Creek			
Foothills Parkway to Eben Fine Park	$100-200 million	11,000	12,000
Total	$300-400 million		