City of Boulder

COMPREHENSIVE FLOOD AND STORMWATER UTILITY MASTER PLAN

October 2004

City of Boulder

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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.

CHAPTER 1 – THE COMPREHENSIVE FLOOD AND STORMWATER UTILITY MASTER PLAN

1.1 OVERVIEW

The Comprehensive Flood and Stormwater Utility Master Plan (CFS) is intended to provide 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 recognize changing trends, philosophies, regulations and standards; ensure maximum effectiveness and cost efficiency; and meet evolving community goals and objectives.

Key issues identified in this plan relate to flood hazards; stormwater quality; stormwater drainage; program integration and implementation; and financial considerations as follows:

Flood Management

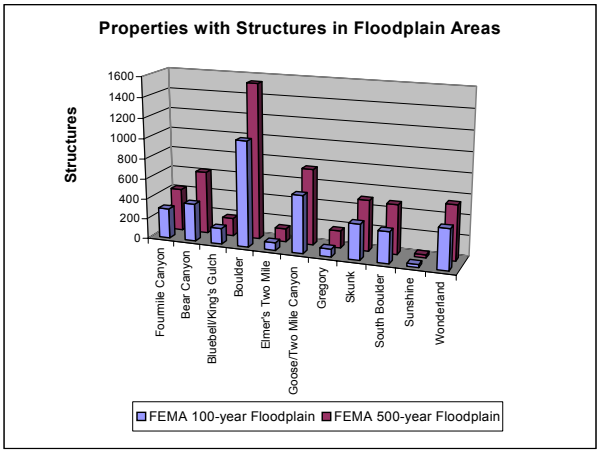
The City of Boulder is extremely vulnerable to flash flooding due to its geographical location at the base of the Rocky Mountains. Flash flooding can occur with less than 30 minutes of warning. Recent flash floods along Colorado's Front Range include a 1997 flood in the City of Fort Collins that caused $200 million in damage and claimed five lives. The flood was caused by a storm that dumped 14.5 inches of rain. Storms of this magnitude aren't uncommon along the Front Range; yet 100-year flooding in Boulder can occur with only 3 inches of rainfall.

In 1976, the Big Thompson River flood destroyed over 300 houses and killed 300 people when 12-14 inches of rain fell in the canyon along Highway 34. The canyon is very similar to the canyons just west of Boulder. 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.

At its inception, the City of Boulder centered its development along Boulder Creek. Today, with little vacant land and City policies promoting compact development, these same flood prone areas are under pressure to redevelop. Although current flood regulations require protection for flood levels up to 100-year event, there is concern that larger floods such as those experienced in Fort Collins and along the Big Thompson River will cause considerable damage and loss of life.

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.



Flood management program elements designed to mitigate these hazards are presented in Chapter 3.

Stormwater Quality

In 2001, in response to Federal Clean Water Act requirements, the Colorado Department of Public Health and 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. The intent of this stormwater permit program is to reduce the amount of pollutants entering streams, lakes, and rivers as a result of runoff from residential, commercial, municipal, and industrial areas, including construction sites. Stormwater permit compliance is based on implementation of stormwater management intended to reduce pollutant loading from urbanized areas.

Water quality in Boulder Creek and its tributaries is a significant concern. The Colorado Department of Public Health and the Environment is considering listing Boulder Creek as an impaired water body for E. coli bacteria contamination. Elevated levels of E. coli have been found in Boulder Creek, just above the City to below its eastern boundary and again in the segment below the confluence with Coal Creek. E. coli are bacteria found in the intestine of warm blooded animals and are associated with fecal waste. The source of the E. coli contamination in Boulder Creek is unknown. Suspected sources include wildlife (raccoons), domestic pets (dogs), and human waste products.

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.

Stormwater quality program elements designed to address these issues are presented in Chapter 4.

Stormwater Drainage

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 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.

Groundwater and sump systems create nuisance drainage in the public rights-of-way and potential hazards due to build-ups 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.

Stormwater drainage program elements designed to address these issues are presented in Chapter 5.

Program Integration and Implementation

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.

A significant opportunity for integration with other City objectives is the 2005 major update to the *Boulder Valley Comprehensive Plan*(2000). 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. Other program integration and implementation issues are presented in Chapter 6.

Financial Considerations

The Stormwater and Flood Management Utility is funded primarily through service charge fees. In general, existing programs are adequately funded. However, several increases to existing program funding are presented in Chapter 7.

To support these increases in funding, money will need to be reallocated from the existing budget or a rate increase will be required. These alternatives will be considered as part of the City's on-going budget process.

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.

1.1.1 Enterprise Utility

The Stormwater and Flood Management Utility is one of three enterprise utilities operated by the City of Boulder (City). Other City operated utilities include the Water Utility and the Wastewater Utility.

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 Utility is an enterprise funded primarily by monthly utility fees. Additional sources of revenue are provided by utility plant investment fees (PIFs) from new development, proceeds from bonds and grants, interest on investments, intergovernmental expenditures, and annual cost-shared allocations from the Urban Drainage and Flood Control District (UDFCD).

Annual base revenues for the Utility are about $4,200,000 given a base monthly fee for single-family properties of $6.20. Monthly fees for larger and multi-family residential and non-residential properties are determined as a ratio of the base rate and the percentage of impervious surface that exists on a property.

The Utility supports a staffing level of 21.3 full time employees (FTEs) distributed among 68 staff members. Annual personnel expenditures of about $1,400,000 (33 percent of the base budget) support activities in administration and billing, maintenance, engineering operations, stormwater quality and planning and development services.

1.2 BACKGROUND

1.2.1 Utility History

The Stormwater and Flood Management Utility began operation following its creation under Ordinance 3927on August 21, 1973. The Utility was created in recognition of Boulder's high susceptibility to damage from flash

flooding due to its geographical location at the base of the Rocky Mountains. It is also suspected that the City of Boulder has the greatest potential for loss of life from a flash flood of any community in Colorado.

City Council found that the City's existing storm drainage and flood control facilities were inadequate to handle a storm having a frequency greater than two years. As a result, Council determined that there was an urgent need to construct additional and improve existing storm drainage facilities to protect the health, safety, welfare, and property of City inhabitants.

A utility fee was imposed on all properties and the owners thereof in order to fund the construction of improvements, acquire needed property to provide for such facilities, and carry out the operation and maintenance of existing and additional facilities. The fee was based on the storm runoff each parcel contributes to the drainage system, with an initial basis of $1.00 per month for a standard single-family dwelling parcel.

The approach to charge a fee to all properties was considered equitable and reasonable for the intended Utility purpose since each property owner in the City makes use of the facilities by contributing increased runoff from the development of their land. This approach remains in effect today.

The Utility was created as an enterprise so that fees would only be applied to the intended purpose of funding stormwater and flood control facilities, and could not be used for general governmental purposes of the City.

A core element of the Utility's original mission was to implement the provisions of the storm drainage and flood control regulations. These regulations were intended to:

- Minimize flood losses and the inconvenience of damage resulting from uncontrolled runoff.
- Permit the movement of emergency vehicles during flooding.
- Establish a Master Plan for storm drainage and flood control facilities.
- Encourage and facilitate urban water resources management techniques, including:
    - Detention of storm runoff,
    - Minimization of the need to construct storm sewers,
    - Reduction of pollution, and
    - Enhancement of the environment.

When the Utility was first created, flood mitigation plans for the major tributaries to Boulder Creek was completed, however no plan was in place for Boulder Creek.

The Boulder Creek Subcommittee on the Corps of Engineers Committee on Environmental Planning (CECEP) proposed a non-structural improvements policy for Boulder Creek on October 8, 1973. The plan was subsequently adopted by City Council on August 20, 1974.

Boulder joined the National Flood Insurance Program (NFIP) in 1978, making flood insurance available to property owners and residents. As part of joining the NFIP, the first

official Flood Insurance Rate Map (FIRM) became effective on July 17, 1978.

The first *Storm Water Collection System Master Plan* (1984) was developed to identify the system of inlets and storm sewers needed to convey stormwater to the major drainageways. Following the development of detailed floodplain mapping for the tributaries to Boulder Creek in 1983, a revised plan for the major tributaries was adopted in 1986. This plan remains effective today.

The *Comprehensive Drainage Utility Master Plan* (CDUMP) (1989) was developed as part of an identified need to update Utility programs and activities. The CDUMP outlined problems and needs of the Utility grouped into five categories: capital improvements; hazard mitigation; stormwater quality; administration, operations, and maintenance; and, rates and finance. The most serious issues facing the Utility were:

- An inadequate source of revenues for capital improvements.
- The lack of a complete, fully integrated flood hazard mitigation program.
- The lack of a stormwater quality program to assess and mitigate stormwater impacts to Boulder Creek and its tributaries.

The CDUMP resulted in the adoption of a prioritized Capital Improvements Plan (CIP). The CIP defined the scope and timing for necessary stormwater and flood management facilities, a flood hazard mitigation plan designed for the acquisition and removal of high hazard structures in the floodplain, increased funding for capital improvements, administration, operations, and maintenance activities, and a Stormwater Quality program that for the first time introduced water quality activities into the Utility.

A master plan for the City's greenways was developed concurrently with CDUMP. The plan established the framework for the Greenways Program that is currently administered within and partially funded by the Utility.

The City of Boulder Greenways system is comprised of a series of corridors along riparian areas including Boulder Creek and six of its tributaries (Bear Canyon Creek, Fourmile Canyon Creek, Goose Creek, Skunk Creek, South Boulder Creek, and Wonderland Creek), which provides an opportunity to integrate multiple-use objectives. The Greenways Program seeks to coordinate and integrate as appropriate the following management objectives:

- Riparian, Floodplain, and Wetland Protection and Restoration.
- Water Quality Enhancement.
- Stormwater Drainage.
- Alternative Transportation Routes for Pedestrians and Bicycles.
- Recreation.
- Protection of Cultural Resources.

The Stormwater Quality Program was created as part of the CDUMP. Local recognition of the importance of clean water quality along Boulder Creek and other stream corridors followed the development of linear parks, now referred to as Greenways, and increased public awareness about the value of protecting

water quality and the riparian habitat along our drainage systems.

The Stormwater Quality Program also served to provide a proactive framework for addressing the future requirements of the Federal Water Quality Act of 1987. This Act re-authorized the 1972 Clean Water Act (CWA) in which the Environmental Protection Agency (EPA) introduced sweeping revisions to approach stormwater quality.

In 1990, the EPA published final Phase 1 rules for stormwater discharges, and required communities with a population of 100,000 or more to obtain a National Pollution Discharge Elimination System (NPDES) permit. Boulder's population at that time did not require an NPDES permit for the City. However, the community chose to adopt a stormwater quality program in advance of Federal requirements given the environmental benefits afforded by such a program.

The CDUMP has remained in effect since 1989. Now, in 2004, the CFS Utility Master Plan was developed as the foundation to move into the next generation of stormwater and flood management.

1.2.2 Area Description

The City of Boulder is located in Boulder County, Colorado in portions of Township and Ranges 1S71W, 1S70W, 1S69W, 1N71W, 1N70W, 1N69W, 2N71W, 2N70W, and 2N69W. The City is situated along the eastern edge of Colorado's Rocky Mountains Flatirons Range, and located about 20 miles northwest of the Denver metro area. The study area for the CFS includes all the watersheds that may impact the City.

The topography within the study area is quite variable and the City's topographic and physiographic features are unique and challenging in terms of stormwater and flood management. The primary drainageway through the City is Boulder Creek with its headwaters at the Continental Divide near Arapahoe Pass and Diamond and Jasper Lakes.

Within the study area, the elevations range from over 5,600 feet on the western edge of the City to elevations near 5,200 feet at the northeast edge of the study area. The study area itself is nearly "built out," resulting in a highly urbanized drainage setting.

There are 15 major drainageways (or creeks) in Boulder. They include:

- Boulder Creek
- Bear Canyon Creek
- Bluebell Creek
- Dry Creek No. 2
- Elmer's Twomile Creek
- Fourmile Canyon Creek

- Goose Creek
- Gregory Canyon Creek
- King's Gulch
- Skunk Creek
- South Boulder Creek
- Sunshine Canyon Creek
- Twomile Canyon Creek
- Viele Channel
- Wonderland Creek

Within these 15 major drainageways, a total of 17 sub-basins have been delineated. The City's basins are shown on Figure 1-1.

The City is generally split by the west to east flow direction of the main stem of Boulder Creek. The Boulder Creek Watershed encompasses some 440 square miles and extends from the Continental Divide to the high plains east of the City.

The tributary drainageways all eventually feed to Boulder Creek north of the Valmont Reservoir. Each of the watersheds for the respective drainages is highly urbanized as a result of the "built out" condition throughout the study area. As such, 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.

1.2.3 Growth and Development

The City continues to grow through a combination of new development and redevelopment activity. Within the floodplain, these activities pose additional potential for hazards based on flash floods. Therefore it is important to manage these activities as discussed in Chapter 3.

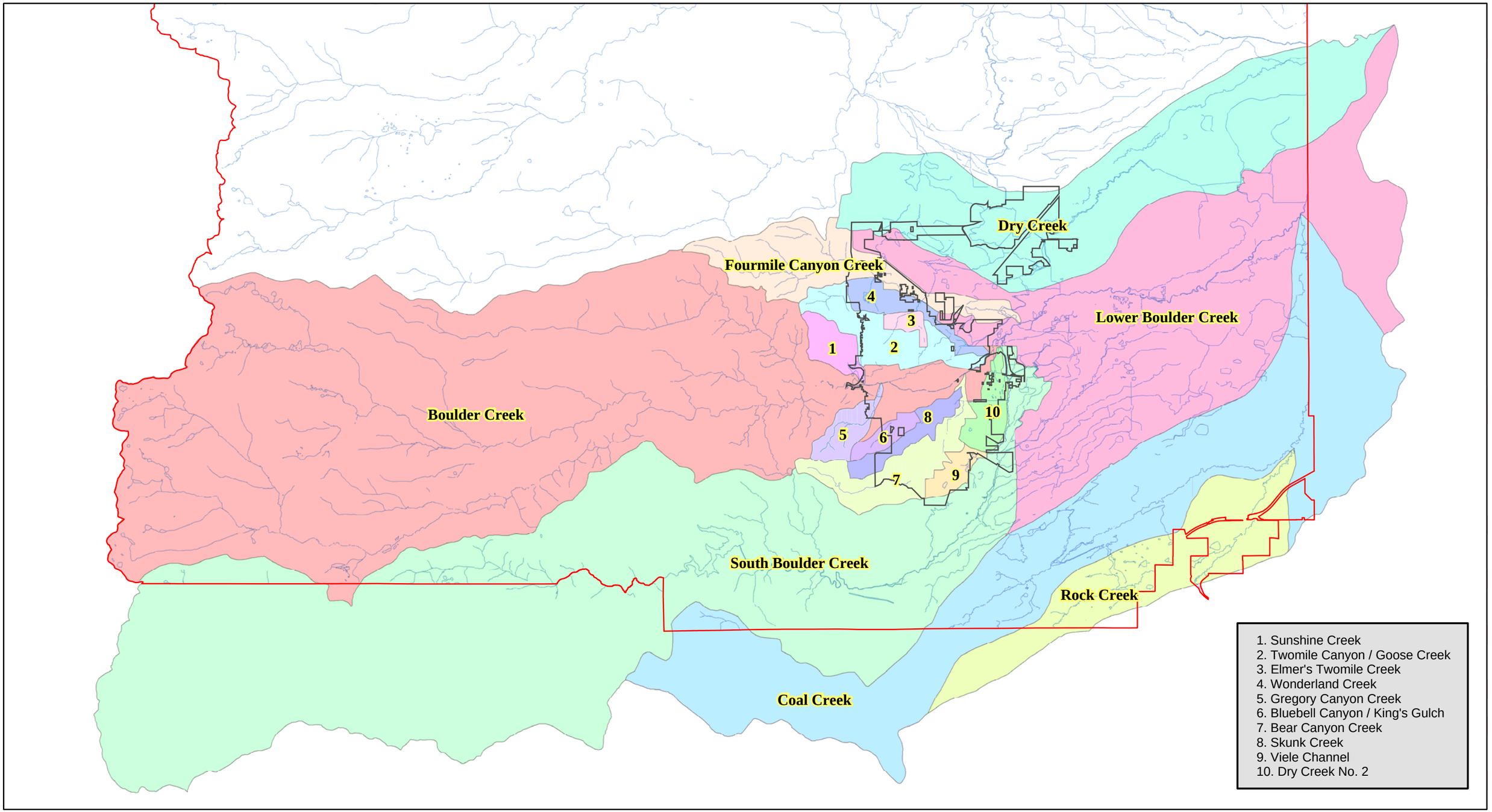
Recent projections indicate that almost 5 percent of the parcels of land designated with redevelopment potential have greater than 50 percent of their land area within the high hazard or conveyance flood zones. Current City regulations would significantly restrict redevelopment of these parcels. Almost 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.

Development activities must also be managed to prevent adverse affects on stormwater quality and drainage as discussed in Chapters 4 and 5.

1.2.4 Current Program Descriptions

Flood Management

Current flood management program elements including floodplain mapping, risk assessments, regulations, flood information and insurance, emergency preparedness,



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Basins

- Streams
- Boulder County
- City of Boulder
- Bear Canyon Creek
- Bluebell Canyon / King's Gulch
- Boulder Creek
- Coal Creek
- Dry Creek
- Dry Creek No. 2
- Elmer's Twomile Creek
- Fourmile Canyon Creek
- Gregory Canyon Creek
- Lower Boulder Creek
- Rock Creek
- Skunk Creek
- South Boulder Creek
- Sunshine Canyon Creek
- Twomile Canyon / Goose Creek
- Viele Channel
- Wonderland Creek

City Of Boulder

Basins

Figure 1-1

property acquisition, and flood mitigation capital improvements.

Current floodplain mapping activities include updating several floodplain studies for Bear Canyon Creek, Boulder Creek, Fourmile Canyon Creek, Gregory Creek, South Boulder Creek, and Wonderland Creek. The Bear Canyon Creek floodplain mapping study was completed and adopted in 2003. The remaining studies are ongoing.

Updated major drainageway planning efforts have been initiated on Fourmile Canyon Creek and Wonderland Creek. South Boulder Creek mitigation planning will follow the current flood mapping study in 2005. Increased public involvement and oversight by an Independent Review Panel have been key elements in current master planning activities.

In addition to annual floodplain notifications, the Utility has improved public access to floodplain information with an interactive floodplain map on the City's Web site. The Utility continues to implement the NFIP Community Rating System (CRS) and has taken recent steps to evaluate activities that may increase Boulder's CRS rating to reduce local flood insurance premiums.

The Utility continues to work with the Boulder County Emergency Preparedness Office to monitor storm events and predict possible flooding. Recent efforts have been initiated to enhance the Boulder Creek flood warning system with an automated flood prediction model.

Local floodplain regulations continue to be enforced by Public Works Planning and Development Services (P&DS) as part of the development review and building permit processes. These activities also provide public access to floodplain information and direct inquiries by the public.

The Utilities Engineering staff maintains current efforts to acquire high hazard flood properties and implement capital improvements for floodplain mitigation, such as the Goose Creek drainageway construction between Folsom Avenue and 28th Street. This staff also manages ongoing floodplain studies.

Stormwater Quality

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

Stormwater is made up of rain and snowmelt, which flows over surfaces such as streets, roadways, commercial and industrial sites, and parking lots. The runoff water is collected into the City's storm drainage systems and goes directly to streams without treatment. In route to streams, stormwater picks up pollutants such as sediment, oil and grease, and nutrients.

These pollutants are delivered to our streams and are a major source of water pollution. Data collected on Boulder Creek over a 10 year period show a downstream pattern of declining water quality. Boulder Creek is generally a high quality stream upstream of the City. As the creek flows through the urbanized areas, water quality and aquatic species composition degrades. Polluted runoff, spills, excess sediment, and loss of riparian habitat all contribute to this degradation.

The City of Boulder was issued a State Stormwater Discharge permit in March 2003. Permit conditions include implementation of the Watershed Approach to Stream Health (WASH) plan. This plan was developed in

cooperation with cities of Longmont and Louisville, the Towns of Superior and Erie, and Boulder County.

In the WASH plan, a number of activities are shared, such as the development of model ordinances, and implementation of public education programs. However, there are some compliance activities which are the sole responsibility of individual communities, such as enforcement and inspection.

In addition, the City currently implements a number of programs which address water quality. These include participating in the regional Household Hazardous Waste program, instituting wetlands protection regulations, implementing an in-stream flow program, the Spill Response Program and preserving waterways through the Greenways Program.

Stormwater Drainage

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

The City's stormwater drainage system evolved over a period of many years as part of on-gong private development, construction of roadways and in response to citizen requests. Most of this work was not well documented until the advent of the City's Stormwater and Flood Management Utility.

Irrigation ditches also have an important influence on stormwater collection and drainage within the City. These ditches were built many years ago and were constructed in such a way as to intercept historical drainage.

The *Storm Water Collection System Master Plan* (1984) was the first effort by the City to comprehensively document and evaluate the City's stormwater collection system. This plan was developed to guide the City's on-going Capital Improvement Program.

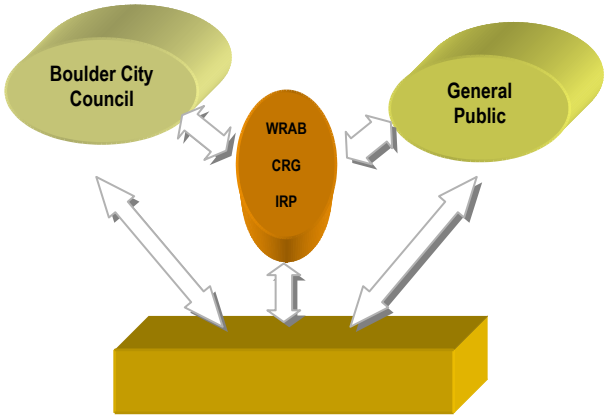
1.3 PUBLIC PROCESS

1.3.1 Master Plan Process

The City of Boulder Utilities staff elected to use a community review group format to provide real-time input to their analysis and draft recommendation for the CFS. This process best served the public input needs of staff during the CFS development phase because of:

- The Complexity of the Information and Data - Having a select group of reviewers with some familiarity or expertise in the subject matter provide a sophisticated public level of scrutiny during the project.
- The need for Initial Filter - Proposed alternatives underwent a high level of scrutiny before they were considered for inclusion in the master plan. This assured that staff was not performing more extensive and costly analysis of alternatives that probably would not stand up to broader public scrutiny.
- Cross-Discipline Analysis – A Community Review Group (CRG) was formed and consisted of a wide array of experts and stakeholders who shared in all presentations and discussions. This process brought a number of points of view to the table, allowing staff to learn more about the impacts for any given

group. This process also provided the CRG participants an opportunity to learn more about one another's point of view.



The Community Review Group

After a thorough analysis of the key interests affected by the CFS, staff prepared an extensive list of individuals and organizations it hoped to involve on the CRG. The ultimate list of CRG participants reflected the following interests:

- Representatives from City boards and commissions who use or address CFS related issues;
- Neighborhood residents affected by flooding;
- Developers and engineers;
- Affordable housing interests;
- Realtor representatives;
- Managers for large government/business facilities;
- Local planning and environmental organization representatives;
- Ad hoc City Advisory Board and Council representatives.

CRG participants were engaged in a dialogue concerning CFS information and draft recommendations using the following means:

- Hard-Copy Packets - Included maps and key issue documents;
- Monthly Meetings - Discussion of key CFS issues and options;
- E-Mail Information Exchange – Lively on-line conversation among citizen review panel participants.

The CRG was tasked with responsibility for raising issues or challenges to the information and draft recommendations that staff presented, given the experience or bias of the individual group members. To this end, monthly CRG meetings typically began with a presentation by City staff and their consultants. During and after the presentation, the CRG asked questions, offered suggestions, and/or expressed concerns which became a part of the meeting record for subsequent staff consideration. At no time was the CRG responsible for offering a group recommendation beyond the individual opinions that its members expressed.

The Independent Review Panel

In December of 1999, the City of Boulder engaged a panel of flood hazard experts, the Independent Review Panel (IRP), to scrutinize the staff-identified errors in the FEMA regulatory floodplain maps for Fourmile

Canyon Creek. The assembled flood hazard experts included the following individuals:

- Brian Hyde, Project Manager, Colorado Water Conservation Board;
- Rich Madole, USGS and Alluvial Geologist;
- Bill Bradley, Professor Emeritus, Geology Department University of Colorado;
- Mary Fran Myers, Executive Director, Natural Hazards Center, University of Colorado;
- Gilbert White, Professor Emeritus, Social Sciences, University of Colorado; and
- Ken Wright, Wright Water Engineers.

In 2001, the IRP issued a recommended approach to floodplain management for the Fourmile Canyon Creek floodplain. In submitting their recommendations, the IRP members stated that their recommendation provided a sound policy basis for the management of all of Boulder's floodplains. It was with this understanding that City Council asked the IRP to participate in the CFS development process.

For purposes of the CFS update, the core members of the IRP added L. Scott Tucker, President of the Urban Drainage and Flood Control District, to their panel.

The IRP met monthly with staff and consultants, from May through November of 2003. During this time, the IRP members reviewed CFS information and draft recommendations. IRP comments and concerns are reflected throughout the CFS document.

Water Resource Advisory Board

The Water Resource Advisory Board (WRAB) met on September 15, 2003, November 17, 2003, March 15, 2004 and April 19, 2004 to discuss key issues and the master plan process. WRAB members asked questions, offered suggestions, and/or expressed concerns which became a part of the meeting record for subsequent staff consideration. WRAB approved the CFS on May 17, 2004 with the following recommendations:

- The path the City has chosen is a slower, more affordable path and there is a faster path that is a lot more expensive.
- There needs to be better coordination between departments on flood issues.

1.3.2 Development of Review Information

The following process and documentation was used to develop the review information for the CRG and IRP Groups.

Preparation of Technical Memoranda and Key Issues for Review

The initial phase of the CFS process included the preparation of Technical Memoranda related to Flood Management, Stormwater Quality, and Stormwater Drainage. The Technical Memoranda included:

- Combined staff and consultant research.
- Strategic interests from work not completed in earlier CDUMP.
- A list of key issues for review.

- Internal guidance for work programming vs. new policy for external audiences.

Review Process: Participant Feedback

Both the CRG and IRP were asked to read and go through a large amount of information for this process. This draft is a testament to the effort of over 25 people who read and considered information that was both new to them and, in some cases, challenged assumptions they held.

In feedback gathered during the review process and in comment forms submitted at the end, we learned:

- Participants were impressed by how much work had been accomplished under CDUMP and noted some of the unique programs implemented;
- Packet information drew both criticism and praise. Some participants reported that packet information was written at a technical level, and it did not always correlate with presentation information;
- The schedule of the review worked very well for some, and left others feeling disconnected during the month between each meeting;
- Many individuals used e-mail to communicate between meetings, ask questions about information they read in the packet and to float opinions which they hoped would be included in the information, but did not want to take up meeting time discussing;
- There was expressed concern for "staff agenda" and assurance that the review input would be used in producing a recommendation;
- Finally, participants were concerned for the information that was not on the table, specifically, money/costs. Participants hoped that staff would assemble information to describe the "who pays" information as the draft was assembled.

IRP members specifically noted that they wished they could have had more time and additional staff resources to develop a professional-level of review input. Both participant groups offered to read and critique assembled recommendations and refined analysis of the CFS master plan documents.

CHAPTER 2 – POLICIES, TRENDS, AND GUIDING PRINCIPLES

2.1 EXISTING CITY POLICIES

City policies concerning stormwater and flood management are summarized below. The Stormwater and Flood Management Utility has been actively working to incorporate these policies in the flood management, stormwater quality and stormwater drainage work programs. One of the purposes of this master plan is to assess if additional measures should be considered in order to conform more closely to these policies. Recommendations are discussed in Chapters 3, 4 and 5.

The following policy statements are provisions of the Boulder Revised Code (BRC) specific to the Stormwater and Flood Management Utility:

1. Promote public health, safety, and welfare by permitting the movement of emergency vehicles during flooding periods and minimizing flood losses and the inconvenience and damage resulting from uncontrolled and unplanned stormwater runoff in the City;

2. Establish a master plan for stormwater and flood management and its implementation, including without limitation, a coordinated program of creating upstream ponding or temporary detention of stormwaters;

3. Establish a stormwater and flood management Utility to coordinate, design, construct, manage, operate, and maintain the stormwater and flood management system;

4. Establish reasonable stormwater and flood management fees based on the use of stormwater and flood drainage facilities; and

5. Encourage and facilitate urban water resources management techniques, including, without limitation, detention of stormwater and floods, reduction of the need to construct storm sewers, reduction of pollution, and enhancement of the environment.

Additional policy statements applicable to the Stormwater and Flood Management Utility are from the *Boulder Valley Comprehensive Plan*(BVCP) (2000):

POLICY 1.06 Leadership in Sustainability. The City will apply the principles of sustainability to its actions and decisions. The City will act as a community leader and steward of our resources, serving as a role model for others and striving to create a sustainable community that lives conscientiously as part of the planet and ecosystems we inhabit and that are influenced by our actions. Through its master plans, regulations, policies and programs, the City will strive to create a healthy, vibrant and sustainable community for future generations.

POLICY 2.26 Urban Open Lands. Open lands within the fabric of the City provide recreational opportunities and density relief from the confines of the City as well as protection of the environmental quality of the urban environment. The City will promote and maintain an urban open lands system to serve the following functions: active and passive recreation, environmental protection, bike-pedestrian connections and enhancement of community character.

POLICY 2.27 Boulder Creek and its Tributaries as Important Urban Design Features. Boulder Creek and its tributaries shall serve as unifying urban design features for the community. Within available appropriations, the City and County shall support the preservation or reclamation of the creek corridors for natural ecosystems, wildlife habitat and cultural resources; for recreation or trails; to provide flood management; to improve air and water quality; and to provide a contrast to urban development. Trail development shall be sensitive to the ecology, terrain and privacy of adjacent residents and surroundings.

POLICY 3.10 Utility Provision to Implement Community Goals. The City shall consider the importance of the other objectives of the Comprehensive Plan in the planning and operation of the water, wastewater and flood control/drainage utilities. These other objectives include in-stream flow maintenance, enhancement of recreational opportunities, water quality management, preservation of natural ecosystems, open space and irrigated agricultural land, and implementation of desired timing and location of growth patterns.

POLICY 4.01 Incorporating Ecological Systems Into Planning. Planning and policy decisions in the Boulder Valley shall be approached through an ecosystem framework in which natural regions like airsheds and watersheds are incorporated into planning, and an appropriate relationship between the built environment and air, water and land quality is considered.

POLICY 4.08 Maintain and Restore Ecological Processes. Recognizing that ecological change is an integral part of the functioning of natural systems, the City and County shall work to ensure that, when appropriate precautions have been taken for human safety and welfare, natural processes will be utilized or mimicked to sustain, protect and enhance ecosystems.

POLICY 4.09 Wetland Protection. Natural and human-made wetlands are valuable for their ecological and, where appropriate, recreational functions, including their ability to enhance water and air quality. Wetlands also function as important wildlife habitat, especially for rare, threatened, and endangered plants and wildlife. The City and County will continue to develop programs to protect and enhance wetlands in the Boulder Valley. The City shall discourage the destruction of wetlands, but in the rare cases when development is permitted and the filling of wetlands cannot be avoided, they shall be restored or replaced within a particular site.

POLICY 4.19 Protection of Water Quality. Water quality is a critical health, economic and aesthetic concern. The City and County shall protect, maintain and improve water quality within the Boulder Creek basin and Boulder Valley watersheds as a necessary component of existing ecosystems and as a critical resource for the human community. The City and County shall seek to establish comprehensive goals for water quality, to maintain full compliance with federal and state water quality standards, and to reduce point and non-point sources of pollutants. Special emphasis shall be placed on regional efforts such as watershed planning and protection. Efforts shall be made to take an integrated approach to the protection of groundwater, surface water, and stormwater and to plan for future needs.

POLICY 4.20 Water Resource Planning. The City and County shall work together and with other governmental agencies to develop and

implement appropriate water quality standards, water resource allocations, and water quality protection programs. Water resource planning efforts shall include such things as: water quality master planning, surface and ground water conservation, and evaluation of pollutant sources. The City shall integrate water quality into other planning processes such as air quality, transportation and land use planning. Land use patterns that reduce water pollution and promote water conservation shall be encouraged. Local development plans shall be reviewed for their impact on water quality.

POLICY 4.22 Stormwater. The City and County shall protect the quality of its surface water, meet all state and federal regulations for stormwater quality and evaluate additional voluntary standards as appropriate.

POLICY 4.23 Minimum Flow Program. The City shall pursue expansion of the existing in-stream flow program consistent with applicable law and shall manage stream flows to protect riparian and aquatic ecosystems within the Boulder Creek watershed.

POLICY 4.24 Groundwater. The City and County shall continue to evaluate aquifers, groundwater recharge and discharge areas, and sources of groundwater pollution within the Boulder Creek watersheds and shall formulate appropriate pollution and source protection programs. Impacts to groundwater shall be considered in land use planning, development review and public land management practices.

POLICY 4.25 Pollution Control. The City and County shall seek to control both point and non-point sources of water through pollution prevention, improved land use configurations, wetland detention areas, standards to control degradation of streams and lakes caused by storm runoff in urban and rural areas, and control and monitoring of direct sources of discharge, including those of gravel extraction and wastewater treatment facilities.

POLICY 4.27 Flood Management. The functional and aesthetic qualities of drainage courses and waterways shall be preserved and enhanced. A non-containment approach to flood management shall be used on Boulder Creek. A generally non-structural approach to flood control that emphasizes a natural appearance shall be used on all major water courses and drainageways. In some cases a structural solution may be used, consistent with adopted master plans.

POLICY 4.28 Drainage Utility Plans. The City shall prepare and maintain drainage utility plans that define maintenance needs, priorities for improvements, funding requirements, the character of necessary structural improvements, and water quality issues. Local development plans will be reviewed for their impacts on air quality, with special emphasis on stabilization of soils, appropriate monitoring of construction and mining operations, and minimizing exposure to both mobile and stationary sources of air pollution.

POLICY 4.29 Protection of High Hazard Areas. The City shall prevent redevelopment of significantly flood-damaged properties in high hazard areas. The City shall prepare a plan for property acquisition of flood-damaged and undeveloped land in flood high hazard areas. Undeveloped flood high hazard areas will be retained in their natural state whenever possible. Compatible uses of riparian corridors, such as natural ecosystems, wildlife habitat, and wetlands shall be encouraged wherever appropriate. Trails or other open

recreational facilities may be feasible in certain areas.

The BVCP also provides standards for urban services as follows:

Flood Control and Drainage

(1) Responsiveness to Public Objectives

(a) Have personnel on call 24 hours per day for flood control and drainage emergencies.

(2) Sufficiency of Financing

(a) Have revenue sources which are guaranteed so that revenues are available for flood control and drainage related projects, materials, equipment, facilities, and personnel.

(b) Be organized to request and receive Urban Drainage and Flood Control District, state and federal funds, if available, for projects, facilities, and equipment.

(3) Operational Effectiveness

(a) Use annual budget for personnel, equipment, projects, facilities, and materials.

(b) Meet standards as exemplified by the Urban Drainage and Flood Control District.

(c) Adopt regulations consistent with the Federal Emergency Management Agency.

(d) The following are standards for flood control and drainage criteria for new urban development within the Boulder Valley:

i. Runoff analysis shall be based upon proposed land use and shall take into consideration all contributing runoff from areas outside the study area.

ii. Storm runoff shall be determined by the Rational Method or the Colorado Urban Hydrograph Procedure.

iii. All local collection systems shall be designed to transport the following storm frequency:
Single Family Residential - two-year storm
All other area - five-year storm

iv. The major drainageway system shall be designed to transport the 100-year event or a modified standard in an approved plan.

v. Storm runoff quantity greater than the 'historical' amount shall not be discharged into irrigation ditches without the approval of the flood regulatory authority or the appropriate irrigation ditch company.

vi. The type of pipe to be installed shall be determined by the flood regulatory authority, and shall be based upon flows, site conditions, and maintenance requirements.

vii. All new urban development in the Boulder Service Area, which shall be annexed, shall be required to meet the intent of the adopted City of Boulder flood plain regulations.

viii. Erosion and sedimentation control shall be exercised.

ix. Detention storage requirements will be reviewed by the flood regulatory authority.

(4) Proficiency of Personnel

(a) All flood control maintenance crews shall be staffed by personnel trained and capable of operating the equipment necessary to maintain the flood control and drainage system.

(5) Location and Adequacy of Equipment and Facilities

(a) Provide essential equipment and vehicles for flood control and storm sewer maintenance activities.

2.1.1 Flood Management Policy Critique

Boulder's floodplain management policies have realized valuable results in developing floodplain studies, adopting floodplain regulations, obtaining national flood insurance, creating an early warning system, acquiring hazardous flood lands, and constructing structural mitigation. The lead focus and primary use of funding and resources has been applied to structure flood mitigation improvements and land acquisition. There are questions whether this approach adequately balances other non-structural flood management activities.

In many ways, the City's current local flood management efforts have provided a framework for how to develop in the floodplain rather than how to avoid the hazards of floodplain development. Issues include:

- The City has yet to adequately consider the potential for floods greater than 100-year magnitude and creating a self-sustaining floodplain system that will not require escalating and ongoing public maintenance resources.
- The City has not fully realized or invested in available opportunities to comprehensively study and evaluate our floodplain lands for varying hydrology and hydraulic conditions, enhanced weather forecasting, and improved emergency preparedness and response measures based on more advanced knowledge of our floodplains and their response to floods.
- The City has not adequately embraced or invested in opportunities to better assist the public in helping them prepare for and protect themselves from the devastating impacts of flooding.
- The City has not fully recognized and preserved the beneficial functions of floodplains and how our floodplain lands can offer community benefits for the environment, local quality of life, and commerce.

Community Perspectives from the Past

During the twentieth century, highly regarded community voices have made predictions and given warning to the impact of future floods on Boulder. On each occasion, these voices spoke of the need to respect the floodplain for its hazardous risks and beneficial values, and to be concerned with continuing encroachments into the floodplain that will ultimately lead to significant community disruption and loses. These voices which spoke of guiding principles to avoid and appropriately manage flood risks and losses included:

Frederick Law Olmsted, Jr., in *The Improvement of Boulder Colorado* Report (1910) to the City Improvement Association:

"The principal waterway in Boulder is Boulder Creek, and its principal function, from which there is no escaping, is to carry off the storm-water which runs into it from the territory which it drains. If, lulled by the security of a few seasons of small storms, the community permits the channel to be encroached upon, it will inevitably pay the price in destructive floods. So with the channel of Sunshine Canyon and others of less importance."

Trafton Bean, former Planning Director in a *Staff Report on Flood Plain Policy* (1959) on the "need for flood plain regulation" to the Boulder County Regional Planning Commission: "Flood damage could be prevented by not building anything in the path of floods or by evacuating to higher ground that development which is already there. Since it is both impossible and impracticable to prevent or remove all development in the flood plains, intelligent planning and regulation of development in these areas is imperative so that damage from floods can be minimized. Adequate basic flood data is needed for such planning and regulation. Federal flood-protective structures are not available, or economically feasible to construct, for most communities with minor or infrequent flood problems."

Dr. Gilbert F. White, in the *Flood Hazard Reduction and Flood Plain Regulations in Boulder City and County Colorado Report* (1966): "There has been no significant decrease during recent years in the conditions contributing to flood flows in Boulder County. At the same time, the increasing encroachment upon the valley flood plains and the aggressive invasion of the mountain drainage areas is making larger amounts of property subject to possible flood losses.

"Rapid expansion of urban land use combined with changes in the policies of Federal agencies dealing with flood losses makes it urgent for the City and County to move forward with the regulation of use of the flood plains so as to protect human life and health, to reduce the prospective drain on public funds for relief and corrective works, to prevent victimization of new property owners, and to promote the general welfare.

"Rarely can the flood hazard in a flood plain be completely eliminated by construction of protective works. Large reservoirs and levee systems are subject to occasional overflows exceeding the design flow. Moreover, it is difficult to fully protect all of the areas in the flood plain by any combination of reservoirs, upstream land treatment, and channel improvements works; some areas will be excluded. Where protection is not feasible or is only partially effective it is desirable for citizens to deal with the threat of flood loss in other ways."

Kenneth Wright and Ruth M. Wright, in the *Non-structural Urban Flood Control* (1974) paper for the American Society of Civil Engineers, where the position taken was that artificial channels, dikes, berms, walls, and other structural approaches to flood control, so popular in the 1930s and 1940s, were no longer sound: "Urban flood hazards can best be resolved using non-structural methods, in effect, working with nature rather than against it."

Boulder has been a pro-active community in pursuing and embracing flood management programs and activities as evidenced by these community leader's statements. In previous decades the City has been recognized for implementing progressive programs to address

flood hazards using the underlying guiding principles outlined by community forefathers; however, the City has yet to fully realize and translate into actions all of the aspirations of Boulder's foresighted leaders from 30 years ago. A readjustment in flood management programs and activities can transition into the future based on the original community vision.

Other Policy Considerations

Boulder Creek Subcommittee of the Corps of Engineers Committee on Environmental Planning (CECEP) – The CECEP was formed in 1970 to address floodplain policy issues in Boulder. At that time the subcommittee's focus was applied to Boulder Creek in response to plans calling for structural measures to mitigate flooding impacts. The subcommittee sought alternatives to manage flood hazards in an effort to preserve the nonstructural character of Boulder Creek that has been recognized as a community asset.

The CECEP was made up of 12 members, including: Dr. Al Bartlett, Sandy Cooper, Ted Dieffenderfer, Robert Easton, Richard McLean, Dr. John Shaeffer, Joe Shoemaker, Scott Tucker, Dr. Gilbert White, Dr. Bettie Willard, Kenneth Wright and Ruth Wright.

City Council adopted Resolution No. 141 in 1974 establishing nonstructural policy guidelines for Boulder Creek floodplain management activities. These general floodplain management policies included: (a) data inventory, (b) evaluation of the existing floodplain, (c) flood proofing, (d) land use management, (e) early warning system, (f) flood insurance, (g) relief and rehabilitation, (h) minor structural improvements, (i) parks and recreation, (j) floodplain building permits and filling restrictions, and (k) program integration.

Independent Review Panel (IRP) – The IRP was appointed by City Council in 2000 to provide community oversight of floodplain master planning efforts for Fourmile Canyon Creek. Following the success of this effort, several members were asked to review South Boulder Creek planning efforts and the IRP also participated in the CFS Master Plan Process. IRP members contributing to the floodplain policy discussion include Dr. Gilbert White, Mary Fran Myers, Ken Wright, Brian Hyde and Rich Madole. Bill Bradley and Jonathan Friedman have also supported the IRP on other projects. The IRP outlined the following guiding principles for floodplain management:

- The benefits and costs of all floodplain functions should be considered in solutions to flood problems including flood conveyance, riparian habitat, open space and aesthetics, and recreation.
- Flood issues should be addressed from the perspective of the entire contributing watershed, and problem solving should be done on an overall basis for various portions of one large floodplain, recognizing that different reaches may deserve different action.
- A variety of floodplain management tools should be used to address flooding problems, and assessing the effectiveness of these tools should be done on individual buildings and properties rather than plans solely for entire reaches.
- Consideration should be given to the effects of upstream land use on stream

flows and potential measures for downstream areas.

- Actions to reduce flood losses must consider natural and beneficial functions.
- A full range of action for individual reaches and buildings for floods up to 500-year frequency should be reviewed.

Other specific policy recommendations presented by the IRP include using the 500-year frequency for flood mitigation and emergency planning, providing data for multiple storm depths (10, 50, 100 and 500-year events), addressing hydraulic bottlenecks (such as bridges and culverts), evaluating the public benefits that might accrue from natural floodplains, protecting critical facilities to 500-year levels, flood proofing individual structures, removing high risk structures, specific flood warning and evacuation plans, and managing upstream watershed conditions.

Citizen Advisors Group (CAG) – The CAG was convened in 2001. It is comprised of citizens concerned about floodplain management policies that would be applied to the South Boulder Creek planning efforts. (Please note this group is different than the CRG formed to specifically provide input on CFS issues.) Over 30 citizens participated in the CAG and developed the following floodplain policy recommendations that may apply to all citywide floodplain management activities:

- Ensure thorough public input on all floodplain management activities.
- Provide flood hazard education.
- Improve emergency notification and warning systems.
- Enable floodplain solutions that best represent community and citizen concerns.
- Do not force relocation of residents.
- Implement floodplain management measures: maintenance of creeks and storm drainage systems, site reviews to identify specific flood conditions, self-help flood protection, etc.
- Preserve natural riparian areas; avoid channelizing the creeks.
- Improve absorption and erosion control throughout watersheds.
- Develop a formal management process to monitor activities in the floodplain and notify community members about changes which may impact them.

For these reasons, additional measures should be considered in order to conform more closely to these policies as recommended in Chapter 3.

2.1.2 Stormwater Management Policy Critique

The City Council has established the goal of becoming a nationwide environmental leader among communities and a role model for exemplary environmental practices. For these reasons, additional measures should be considered in order to conform more closely to related policies articulated in the BVCP as recommended in Chapters 4 and 5.

2.1.3 Policy Integration

The City has many policies concerning multiple objectives. Integration of multiple objectives is identified as a key issue as discussed in Chapter 6.

The Greenways Programs provides a good opportunity to integrate stormwater and flood management objectives with the competing and sometimes conflicting goals of transportation, recreation, preservation of natural ecosystems, and water quality management. Other integration opportunities are available as recommended in Chapter 6.

2.2 TRENDS

2.2.1 Flood Management

The City of Boulder has had stormwater and flood management policies in place for over 30 years. During this time the City has been effective in mapping 100-year floodplains to identify flood hazard areas, developing master plans to pursue mitigation of flood impacts, and creating a Stormwater and Flood Management Utility to fund ongoing activities. 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. The floodplain management program was one of the first nationwide and was earlier recognized as a progressive leader in the field.

Floodplain policies need to recognize multiple community objectives and balance overall community goals with the protection of Boulder residents. Community goals that include maintaining affordable housing stock, fostering alternate modes of travel, maintaining quality of life, promoting redevelopment and maintaining a strong economy may affect floodplain policies and the manner in which they are implemented. Such policies must address the flood hazard while providing flexibility to meet other goals. This requires an adjustment of policies from time to time to better protect and serve the citizens through multiple and creative approaches.

Boulder floodplain policies have not been updated since adoption of the CDUMP in 1989. 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. As the City moves forward in updating its floodplain management policies, there is a renewed opportunity to readjust our objectives to implement Boulder's original vision for floodplain management and regain a national leadership role in this field.

National Trends

Over the last several decades, national flood losses have continued to increase in the wake of traditional programs that seek to control flooding through structural measures such as constructing channels, dams, floodwalls and levees. It is recognized that our continued encroachment into floodplains coupled with lack of available funding for structural mitigation measures will continue to increase our risk for flood damages. There are also concerns that structural improvements designed for the 100-year storm may fail from larger flood events. More than half of national flood losses have resulted from storms of greater than 100-year magnitude. The

national and regional frontier has been taking on new directions to address these challenges.

Boulder also faces other challenges in addressing flood hazards. With the implementation of our Open Space greenbelt community buffer, local growth management, and the desired community population goals to ensure the current quality of life, Boulder is a community that is near "build-out." This suggests that the primary focus in floodplain management should apply to developed areas already existing in the floodplain (given that most floodplain structures in Boulder were constructed prior to adoption of floodplain regulations). This greatly affects the notion that new raw-land development activities will play the major role in achieving floodplain objectives. With less available land for growth, new pressures to increase density and redevelop existing areas in the floodplain are expected. Instead of emphasizing floodplain policies that provide a guideline on how to develop in the floodplain, the greater value in floodplain policy may be to emphasize incentives to avoid further encroachment into flood hazard areas, increase flood preparedness, and better educate the public about living with and managing the hazard.

"Structural" Type Drainageway Constructed in the 1980s

In addition, the many critical environmental factors predominant in floodplain lands suggest that the approach to floodplain management should be oriented towards preservation of floodplains and their beneficial environmental functions and less toward structural measures. There is evidence that the City's local floodplain policy perspective is moving towards nonstructural flood mitigation measures as much as possible. A nonstructural policy has been applied to Boulder Creek since 1973, and the BVCP emphasizes this approach. Recent public response has also endorsed a more nonstructural approach to maintain the environmental, open space, recreational, and aesthetic benefits that are derived.

Local floodplain management policies should also be adjusted to ensure that all people affected by the flood hazard are reached and served in a timely and cost-effective manner. Current floodplain management activities primarily involve funding structural CIP projects to acquire right-of-way for and construct major draingeways in an effort to control flooding. Because of the significant costs involved in these major construction endeavors, progress in completing such efforts citywide extend more than 50 years into the future. Goose Creek construction alone has required more than 15 years and over $20 million to extend from Boulder Creek to 28th Street, but significant flood risks still remain in the residential and hospital areas to the west.

Focusing primarily on structural improvements also means that many affected properties and the public may not benefit from current floodplain management activities for many

years while remaining exposed to the flood hazard. An increased balance in floodplain management policies and program activities may provide opportunities to better prepare for imminent flood hazards and help residents protect themselves from flooding, thereby immediately reducing potential damages and safety hazards through nonstructural flood protection measures. In addition, it appears that the cost effectiveness of these increasingly more expensive construction projects may not be reasonably justified. A 2001 master plan proposal for South Boulder Creek detailed extensive structural improvements estimated at more than $140 million. This expense would have served to protect about 1,400 existing structures, revealing an average cost factor for flood mitigation of $100,000 per structure. Much more benefit may be derived in more creative, multiple and cost-effective approaches.

National trends in floodplain management policies include such programs and philosophies as:

"Wise Use of the Nation's Floodplains." This aims to achieve both reduced flood losses and protection of the natural resources and functions of floodplains. This approach was developed under a program created by Congress called the Unified National Program for Floodplain Management under the National Flood Insurance Act of 1968. The program is coordinated by the Federal Interagency Floodplain Management Task Force, which defines floodplain management as a decision-making process to achieve the wise use of floodplains. Wise use strategies include: (a) modifying human susceptibility to flood damage, (b) modifying the impact of flooding, (c) modifying flooding itself, and (d) preserving and restoring natural resources.

"No Adverse Impact" means to manage floodplain activities at the local community level to move towards a future that includes sustainable floodplain lands and disaster-resilient communities. This approach was developed by the Association of State Floodplain Managers (ASFPM) under a report seeking fundamental shifts in national floodplain policy entitled *National Flood Programs in Review – 2000*. The No Adverse Impact approach seeks to ensure that the actions of one property owner not increase the flood risk of other property owners. It would require those who alter flood conditions to mitigate the impact of their actions on other properties and adjacent communities. No Adverse Impact is essentially a "do no harm" policy intended to significantly decrease the creation of new flood damages. Local communities are encouraged to seek their own solutions to best manage local flooding through the following goals: (a) foster responsibility and capability at individual, local, and state levels, (b) refine policies, programs, and coordination, (c) assemble and improve necessary data and tools, (d) enhance education, training, and public awareness, and (e) assess and evaluate floodplain management programs.

"Future Conditions Hydrology" means to evaluate and regulate floodplains based on the increased flood discharges that would occur assuming fully developed conditions based on a community's current land-use and zoning maps. This approach anticipates the expanded floodplain that would be realized following community build-out given floodplain encroachments and increased runoff from developed impervious surfaces (such as buildings, pavements, streets and modified landscapes). The UDFCD currently uses future conditions hydrology for the following reasons:

(a) reduction of loss of life and damage to structures, (b) improved CRS rating opportunities, (c) more informed decisions, and (d) reduced need to update floodplain studies.

"Community Rating System" is the system for recognizing and encouraging floodplain management activities that exceed minimum National Flood Insurance Program (NFIP) standards as discussed earlier. Of the 938 communities participating in the CRS, 182 are rated class 7 or better and 394 are rated class 9. Boulder joins 362 communities in the class 8 rating. The highest classifications awarded include one in class 3 (Tulsa, Oklahoma) and two in class 4 (one of which is the City of Fort Collins). The CRS claims a series of rewards in addition to reduced flood insurance premiums. These include: (a) enhanced local floodplain management, (b) benchmark assessments, (c) federal technical assistance, (d) incentive based program maintenance, and (e) qualification for federal assistance programs. Primary credit categories include public information activities, mapping and regulations, flood damage reduction activities and flood preparedness activities.

Regional Trends

Regional stormwater and flood management trends and philosophies adopted in recent years include:

City of Fort Collins - Following the flooding of 1997, the City of Fort Collins updated its stormwater management program. The most significant change in the program involved the 1999 adoption of increased rainfall conditions for major flood events. The primary components emphasized include: (a) increasing 100-year rainfall standards, (b) additional factors of safety in design, (c) sensible floodplain regulations, (d) improving emergency response, (e) providing education and outreach, (f) providing flood proofing information and flood insurance benefits, and (g) maintaining the stormwater system.

Urban Drainage and Flood Control District – The UDFCD recently updated its *Urban Storm Drainage Criteria Manual Volumes 1&2* (2002-2004). The manual provides the UDFCD's drainage policy and is adopted by the City's *Design and Construction Standards* (DCS) (2000) for many stormwater and flood management improvements.

A summary of UDFCD principles and policies include: (a) drainage is a regional phenomenon that does not respect the boundaries between government jurisdictions or between properties, (b) a storm drainage system is a subsystem of the total urban water resource system, (c) every urban area has an initial (minor) and a major drainage system, whether or not they are actually planned and designed, (d) runoff routing is primarily a space allocation problem, (e) planning and design of stormwater drainage systems generally should not be based on the premise that problems can be transferred from one location to another, (f) an urban storm drainage strategy should be a multi-objective and multi-means effort, (g) design of the stormwater drainage system should consider the features and functions of the existing drainage system, (h) in new developments, attempts should be made to reduce stormwater runoff rates and pollutant load increases after development to the maximum extent practicable, (i) the stormwater management system should be designed, beginning with the outlet or point of outflow from the project, giving full consideration to downstream effects

and the effects of off-site flows entering the system, (j) the stormwater management system should receive regular maintenance, (k) floodplains need to be preserved whenever feasible and practicable, and (l) sufficient right-of-way should be reserved to permit lateral channel movement in the floodplain when the stream is contained within a narrow natural channel.

2.2.2 Stormwater Management

To effectively address the impacts to our urban streams from stormwater runoff, Boulder faces many of the same water quality management challenges which other highly urbanized communities face. These challenges include the following:

- By its very nature, stormwater runoff is difficult to control. Therefore, management measures must focus on prevention.
- In urbanized areas there are limited land surfaces to retain water and reduce runoff to streams.
- In cities that are predominantly built out, there is little opportunity to address water quality issues with standards for new development.

National Trends

To address these challenges, stormwater management includes the following national trends:

- *Addressing Impacts of Urbanization on Water Quality* - urbanization results in larger percentages of impervious cover and more polluted runoff. New strategies to address impervious surface reduction strategies are being used to improve stream health.
- *Adopting Better Site Design Practices* - More communities are turning to "better site design" to conserve natural areas and minimize stormwater pollution from new development and to apply innovative stormwater treatment techniques to re-development sites.
- *Protecting Wetlands and Riparian Buffers* - Riparian buffer and wetlands protection is critical in maintaining and enhancing aquatic habitat.
- *Regulating Stormwater Discharges* – New federal and state regulations mandate the management of pollutants from stormwater runoff.

2.3 Stormwater And Flood Management Utility "Guiding Principles"

The recommended approach to achieving community goals and objectives is to enact and adhere to a series of guiding principles as part of the culture within the Utility. These principles then create an integral framework for considering, developing, and implementing appropriate programs and activities.

An overview of the guiding principles is presented below.

2.3.1 Flood Management

Flood management focuses on activities to be prepared for, reduce, or prevent flooding in order to protect life safety and property damage. It includes floodplain preservation, mapping, regulation, education, emergency preparedness and mitigation.

A Study Session on Floodplain Policies was presented to City Council on January 29, 2002. The study session provided Council with background information on local floodplain policies, an analysis of floodplain policy trends and philosophies, and staff-recommended floodplain policy objectives to update and adjust the CFS. Council members supported the following recommended guiding principles outlined by staff:

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."***

A successful program must address and implement all five objectives to meet multiple flood management goals for preservation, preparedness, education, regulation and mitigation. In addition, these guiding principles need to be incorporated into multi-disciplined activities performed in all City departments to truly reflect the City's commitment to meeting flood management objectives.

2.3.2 Stormwater Quality

Stormwater quality focuses on managing local activities to preserve, protect, and enhance water quality affecting Boulder's streams and drainages. The current program includes public education, water quality monitoring, regulatory compliance, and source control.

Stormwater quality objectives include taking a regional approach to stormwater quality planning. With the adoption of stormwater quality regulations by the Colorado Department of Health & Environment and the issuance of a state permit for discharge from the City's storm sewer system in 2003, the Utility again needs to move forward in establishing updated programs and activities to meet evolving standards. Recommended stormwater quality guiding principles include:

1. ***"Preserve Our Streams."***
2. ***"Prevent Adverse Impacts from Stormwater."***
3. ***"Protect and Enhance Our Stream Corridors."***

2.3.3 Stormwater Drainage

Stormwater drainage focuses on the more frequent minor storm events that are common every year. Stormwater drainage systems include storm sewers and inlets, open drainage swales, and detention ponds to manage runoff from development. Drainage objectives include maintaining drainage system infrastructure, controlling increased runoff that may contribute to flooding, and addressing drainage problems and inadequate facilities. Recommended stormwater drainage guiding principles include:

1. ***"Maintain and Preserve Existing and Natural Drainage Systems."***

2. "Reduce and Manage Developed Runoff."

3. "Eliminate Drainage Problems and Nuisances."

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. The guiding principles are intended to develop a balance of structural and non-structural solutions to these programs and activities.

CHAPTER 3 – FLOOD MANAGEMENT

3.1 OVERVIEW

Boulder is considered the number one flood risk city in Colorado. The City's location at the base of the Rocky Mountain Foothills makes it vulnerable to flash flooding that can occur with little or no warning. A major flash flood along Boulder Creek is expected to result in millions of dollars in property damage and loss of human life.

The Flood Management Program is responsible for all programs and activities related to addressing local flooding and managing the floodplain. Current program elements and activities include:

- Regulating the 100-year floodplain.
- Participating in the National Flood Insurance Program (NFIP) and Community Rating System (CRS).
- Maintaining and updating floodplain mapping studies and mitigation master plans.
- Acquiring high hazard flood properties and preserving these lands for flooding.
- Designing and constructing flood mitigation capital improvements.
- Physically maintaining major drainageways and structures (such as bridges, culverts and erosion control features) to ensure flood water conveyance.
- Participating with the Boulder County Office of Emergency Management (OEM) to provide flood monitoring, prediction, warning, and response.
- Providing flood information to the public.
- Managing post-flood property acquisition funds to address the aftermath of a flood emergency.

3.2 GUIDING PRINCIPLES FOR FLOOD MANAGEMENT

Flood Management Program elements and activities need to be updated periodically to meet changes in national and state regulatory standards, emerging trends and philosophies, evolving community goals and objectives, and to ensure program effectiveness and cost efficiency.

In order to satisfy the City's original vision and address the current trends in flood management discussed in Chapter 2, five guiding principles are recommended. The guiding principles include:

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

The following is a more detailed description of the guiding principles and listings of possible tools for implementation.

"Preserve Floodplains" by recognizing the prescriptive floodplain easement that offers "beneficial functions" for flood hazard reduction, water quality enhancement, wetland protection, wildlife habitat, riparian corridors, recreation, alternate modes travel, environmental relief, aesthetics, and urban open lands. Possible tools for implementation include:

- Continue public land acquisition of high hazard properties.
- Require private land dedication for floodplain preservation and protection of "beneficial functions."
- Integrate coordination of multiple program activities for wetland protection, water quality, greenways, and flood mitigation.

"Non-structural" Type Drainageway Constructed in the 1990s

"Be Prepared for Floods" through updated hydrology, multiple-frequency storm analysis, detailed risk assessments, enhanced early warning systems, multiple emergency notification measures, understandable response plans, workable recovery plans, and ongoing storm monitoring. Possible tools for implementation include:

- Develop "state of the art" flood mapping studies to update current floodplains.
- Develop detailed risk assessments as part of updated flood mapping studies.
- Improve coordination with the Boulder County OEM to enhance flood monitoring and prediction.
- Enhance the early warning system with additional monitoring and prediction capabilities.
- Install multiple and diverse systems for emergency notification measures to most effectively reach the public.
- Update and enhance flood response and flood recovery plans to direct both City officials and the public.

"Help People Protect Themselves from Flood Hazards" through public interaction and involvement, available floodplain information, community outreach and education, self-help measures, flood proofing options, affordable flood insurance, and emergency preparedness. Possible tools for implementation include:

- Make a greater commitment to the CRS to reduce local flood insurance premiums and increase NFIP program benefits.
- Create a flood management office or identifiable program point of contact to establish a high profile, recognizable resource for the benefit of the public.

- Implement a comprehensive Internet web site for flood management information, outreach, and e-business.

- Create an assistance program to help citizens protect their property from floods.

"Prevent Adverse Impacts and Unwise Uses in the Floodplain" through appropriate regulation and land zoning, open land preservation and acquisition, multi-objective planning, acquisition and relocation of high hazard structures, and prohibiting unacceptable encroachments. Possible tools for implementation include:

- Revise floodplain regulations to reflect changing conditions, evolving community goals, and safety concerns.

- Apply these guiding principles to all flood management and mitigation.

- Expand property acquisition and urban open lands preservation areas with beneficial floodplain functions.

- Enhance stormwater drainage ongoing monitoring and maintenance activities.

Goose Creek – Existing Conditions

"Seek to Accommodate Floods, Not Control Them" through planned and monitored system maintenance, nonstructural flood proofing, opening non-containment corridors, overbank land shaping to train flood waters, and limited structural measures at constrained locations. Possible tools for implementation include:

- Update mitigation master plans to emphasize nonstructural measures.

- Re-evaluate mitigation priorities to eliminate bottlenecks, acquire land to avoid channel improvements, provide non-structural overbank grading, target limited flood protection improvements for high hazards, and research alternative mitigation approaches.

- Assess any need for structural improvements with evaluation of multiple alternatives.

- Focus on mitigating high hazard locations citywide and give priority to areas of the greatest risk.

These guiding principles are applied to the following recommended program elements.

3.3 Recommended Flood Management Program Elements

The following sections in this chapter outline the program elements necessary to meet the guiding principals. Focus areas include:

- Floodplain Mapping
- Public Education and Flood Insurance
- Flood Preparedness
- Floodplain Regulations

- Property Acquisition and Flood Mitigation

3.3.1 Floodplain Mapping Studies

Floodplain mapping studies provide the basis for flood management by identifying the areas subject to flooding. This information is essential in determining areas where life safety is threatened and damage to property is likely.

Floodplain mapping studies need to be updated periodically to reflect changes in the floodplain resulting from land development, flood mitigation improvements, new study technologies, and the impacts of major flooding.

Boulder's current floodplain mapping studies average more than 15 years old and are generally updated in a piecemeal manner through incremental changes initiated for specific development or mitigation activities. Since 1986, only floodplain mapping studies for Two-mile Canyon Creek (1991) and Bear Canyon Creek (2002) have been updated in their entirety.

Issues and Analysis

Boulder is crossed by 15 major drainageways (shown in Figure 3-1) with associated 100-year floodplain boundaries covering more that 15% of the lands inside the City limits (shown in Figure 3-2). In order to adequately manage the floodplain, a budgeted program to renew and update floodplain mapping studies on a periodic and consistent basis is needed. Program issues for consideration include:

- Identify ongoing funding for floodplain mapping study updates.
- Determine an appropriate update cycle.
- Maintain a Geographic Information System (GIS) based floodplain resource atlas and model using the most current topographic mapping.
- Participate in federal and state floodplain map modernization efforts to stay current with industry standards and access available study matching funds.
- Incorporate risk assessments in new floodplain mapping studies to better define the flood hazard problems faced by the community and identify areas of greatest risk.
- Provide an Internet based floodplain mapping tool that allows the public to readily access flood hazard information.

Update Cycle and Funding

Most local floodplain mapping studies were completed in the mid-1980s. These studies updated the first official floodplain map adopted in 1971 and are now becoming obsolete. Significant development changes have occurred in the last 20 years, especially in the outlying and perimeter areas, such as the North Boulder area annexed in 1990. Costs to update floodplain mapping studies can exceed $100,000 for hydraulic analysis alone. This cost could increase by 75 percent or more if the hydrology is also updated. In complicated floodplain areas, such as South Boulder Creek, the need to use more sophisticated floodplain models, capable of performing dynamic-unsteady flow and two dimensional analyses, can increase these costs by an additional 30 to 50 percent.

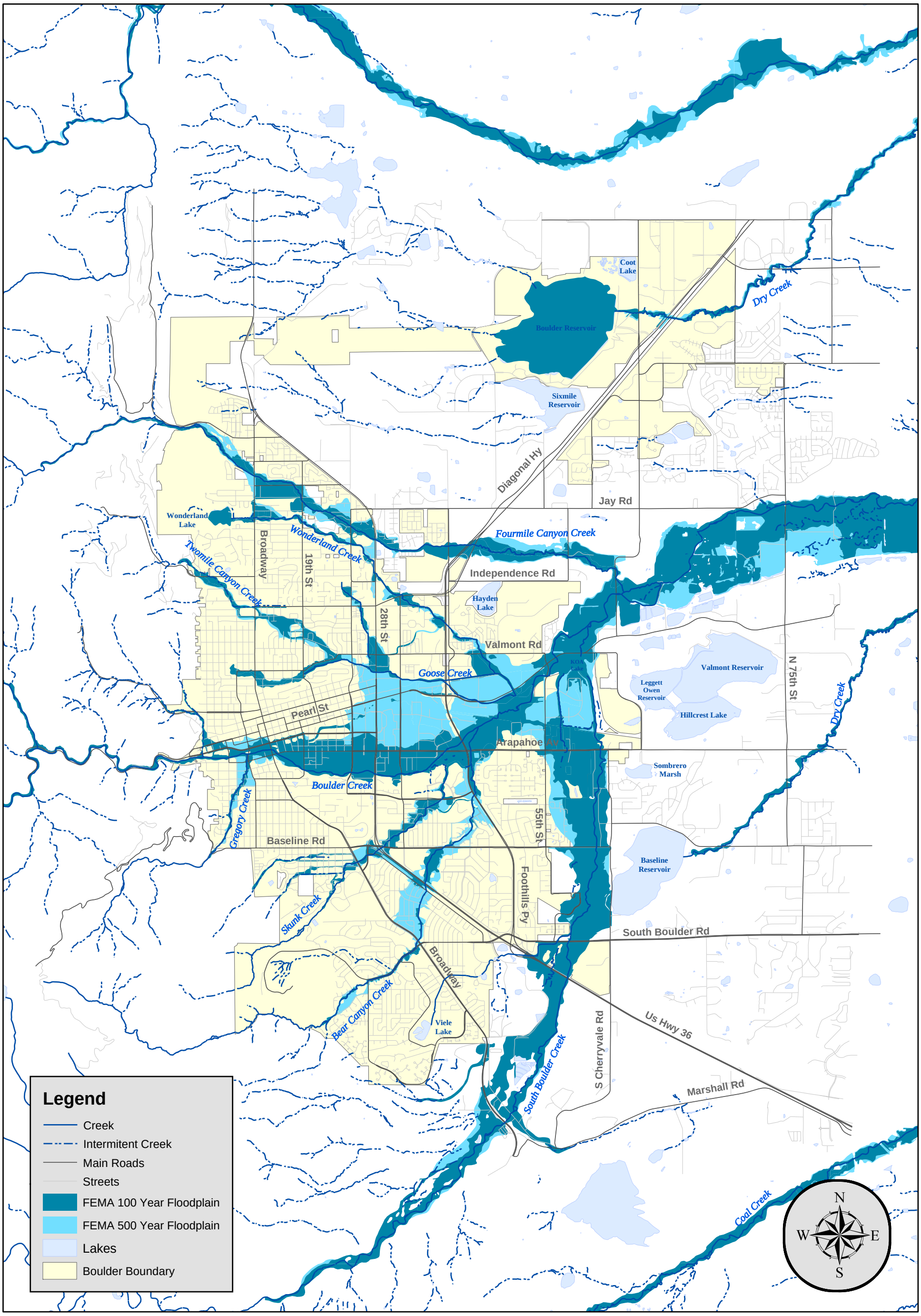
Ideally, floodplain mapping studies should be updated every five to 10-years. The Federal Emergency Management Agency (FEMA) Map Modernization Program recommends a six year

Coot Lake
Boulder Reservoir
Dry Creek
Sixmile Reservoir
Diagonal Hy
Jay Rd
Fourmile Canyon Creek
Wonderland Lake
19th St
Independence Rd
Twomile Canyon Creek
Twomile Creek
Elmers
Wonderland Creek
Hayden Lake
Broadway
Valmont Rd
KOA Lake
Valmont Reservoir
N 75th St
Leggett Owen Reservoir
Hillcrest Lake
Sunshine Creek
Goose Creek
Pearl St
Canyon Bv
28th St
55th St
Arapahoe Av
Dry Creek No.2 Ditch
Boulder Creek
Sombrero Marsh
Gregory Canyon Creek
Skunk Creek
South Boulder Creek
Baseline Rd
Baseline Reservoir
Bluebell Canyon Creek
Kings Gulch
Bear Canyon Creek
Foothills Py
South Boulder Rd
Viele Channel
Broadway
Us Hwy 36
Viele Lake
S Cherryvale Rd
N
W
E
S
Legend
Drainageways
Main Roads
Streets
Lakes
Boulder Boundary
0 0.5 1 2 3 Miles

City Of Boulder

Major Drainageways

Figure 3-1



City Of Boulder

FEMA Floodplains

Figure 3-2

cycle. Boulder currently has no formal schedule for updating local studies. Given the time that has passed since the 1980's, the City is operating on a 15 to 25 year update cycle.

Several other communities were contacted, including the City of Fort Collins, Colorado and DuPage County, Illinois. These communities chose to update floodplain mapping studies in coordination with mitigation master planning, and did not specify a specific renewal cycle.

For Boulder with its numerous drainageways, a routine 10-year update cycle is recommended. This schedule calls for renewing a floodplain mapping study for at least one creek each year. To accomplish this objective, annual funding will need to be allocated for this specific purpose.

Risk Assessments

Floodplain mapping studies typically provide technical information about the magnitude and extent of flooding, but do not delve into the degree of hazard within the floodplain. In depth analysis of floodplain mapping results can offer insights into the associated risks and levels of hazard inside the floodplain. Floodplain risk may be defined by the probability of flooding combined with the magnitude of its consequences (such as loss of life and the amount of damage). Within each floodplain the risk and level of hazard varies by location. For example, a structure located on the bank of a creek is probably at greater risk than a structure located on the flood fringe.

A flood risk assessment evaluates the level of risk throughout the floodplain. It provides a framework for defining "the flood problem" to inform and educate the public and community officials. It uses the results of floodplain mapping studies to determine properties and structures impacted by flooding, areas most subject to frequent flooding, highest hazard areas due to depths and velocities of flood waters, primary life safety threats, and anticipated levels of damage to property.

Day Care Center Exposed to Flood Hazard Risk

Risk assessments would help to guide public education and community decisions for floodplain management activities to reduce flood hazards, including mitigation planning, floodplain regulations, flood preparedness activities, flood proofing, flood insurance, self help programs and the on-going annual prioritization and funding allocations for Capital Improvement Program (CIP) projects.

Boulder's current high hazard zone provides an initial groundwork and one effective measure for risk assessment by defining areas in the 100-year floodplain where an unacceptably high risk to human life exists. Other approaches have been developed to identify risk and prioritize appropriate management strategies.

Costs for flood risk assessments range from $30,000 to $50,000. The current South Boulder Creek floodplain mapping study

includes a risk assessment to assist in the future evaluation of floodplain management and mitigation alternatives. These costs may reduce future costs associated with floodplain master planning.

Day Care Center After Flood Mitigation Improvements

No communities contacted outside of Boulder perform risk assessments separate from mitigation master planning activities. Some communities, such as Johnson County, Kansas, use a ranking system to prioritize mitigation projects as part of their master plans.

Public Input

The Community Review Group (CRG) agreed that floodplain mapping studies should be updated periodically. The CRG also suggested that additional funds should be allocated in the near term to "get caught up" and renew the most outdated studies. They also suggested that updates be prioritized to focus on floodplains that have been most affected by recent development and where potential development is most anticipated.

The CRG also requested that technical assumptions used in the studies (such as storm frequency, culvert blockages, and debris transport) and limitations of studies (such as level of accuracy and mapping detail) be openly identified for the public. They also requested that information on extreme events, such as a Barker Dam break, be made readily available.

The CRG wanted a demonstration of the need for risk assessments if they are not performed by other communities. They indicated that more information about how these would be integrated into the flood management program along with the derived benefits be presented for consideration prior to their adoption. However, the Independent Review Panel (IRP) and the Hydrology Advisory Panel (HAP) that developed the South Boulder Creek flood study scope of work recommended that a detailed risk assessment was a vital component of a complete and adequate floodplain mapping study.

Recommendations and Action Items

The following floodplain mapping study actions are recommended.

Floodplain Mapping Action Items

- floodplain mapping studies.
- floodplain mapping updates.

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. An

annual budget allocation of $150,000 for floodplain mapping studies and $50,000 for associated risk assessments provides a reasonable funding basis for satisfying the 10-year update cycle, and may be leveraged to apply for external funding supplements, such as FEMA's Cooperating Technical Partners (CTP) program or Urban Drainage and Flood Control District (UDFCD) matching funds.

Without a study update program, floodplains may only be updated in a piecemeal fashion based on FEMA issued Letters of Map Revisions (LOMR) or independent analyses performed on limited drainageway reaches. Piecemeal updates can not ensure the accuracy of floodplain maps over time since incremental changes do not fully consider the entire watercourse.

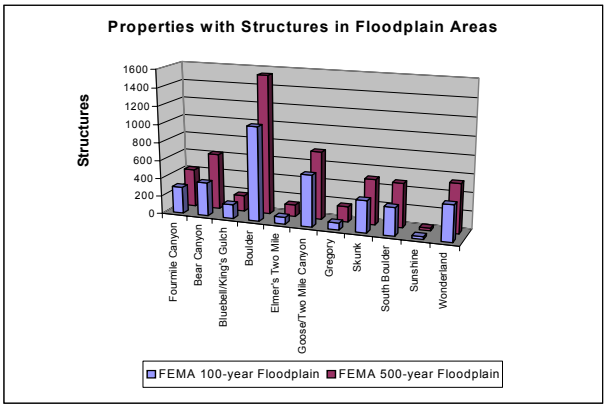
Currently, floodplain mapping studies are underway for South Boulder Creek, Fourmile Canyon and Wonderland Creeks, and Gregory Canyon Creek. Other mapping priorities are recommended for Boulder Creek, Skunk Creek, Goose Creek upstream of Folsom, Sunshine Canyon Creek, and then Dry Creek in Gunbarrel over the next five years.

Including risk assessments as part of new floodplain mapping studies is recommended for Boulder. While we found no other communities that currently include risk assessments in floodplain mapping studies, the innovation of adopting formal risk assessments provides a proactive and progressive step in dealing with the risks of flooding. In addition, the recommendation from the IRP and others indicates that risk assessments offer valuable information. The expanded hazard information is valuable for enhancing non-structural flood management program activities supported by the community. To accomplish this objective, annual funding will need to be allocated for this specific purpose.

3.3.2 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.

Today, numerous properties contain structures in the various floodplain areas. As shown below, Boulder Creek has over 1,000 structures in the 100-year floodplain.



Properties with Structures in Floodplain Areas

A primary focus in floodplain management should apply to the substantial amount of developed areas already existing in the floodplain. Most floodplain structures in Boulder were constructed prior to the adoption of floodplain regulations and in fact, prior to the mapping of floodplains. This reality counters the notion that new raw-land development activities will play a major role in achieving local floodplain management objectives, and further emphasizes the already significant potential for flood losses and safety hazards. Therefore, helping people protect

themselves from flood hazards is critical to the health and wellbeing of the City.

Issues and Analysis

Floodplain education is important for everyone and vital for those who are directly exposed to, are living in, and/or are working in the floodplain. Education requires a program that promotes public interaction and involvement, availability of floodplain information, community outreach, self-help measures, flood-proofing options, affordable flood insurance, and emergency preparedness. If the public is educated and has access to the many tools available to address flood hazards, the community will be more adequately prepared to deal with flooding.

Boulder currently implements the following flood education activities:

- Annual mail updates to floodplain properties through UDFCD.
- Annual flyer inserts in the utility bills.
- Flood fact sheets on the City's Natural Hazards Web site.
- The *Boulder County Flood Protection Handbook* (2002).
- Online interactive floodplain map allowing inquiries into property locations.

In combination with education for self-preparedness, affordable flood insurance helps victims recover from the devastating financial losses of flooding. Boulder participates in the NFIP that makes flood insurance available. An element of the NFIP is the CRS. This national program offers opportunities to reduce flood insurance premiums where communities implement measures that exceed NFIP minimum requirements. Such measures may include higher regulatory standards, floodplain acquisition, community outreach, education, and early warning systems.

In order to improve flood education and pursue more affordable flood insurance, a program is needed to focus available resources in this area. Issues for consideration include:

- Create an identifiable flood management program resource center that is openly accessible to the public.
- Designate a program manager to direct and coordinate resources, and provide a point of public contact, to promote non-structural flood management activities.
- Allocate adequate resources and staff to offer public education for self help activities, individual assistance, community workshops, and flood preparedness training.
- Enhance Internet access to floodplain information and develop interactive e-based applications for self-help activities.
- Promote public interaction and response to evaluate and improve program effectiveness.
- Pursue an improved CRS rating by allocating necessary resources to support program efforts.
- Pursue opportunities to set up a local flood-proofing program.

A floodplain management program resource center and program manager would establish a source location identifiable to the public responsible for:

- Providing direct community services and assistance for floodplain information, education and self-help flood protection through individual consultations or a speaker's bureau.

- Maintaining required records of floodplain mapping studies, map changes, and floodplain certifications for public access.

- Managing floodplain mapping study updates and floodplain management and mitigation master planning.

- Developing and implementing non-structural flood management activities.

- Implementing and maintaining required NFIP and CRS program elements.

This program resource could also coordinate with and compliment the Boulder County OEM by providing educational and planning services for floodplain preparedness in advance of flooding. Additionally, it can coordinate with regional flood management activities with Boulder County.

CRS Rating Issues

The City has not aggressively pursued the best possible CRS rating given limited resources. However, the CRS offers additional community benefits beyond reductions in flood insurance premiums. It also provides an implementation focus for flood management programs to ensure consistency and performance, and establishes a "benchmark" to compare local efforts with the efforts of other cities nationally. Table 3-1 summarizes properties affected by floodplain areas in Boulder.

Table 3-1
Properties Affected by
Floodplain Areas in Bounder
(January 2002)

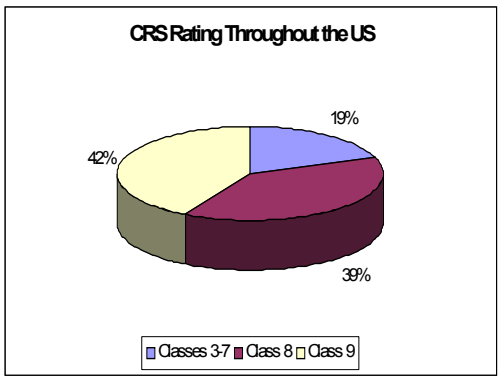
	FEMA 100-year	FEMA 500-year
Number of Properties	3,582	5,295
Assessed Value	$988,696,800	$1,414,277,100

While additional staff support and funding for flood education and CRS program management may not produce revenue to recover direct costs, community benefits may be reflected by flood insurance premium reductions to policy holders. Of 2,072 current policies in Boulder, an improved CRS rating to Class 7 from Class 8 would yield over $30,000 in annual savings to the flood insured. If Boulder were to achieve a Class 4 Rating, the annual savings could exceed $120,000 (offsetting program costs in community benefits). In addition, affordable policies could encourage greater flood insurance purchases producing a more flood prepared community.

There are approximately 2,000 flood insurance policies issued in Boulder where there are over 3,500 floodplain properties. Reduced flood insurance premiums may help encourage protection policy purchases, and increased education can improve public awareness of self-help options.
CRS rate reductions are earned on a point basis (similar to local fire insurance ratings) equating to one of 10 class ratings. A Class 1 rating would reduce premiums by 45 percent and a Class 10 rating receives no reduction.

The City currently has a Class 8 CRS rating earning a 10 percent reduction in flood

insurance premiums. This is consistent with most CRS participating communities. Of 938 communities participating, 182 (19 percent) are rated Class 7 or better and 394 (42 percent) are rated Class 9. Boulder joins 362 (39 percent) communities in Class 8. The highest classifications awarded include one in Class 3 (Tulsa, Oklahoma) and two in Class 4 (one of which is the City of Fort Collins).



Public Input

The CRG recommended that public education activities be initiated with an enhanced Web page offering links to the UDFCD and NFIP. Members agreed that the proposed program elements were all worth doing, but weren't confident that funding would be approved. They indicated that program benefits would need to be clear to gain public support.

Some members expressed concern that encouraging the purchase of flood insurance would require City-implemented incentives to offset premium costs, such as reduced monthly utility fees or property tax refunds. Another perspective felt that flood insurance incentives would equate to City-funded subsidies to purchase flood insurance for people to live in flood risk areas. This raised a concern that the City would be supporting development in the floodplain with subsidized flood insurance.

CRG members suggested that providing flood protection measures is a better community investment than subsidizing flood insurance costs. Even with flood insurance subsidies, premium costs could still rise without local control. The costs and benefits of improving the CRS ranking need to be demonstrated further to earn public support. The flood insurance program should be evaluated like fire insurance programs that rate the fire prevention/control capabilities.

Recommendations and Action Items

The following public education and flood insurance actions are recommended.

Flood Education and Insurance Action Items

- resource center and program manager.
- staff resources for program support.
-
- available resources.
-

Boulder currently has a progressive Web site. Implementation of enhanced and comprehensive Internet applications for floodplain information and e-business will offer an effective approach for reaching the Boulder public. With the high level of Internet access and usage in Boulder, this tool could provide direct public access to important floodplain information, such as floodplain maps, letters of map revision, flood insurance information and a record of elevation certificates for buildings.

The backbone of such a Web site has already been launched with an interactive GIS-based floodplain map and is suited for dramatic expansion.

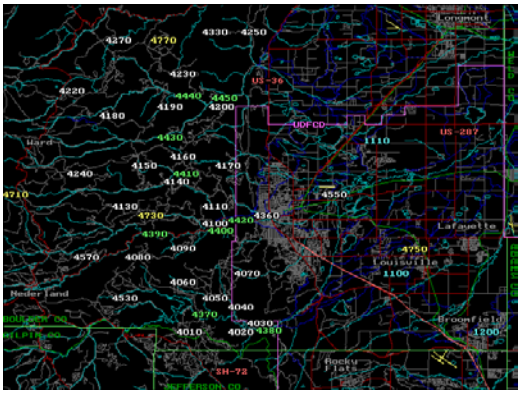
Reallocated funding and staff resources would be needed to adequately provide services for a non-structural flood management program. Funding of $125,000 and reassignment of engineering staff are proposed to initiate this program.

3.3.3 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 the significant number of structures, including dwellings, which are located in the floodplain. With 15 major drainageways and more than 15 percent of the community impacted by floodplains, Boulder faces a significant challenge in addressing measures to protect its residents and lands from future disaster.

Flood preparedness is a program element that must reach and serve all people affected by the flood hazard. Flood monitoring and warning must provide notification in an extremely timely manner, given that 20 minutes may be all that can possibly be provided from a flood warning to critical human response. 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.

The City of Boulder and Boulder County developed a flood monitoring and warning system in conjunction with the UDFCD in 1979. The system is managed by the Boulder County OEM and is made up of numerous rainfall and stream flow gauges located in the foothills and canyons that telemetry storm data to assess flood potential.



Network of Rainfall and Stream Flow Gauges

The National Weather Service and a meteorological consultant retained by the UDFCD also provide weather information to assist in predicting flooding. A weakness in the system is the lack of rainfall monitoring gauges inside the City that could serve to provide data for the smaller drainage basins and creeks.

Boulder's flood warning plan is updated annually along with an annual exercise and monthly tests of the siren system in the summer months. The UDFCD provides maintenance funding for the flood warning (ALERT) system. Under the system, City and County officials work together using the procedures outlined in the *Boulder Creek Flood Warning Plan* (2003) and the *Emergency Operations Plan – Boulder County and City of Boulder* (1998) to determine if a flood warning is warranted, disseminate any necessary warnings, and respond to flooding accordingly.

The Boulder Creek flood warning system and existing response plans were recently evaluated and recommendations were developed to upgrade plan components. The recommendations identify enhancements to

improve the effectiveness of the City's programs by providing multiple emergency notification measures and improving the local response and recovery plans. Additionally, the City is actively considering upgrades for emergency siren locations and adding an automated flood warning software program to the Boulder Creek system.

Flood response is addressed in the City's *Emergency Operations Guidelines* (2004). The guidelines address individual responsibilities in a step-by-step guide through the progression of four flood "modes." This plan is an excellent foundation for flood response and should continue to serve as a guideline for the steps to be taken to respond to a flood.

August 5, 2002, Storm Threatens to Flood a Major Traffic Artery. This Storm occurred simultaneously with drought conditions

Flooding places lives and property at risk and a community's ability to respond may be the deciding factor to reduce those risks. It takes time for emergency response agencies to set up and prepare for an organized response, and damaged roads and disrupted communications systems may restrict their access into critically affected areas. Individual preparedness, planning, survival skills, and mutual aid within neighborhoods and worksites during this initial period are essential measures in coping with the aftermath of a flood.

No community wants to be faced with the daunting task of disaster recovery. However, many disasters are followed by the largest infusion of federal, state and local recovery capital that will ever occur at one time. Communities with up-to-date response plans can clearly and quickly identify and articulate their needs to state and federal officials. These communities will have a competitive edge when post-disaster funding and technical assistance are needed.

Issues and Analysis

Several flood preparedness issues were identified for consideration including:

- Improving coordination with the Boulder County OEM.
- Enhancing the early warning system.
- Implementing multiple emergency notification measures.
- Updating and enhancing the flood response and recovery plans.

Information regarding flood warning, response, and recovery obtained from other communities found Boulder's procedures to be comparable with the efforts of several flood-prone communities. In general, other communities are using similar software applications and provide warnings based on a series of elevated flood "modes."

Communities used a variety of methods to educate the public about flood warning and generally had a step-by-step procedure to

follow through each progression of the flood modes. Flood recovery and response were addressed either in the individual steps of their flood warning plans or in their emergency operations manuals. In general, flood recovery plans were found to be the least detailed of the three stages of warning, response and recovery.

Public Input

The CRG indicated that improved emergency preparedness must answer the following questions:

- When will the flood happen in each area, and where does a person go when it occurs?
- How will the City provide flood emergency information in both "low-tech" and "high-tech" applications?
- During an emergency, where can the public go quickly for instruction?

The CRG agreed that flood preparedness postings should be placed in non-residential structures. They also suggested that handy information materials, such as door hangers, refrigerator magnets, phone book inserts, and radios with batteries, be provided for the public instead of mailing annual flyers. The CRG indicated that the City should promote flood proofing activities to help in preparing for flooding events.

Recommendations and Action Items

The following flood preparedness actions are recommended.

Flood Preparedness Action Items

- Enhance coordination with the Boulder County OEM 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 of 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.

The Boulder County OEM and City officials have indicated a desire to work together and compliment each other's capabilities, and should work to foster this relationship. The Utility is already represented by technical staff that respond to flood monitoring and prediction activities, and by maintenance operations that assist with emergency actions.

The recent flood preparedness evaluations by the University of Colorado and HDR Engineering, Inc. provide a renewed foundation for the City's flood preparedness program and should be implemented.

The evaluation of the City's flood warning system recommended updating flood warning and response plans. The findings identified several response activities to include in the plan.

Currently the Emergency Manager has access to sirens, radio, cable override and a "911-

type" callback system. Boulder should institute a procedure that will reach a maximum number of citizens both indoors and outside that is equally effective both during the day and at night.

The current flood response plan provides step-by-step procedures for public officials to follow during the early stages of a flood. The response plan is comprehensive; however, modifications to the plan are recommended, such as providing procedures for daytime response and nighttime response.

Emergency plans must address necessary recovery elements as well, such as identifying early actions and decisions that must be made, meeting victim's immediate needs, performing building and infrastructure damage assessments, re-establishing critical community services, acquiring or preserving post-flood properties to avoid future losses, issuing building permits for allowed reconstruction, and restoring normal City operations.

3.3.4 Floodplain Regulations

Local floodplain regulations were adopted in 1969 in response to Front Range flooding. Floodplain regulations are a critical element in local flood management and are a primary component in the City's participation in the NFIP.

Since joining the NFIP in 1978, the floodplain regulations have been revised several times to meet changing needs and federal standards. The last major regulatory changes occurred in 1989 with the adoption of the high hazard zone and in 2002 to address federal changes regarding the construction of crawlspaces.

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. A limited overview of existing floodplain regulations is as follows:

- New structures and additions in the 100-year floodplain must be protected to an elevation two feet above the flood elevation.
- New residential structures and additions must have floors elevated above the flood protection elevation and cannot have basements or below grade crawlspaces.
- Non-residential structures may be flood proofed without human intervention to the flood protection elevation.
- New structures and additions are prohibited in the high hazard zone.
- Improvements or development proposed in the conveyance zone may not create any increase in the flood elevation.

Floodplain regulations should periodically be reviewed and updated to reflect changing community needs and ensure that flood management and NFIP objectives are achieved. Nationally, flood losses have continued to rise over the last decade and floodplain administrators need to seek creative solutions to balance community goals with the protection of the public from flood hazards. Continuing pressure for new local development and re-development in the floodplain presents a challenge for enabling community growth while preventing increased risks and expanded floodplain hazard.

As outlined in the guiding principle to "prevent adverse impacts and unwise uses in the floodplain," staff is recommending activities to evaluate and consider regulatory updates that would continue to maintain high hazard zone standards, increase protection measures for critical facilities, pursue options to reduce future encroachments into critical floodplain corridors that continue to increase flood risk exposures , enhance building safety measures, analyze the effectiveness of assessing flood risks based on multiple level storms (and not based only on the 100-year flood), develop alternatives to account for mapping uncertainties and impacts from floodplain encroachments that expand flood exposure beyond delineated floodplain boundaries, and recognize and preserve the beneficial functions of floodplains.

There are a variety of Federal, State, and Local regulations related to floodplain management. Typically, these regulations set a minimum standard that must be met by those entities within the established jurisdiction, and communities are encouraged to enforce more restrictive regulations to promote sound floodplain management and protect life safety and property. The City of Boulder's regulations currently meet or exceed all Federal, State, and regional agency requirements.

Issues and Analysis

Evolving trends and philosophies in national and regional flood management have outlined alternative approaches and measures for addressing flood hazards in the future. These trends focus on the "Wise Use of the Nation's Floodplains" and "No Adverse Impacts." Issues recommended to be evaluated and considered are listed as follows.

- Assess the adequacy of ***life safety measures*** for ensuring emergency access, the need for flood warning devices and signage for non-residential, public and residential rental structures, concerns for fire suppression, and the potential need for emergency escape openings.

- Address ***floodplain mapping uncertainties*** resulting from the impacts of development encroachments that expand the floodplain over time. Uncertainties could be addressed with floodplain buffers, added "freeboard" flood elevations or by analyzing multiple-frequency flood impacts to better define critical inundation zones.

- Develop options for ***mitigating new floodplain encroachments*** to prevent increased exposure to flood losses and life safety hazards by targeting structure placement or shifting density to the least flood exposed site areas.

- Develop ***500-year protection standards for critical facilities*** in line with Federal guidance to ensure access to, use of, and uninterrupted service for critical facilities such as fire and police stations, water and sewer treatment plants, utility infrastructure for water, sewer, gas, electric, and communications, schools, day care and senior care facilities, hospitals, major roads and bridges, and hazardous material storage.

- Evaluate the adequacy of the ***flood protection elevation for flood proofed structures*** that are susceptible to overtopping.

- Develop ***hazard analysis standards*** to determine levels of risk, identify least hazardous building placement and maximum avoidance of flood impacts.

- Research *engineered foundation standards* for structures to request NFIP approval to allow standard construction of crawl spaces.

- Research options for lower-risk shallow flooding areas to allow possible development flexibility that would not produce the need to implement publicly funded drainageway improvements to contain flood waters such as allowing limited *residential flood-proofing of structures.*

- Evaluate the use and application of the Association of State Floodplain Managers (ASFPM) recommended *"no adverse impact" standards* to prohibit floodplain development that would increase flood elevations, reduce flood storage or expand high hazard conditions without acceptable measures to mitigate such impacts. These measures could include consideration of a *"no-rise" conveyance (floodway) standard* to replace the current six-inch rise standard to account for previous floodplain development.

- Seek NFIP and state approval to accept the *local conveyance zone (floodway) standard* to develop consistency between local and federal floodplain maps.

- Seek opportunities to develop *consistency between City and County floodplain regulations* to improve coordination and reduce future nonconformities for areas anticipated to annex into the City.

Several communities contacted, including the town of Parker, Colorado and DuPage County, Illinois, have implemented added elevation and/or setback ordinances that extend the regulatory floodplain beyond the 100-year boundaries. Parker and DuPage report that these ordinances have been difficult to enforce.

However, the City of Tulsa, Oklahoma, implemented both elevation and no-rise regulations that have not been difficult to enforce. Tulsa attributes this to the public's awareness of past flooding events (1980s), the political support it receives for its program, the effort made to work proactively with developers, and the public outreach program.

Several communities, including the City of Fort Collins, Colorado and DuPage County, require that a level of protection greater than the 100-year frequency be provided for critical facilities. Many communities require specific flood mitigation measures for new and proposed structures within the floodplain.

Public Input

The CRG indicated a great deal of concern and opposition to expanding the current regulatory floodplain area beyond the 100-year floodplain (and reacted strongly against adopting the 500-year floodplain for regulation), but did indicate reasonable support for regulating critical structures to the 500-year flood level, subject to clear definition of critical structures.

In general there was expressed concern that no new regulations be imposed that would make development approvals more difficult given local interests to improve economic conditions in Boulder. The CRG indicated that the City should carefully evaluate and present the costs and benefits of any new regulations to the community at large prior to any regulatory adoptions. They also suggested that case study evaluations be performed to better define the impacts of any proposed regulatory changes.

The CRG did not support floodplain buffers citing a poor correlation with actual flood impacts. They also did not support requiring fire suppression systems for new structures in the floodplain based on perceived high costs and limited benefit.

There was mixed support for a no-rise or *De minimis* rise floodplain with some members advocating the "good neighbor" or "no adverse impact" principle while others believed that it would make development or redevelopment extremely difficult with profound adverse impacts on numerous properties. Members also suggested that a "no adverse impact" standard may not be acceptable since it is unrealistic to fully avoid any impacts in the floodplain.

Recommendations and Action Items

The following possible revisions to local floodplain regulations are proposed to be researched and considered for implementation subject to an acceptable finding of community benefit balanced with improved levels of public safety and reduced damage potential from floods.

Floodplain Regulation Action Items

- 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 ASFPM's "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.

Possible considerations for local floodplain regulations include progressive flood protection measures to better address life safety with emergency ingress and egress access standards, inclusion of automated warning devices (such as tone alert radios) and notification signage in multi-family and non-residential construction, and provisions for emergency escape openings above for building evacuation above flood waters.

There is also an interest in mitigating or reducing continued encroachments into the floodplain that increase the life safety risk and exposure to flood damages. Such land use alternatives would seek to preserve the floodplain for beneficial purposes and prevent land uses that may increase flood hazards.

Consistent with Federal guidelines and the construction of the new Boulder Foothills Community Hospital, providing 500-year protection standards for critical facilities could help ensure that such facilities remain functional during times of flooding.

Because flood proofed structures are subject to full inundation if flood protection levels are exceed, additional freeboard protection above flood waters could offer a greater factor of safety for such buildings.

FEMA currently requires that the ground elevation inside crawlspaces match grades adjacent to the structure. This requirement to "fill" crawlspaces is inconsistent with standard construction practices for regions subject to deep frost conditions. The recommendation to seek FEMA approval for engineered foundations would allow more common construction practices to be used.

Adoption of the 1/2–foot rise floodway standard would provide consistency between FEMA' floodway, UDFCD's floodway, and the City of Boulder's conveyance zone standards.

Recommending consistent regulatory requirements for floodplain activities in Boulder County and within the City of Boulder would eliminate new land use and construction activities that may become "non-conforming" when property is annexed into the City.

Floodplain regulations must be adopted as set forth under an ordinance as approved by City Council. The process involved in proposing and adopting new regulatory revisions requires in-depth analysis, an open public review process that includes public meetings, and an assessment and recommendation from the WRAB, City of Boulder Planning Board and FEMA.

Approval of the CFS will not officially revise the floodplain regulations. CFS approval will serve to include the review and proposal of regulatory revisions in the flood management program, and provides a framework for program activities intended to update local regulations. A subsequent process to consider possible revisions to the floodplain regulations will still be required.

3.3.5 Property Acquisition and Flood Mitigation

The guiding principles to "preserve floodplains" and "seek to accommodate floods, not control them" apply to the flood management programs for property acquisition and flood mitigation.

Over the course of time, the majority of Utilities funding has been applied to constructed flood mitigation projects and property acquisition. The CDUMP and major driangeway master plans recommended numerous capital improvements to convey flood waters in an approach to contain flooding. Many of these projects have been developed in conjunction with the UDFCD. Goose Creek is a primary example.

Other "opportunity-based" projects have also been completed as major program elements. These have also supported other community goals for Greenways, Transportation, and Parks and Recreation. Bear Canyon Creek is a good example of such opportunity-based planning.

The City has also purchased numerous flood-prone properties over the years as part of the CDUMP-based pre-flood property acquisition program targeted for high hazard properties. Such acquisitions have been primarily prioritized based on the level of hazard to the

structure. They were outlined in CDUMP and later updated by Love & Associates. Examples include the purchase of several separate residential structures along Boulder Creek, including a 22-unit apartment building near Eben Fine Park. Opportunity-based property acquisition is also a key element of the program given the City's interest in working with a "willing seller." Based on this, floodplain properties may be pursued as they become available on the real estate market.

The property acquisition and constructed flood mitigation program has been very successful over the years. Through these efforts 134 of 279 identified high hazard structures have been removed from the high hazard zone as a result of major drainageway improvements that narrowed the floodplain and/or the acquisition and physical removal of individual structures. The Boulder Creek Project that acquired and physically removed 13 multi-family structures (169 units) near Boulder High School and reworked the creek over-bank to improve conveyance is a major example. Structures located in the High Hazard Flood Zone within the City Limits are shown in Figure 3-3.

However, modern community interests and national trends away from structural drainageway construction have raised questions regarding previous structurally oriented projects, such as Goose Creek, that involve significant costs and raise environmental and aesthetic issues. Constructed flood mitigation projects may also conflict with the guiding principles, "seek to accommodate floods, not control them" and "preserve floodplains." These principles are consistent with the City's commitment to sustainable development and reflect the 1974 nonstructural policy guidelines adopted for Boulder Creek.

Boulder also has a post-flood property acquisition program. Currently $1,050,000 is reserved in the Utility fund balance for this purpose. This funding is available for the purchase of properties whose structures sustain significant flood damage. Although given the relatively limited level of funding, this money would likely be used to leverage available state or federal disaster relief funds following a major flood event.

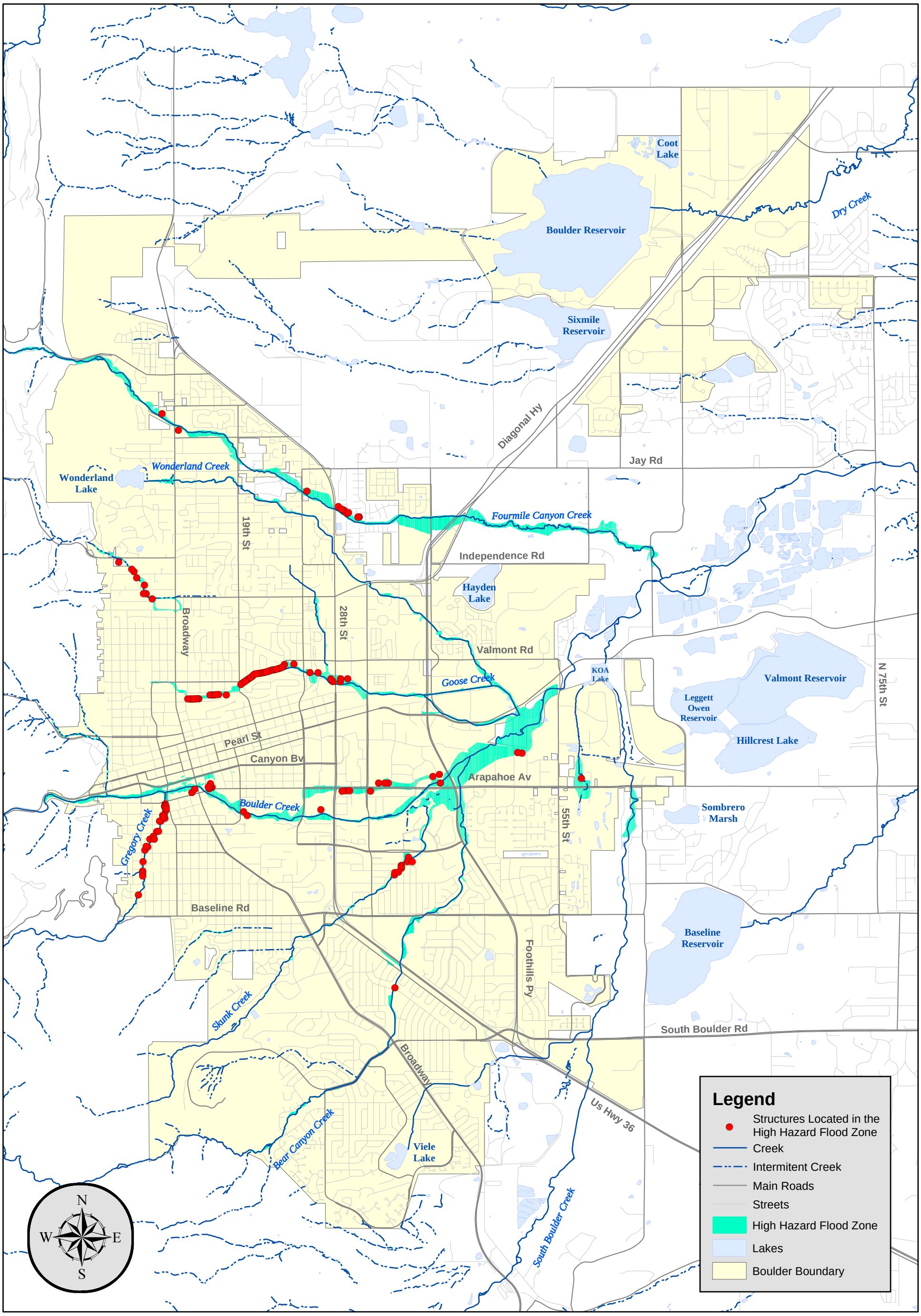
Issues and Analysis

Several property acquisition and floodplain mitigation issues are listed for consideration.

- Incorporate risk assessments into the process for identifying mitigation sites and mitigation solutions.
- Focus on non structural mitigation solutions in conjunction with proposed mitigation projects.
- Continue to acquire high hazard properties under the currently identified acquisition plan.

Most communities contacted had established mitigation plans that identify specific flooding problems and possible mitigation solutions, including property acquisition. However, methods to prioritize mitigation projects differed by community. For example Johnson County, Kansas developed a customized ranking system (awarding points for severity of flooding, erosion impacts, etc.), whereas DuPage County, Illinois prioritizes projects based on standard damage assessment calculations.

Prioritization of acquisition projects versus structural projects also differed by community. For example the City of Tulsa, Oklahoma



City Of Boulder

Structures Located in the High Hazard Flood Zone within City Limits

Figure 3-3

Note: This map was created by using parcels and structures which were included in "High Hazard Zone Property Acquisition Analysis" LOVE & ASSOCIATES, INC. November 1996 minus structures which have been removed due to channel improvements.

selects either mitigation or acquisition projects based on the project that is more cost effective. Mecklenburg County, North Carolina has a specific acquisition account that accumulates

funds to acquire property. In general, communities that are considered to be more progressive are using funding in a variety of ways and suggest that "finding the right balance of solutions" and "using more funding for support projects rather than solely funding construction projects" was the best solution to local flood management problems.

Public Input

The CRG suggested a preference to preserve existing floodplain conveyance along the major drainageways through actionable maintenance programs in addition to constructed flood mitigation and property acquisition. They indicated that previous criticism aimed at constructed flood mitigation did not consider all factors such as the cost of property acquisition and related flood mitigation benefits.

Some CRG members expressed concern that the City would discontinue the use of flood control options for neighborhoods that have not yet been protected but have contributed to the costs for previously completed structural flood mitigation. These concerns represent an issue with fairness and equity pertaining to citywide expectations for floodplain management and commitments to address all floodplains.

There was an indication that many CRG members would be dissatisfied if the City decided to stop making structural floodplain improvements to serve environmental interests at the expense of private property owners. They suggested that the same attention and consideration should be provided for the built environment that we provide for accommodating our natural environment.

There was also a suggestion that the City re-evaluate the Boulder Creek non-structural policy guidelines such that a non-containment approach should be rethought, refined and not considered an absolute.

Recommendations and Action Items

The following property acquisition and floodplain mitigation actions are recommended.

Property Acquisition and Floodplain Mitigation Action Items

- 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.

Risk assessments should be used to assist in updating and prioritizing floodplain management and mitigation master planning for major drainageways. Information about the

level of risk would provide a more detailed framework for evaluating floodplain management and/or mitigation alternatives.

Continued use of the prioritized list of high hazard structures developed by Love & Associates in 1997 is recommended as a basis for property acquisition in the immediate future.

Constructed flood mitigation projects should utilize low impact approaches wherever possible by maximizing vegetative cover and minimizing major structural components such as narrow trapezoidal shapes, drop structures, walls and levees.

Given an expectation that significant property damage will likely occur as a result of flooding in the future (even if the pre-flood property acquisition plan is fully implemented), the City should evaluate how money reserved in the post-flood property acquisition fund would be leveraged with state or federal disaster relief funds. Various flooding scenarios for individual drainageways should be developed to identify potential post-flood property acquisition in order to assess the adequacy of current funding levels.

CHAPTER 4 – STORMWATER QUALITY

4.1 OVERVIEW

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

Stormwater regulations, policies, and community water quality goals and objectives provide the basis for the Stormwater Quality Program. These program elements need to be updated periodically to meet regulatory standards, accommodate changing trends and philosophies, ensure program effectiveness and cost efficiency, and to meet evolving community goals and objectives.

The City has been a leader in addressing stormwater quality through the development of the stormwater quality program 10 years before required by federal and state regulations. However, to remain pro-active in addressing water quality issues, the City must adjust its policies and approaches. These changes will ensure that our programs will:

- More adequately address impervious cover, conserving natural areas and minimizing stormwater pollution from re-development.
- Better protect and enhance critical aquatic habitat.
- Place greater emphasis on small streams (perennial or ephemeral) and small storms.
- Utilize a multidisciplinary approach to address multiple, often conflicting, objectives.
- Comply with stormwater permit requirements and other standards and regulations.
- Also, stormwater management practices and policies must be updated to meet the water quality policies outlined in the *Boulder Valley Comprehensive Plan* (BVCP) (2000)

4.2 GUIDING PRINCIPLES FOR STORMWATER QUALITY

The guiding principals recommended for adoption in this master plan include:

1. ***"Protect Public Health and the Environment."***
2. ***"Manage Pollution at the Source."***
3. ***"Enhance Stream Corridors."***

4.3 RECOMMENDED STORMWATER QUALITY PROGRAM ELEMENTS

The following sections in this chapter outline the program elements necessary to meet the guiding principals. Focus areas include:

- Water Quality Regulations

- Sub-basin Management
- Stream Enhancement

4.3.1 Water Quality Regulations

The Clean Water Act (CWA) of 1972 mandated the development of federal programs to protect waters throughout the United States. Until recently, CWA focused on management of point source pollution, such as wastewater treatment discharges through a permit system. The Colorado Department of Public Health and Environment (CDPHE) is the state agency charged with implementing CWA permitting requirements. Among these regulatory responsibilities are the implementation of stream use classifications and numeric standards and the issuance of discharge permits. The City is responsible for meeting applicable stream standards and discharge permit requirements.

The intent of the CWA and stream classification system is to protect water quality and aquatic life. These objectives are consistent with the City's objective to *"Protect Public Health and the Environment."*

In 2001, in response to CWA requirements, 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. This is Phase II of the Colorado Discharge Permit System (CDPS) regulations. The intent of this stormwater permit program is to reduce the amount of pollutants entering streams, lakes, and rivers as a result of runoff from residential, commercial, municipal, and industrial areas, including construction sites.

Traditionally, permit compliance has been based on monitoring of pollutant discharges to ensure compliance with numeric water quality standards. This approach is not necessarily effective for stormwater quality management. Thus stormwater permit compliance is based on implementation of stormwater management programs intended to reduce pollutant loading from urbanized areas. Compliance with a permit requires implementation of the following six programs:

1. Public Education: Provide information and training for the general public to understand their role in stormwater pollution impacts to streams in their community.

2. Public Involvement: Provide opportunities for public to be involved in decisions that address stormwater pollution management.

3. Illicit Discharge Elimination: Develop and implement programs to track and stop illegal discharges to storm sewer systems.

4. Construction Management: Develop and implement ordinances and inspection and enforcement procedures to manage sediment and pollutant discharges from construction sites that disturb greater than one acre.

5. Post Construction Management: Develop and implement ordinances and inspection and enforcement procedures to manage pollutant discharges after construction is complete.

6. Municipal Good Housekeeping: Implement procedures and practices to prevent pollution from operations of City, County, and other public entities.

Watershed Approach to Stream Health

Locally, the cities of Boulder, Longmont and Louisville, the Towns of Superior and Erie, and Boulder County also fall under the Phase II stormwater regulations. Because all of these communities must implement these six programs, staff from these communities recognized that many benefits could be achieved by working together to implement common programs. These communities partnered in the Watershed Approach to Stream Health (WASH) Program to address the requirements of the Phase II stormwater regulations and to address broader water quality concerns. Under the WASH program, a plan was developed that outlines activities to address permit requirements.

The communities participating in the WASH program were each issued a State Stormwater Discharge permit in March 2003. Permit conditions include implementation of the WASH plan and the six program areas mentioned above. In the WASH plan, a number of activities are shared, such as the development of model ordinances, and implementation of public education programs. However, there are some compliance activities which are the sole responsibility of individual communities, such as enforcement and inspection.

The City of Boulder's participation in this regional partnership is consistent with the direction received from the BVCP to place special emphasis on regional efforts such as watershed planning and protection. Implementation of a common approach results in consistent approaches throughout the Boulder Creek watershed and provides more comprehensive, regional protection of water quality. This approach is not required by state regulations and the WASH program is one of the few examples of a cooperative approach to permit compliance in Colorado.

Total Maximum Daily Load

Under section 303(d) of the 1972 CWA, states are required to develop lists of impaired waters. Once a waterbody has been listed, a Total Maximum Daily Load (TMDL) must be developed. A TMDL is *a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources*.

Boulder Creek has been listed by CDPHE on the 303(d) list as an impaired waterbody for unionized ammonia and aquatic life. The City has responded to the listing with a combination of wastewater treatment plant upgrades, Best Management Practices (BMPs), and habitat restoration to improve water quality in Boulder Creek.

In addition, CDPHE is considering listing Boulder Creek for E. coli bacteria contamination. Elevated levels of E. coli have been found in Boulder Creek, just above the City to below its eastern boundary and again in the segment below the confluence with Coal Creek. E. coli are bacteria found in the intestine of warm blooded animals and are associated with fecal waste. The source of the E. coli contamination in Boulder Creek is unknown. Suspected sources include wildlife (raccoons), domestic pets (dogs), and human waste products. Bacterial contamination from these sources might enter Boulder Creek through the City's storm sewer system, cross connection of the storm and sanitary sewer, or through groundwater from failing septic systems.

To address bacterial contamination, the City must implement source controls and management. The City is currently working with the Colorado School of Mines to determine the source of contamination. Control practices will be dependent on these findings, and may include public education, septic system controls, and wildlife management strategies.

The City currently has a comprehensive monitoring program that evaluates baseline conditions of Boulder Creek's water quality and aquatic community structure. This program is vital in assessing stream health and evaluating potential sources of pollutants. In addition, this information can be used to evaluate responses necessary to meet current and future water quality regulations.

Sediment and Aquatic Life Regulations

Recently the Colorado Water Quality Control Commission (WQCC) has developed the *Provisional Implementation Guidance for Determining Sediment Deposition Impacts to Aquatic Life in Streams and Rivers* (2002). This guidance is an interpretation of the WQCC's more general narrative standards in The Basic Standard and Methodologies for Surface Water Regulation (5CCR 1002-31) which outlines stream standards throughout Colorado. This guidance document outlines requirements to reduce sediment loading caused by erosion and bank instability, and it provides a methodology for assessing the impacts of sediment on aquatic life. This methodology is based on other EPA guidance, including the rapid bio-assessment protocols (RBP).
To comply with the sediment guidance document, the City must institute controls to address sediment and preserve riparian and aquatic habitat. These controls may include stabilizing stream banks and enhancing riparian habitat, preserving natural stream corridors and floodplains, and implementing runoff and erosion controls.

Issues and Analysis

Several regulatory compliance issues were identified during the CFS process and are listed below for consideration and for use in future efforts.

- The City is committed to meeting all applicable regulations related to water quality. The intent of these regulations is to protect water resources and the natural environment.
- Regional cooperation and watershed based water quality management and compliance activities.

The City recognizes the importance of watershed protection as expressed in numerous resolutions passed by the City Council and advisory boards and by its adoption of watershed and water quality protection provisions in the BVCP. The successful implementation of a watershed based approach to stormwater quality management is represented by the City's participation in the WASH program. Continued evaluation of regulatory requirements and regional watershed issues is needed to identify future opportunities to build on this successful program.

These opportunities may arise from flood and stormwater management issues. These opportunities may also become available through internal collaboration between City departments and programs. The City is currently in the process of developing a Water

Quality Master Plan. This Master Plan can be used to outline future regional and internal opportunities which are linked to City of Boulder stormwater quality protection efforts.

- Water Quality monitoring to track baseline conditions and evaluate regulatory compliance.

The City conducts monthly water quality monitory of the main stem of Boulder Creek. Continued monitoring will provide information needed to evaluate impact of existing and new regulatory requirements such as the TMDL and sediment/aquatic life standards.

Public Input

The issues related to regulatory compliance were discussed during a Water Resource Advisory Board (WRAB) meeting (July 15, 2002). At that time WRAB generally accepted the staff recommendations outlined in the discussion so that staff might proceed in the development of these issues in the CFS master planning process.

Recommendations and Action Items

Based on analysis and public input, and in following the guiding principals set out in this chapter, the following regulatory compliance activities are recommended.

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

4.3.2 Sub-basin Management

There are 15 major drainageways (or creeks) in Boulder and each has an associated drainage basin, or sub-basins. Most of the sub-basins have a high percent of impervious surfaces, consequently, the water flows quickly and in great volumes to Boulder's creeks. There is no opportunity for water to infiltrate into the ground, and thus soils and vegetation cannot filter out pollutants from surface runoff before it reaches the stream. Sub-basin management focuses on reducing the impact of runoff by focusing on preventive measures to "Minimize Pollution at the Source."

Currently, sub-basin management practices are included in a number of the City's program and documents. These include the City's *Design and Construction Standards* (DCS) (2001), Boulder Revised Code (BRC), and the *Boulder Creek Watershed Study* (2000).

Design and Construction Standards

The City's DCS requires implementation of stormwater quality BMPs for construction and post-construction. Construction BMPs include the submittal of stormwater reports and plans, which include necessary analyses, mitigation measures, and improvements needed to meet City stormwater quality and erosion control standards. Post-construction BMP requirements are intended to reduce the impacts of sediment and pollutant discharge from developed sites and include the following:

- Minimize Directly Connected Impervious Areas (MDCIA)
- Provide stormwater detention and provide water quality capture volume for the major and minor storm event (where required)
- Provide stormwater quality facilities to the extent practicable (if not required)
- Utilize "Industrial and Commercial Best Management Practices" for commercial or industrial projects.

The BMPs outlined in the DCS are well suited for new and suburban development. However, Boulder is nearly built-out and, therefore, must develop BMPs that are more appropriate for urbanized applications.

Boulder Revised Code

Title 11, Chapter 5, "Stormwater and Flood Management Utility" in the BRC, outlines the major objectives of flood protection, storm drainage management and stormwater quality goals. The regulations outlined in this chapter currently focus on the flood utility fee structure and drainage requirements. The chapter only addresses stormwater quality issues in a very cursory manner.

Boulder Creek Watershed Study

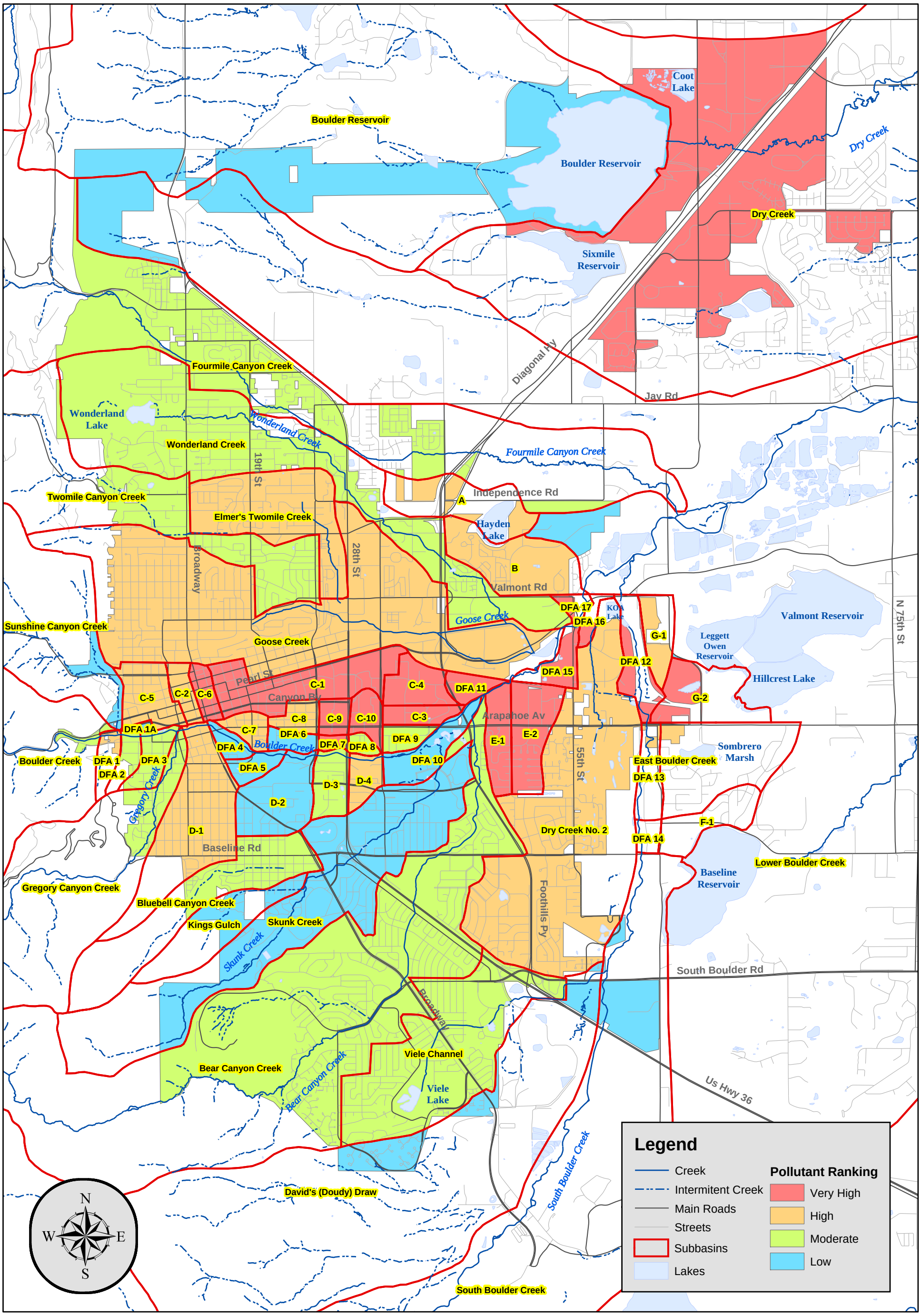
In 1997, the Boulder Creek Watershed Study was initiated to provide support for a comprehensive, watershed approach to water quality management. One of the most important elements of the study was the development of the Boulder Creek Watershed GIS. Using this GIS, a water quality model was developed to estimated pollutant loads from each subbasin. A statistical method of analysis was used to sort the predicted loadings into categories ranging from very high to low. These are illustrated on Figure 4-1. A similar analysis was conducted for natural resources such as aquatic habitat quality and wetland acreage and ranking of good to poor quality were developed. The Boulder Creek Watershed Study GIS and associated rankings can be used to prioritize water quality improvement projects. Figure 4-2 illustrates how these rankings can be used to develop a map of prioritized areas.

Issues and Analysis

The following key issues most directly impacting the public are identified.

- Best Management Practices (BMPs) for redevelopment and implementing BMPs in existing development sites (treating runoff)
- Use of incentives to encourage implementation of BMPs.

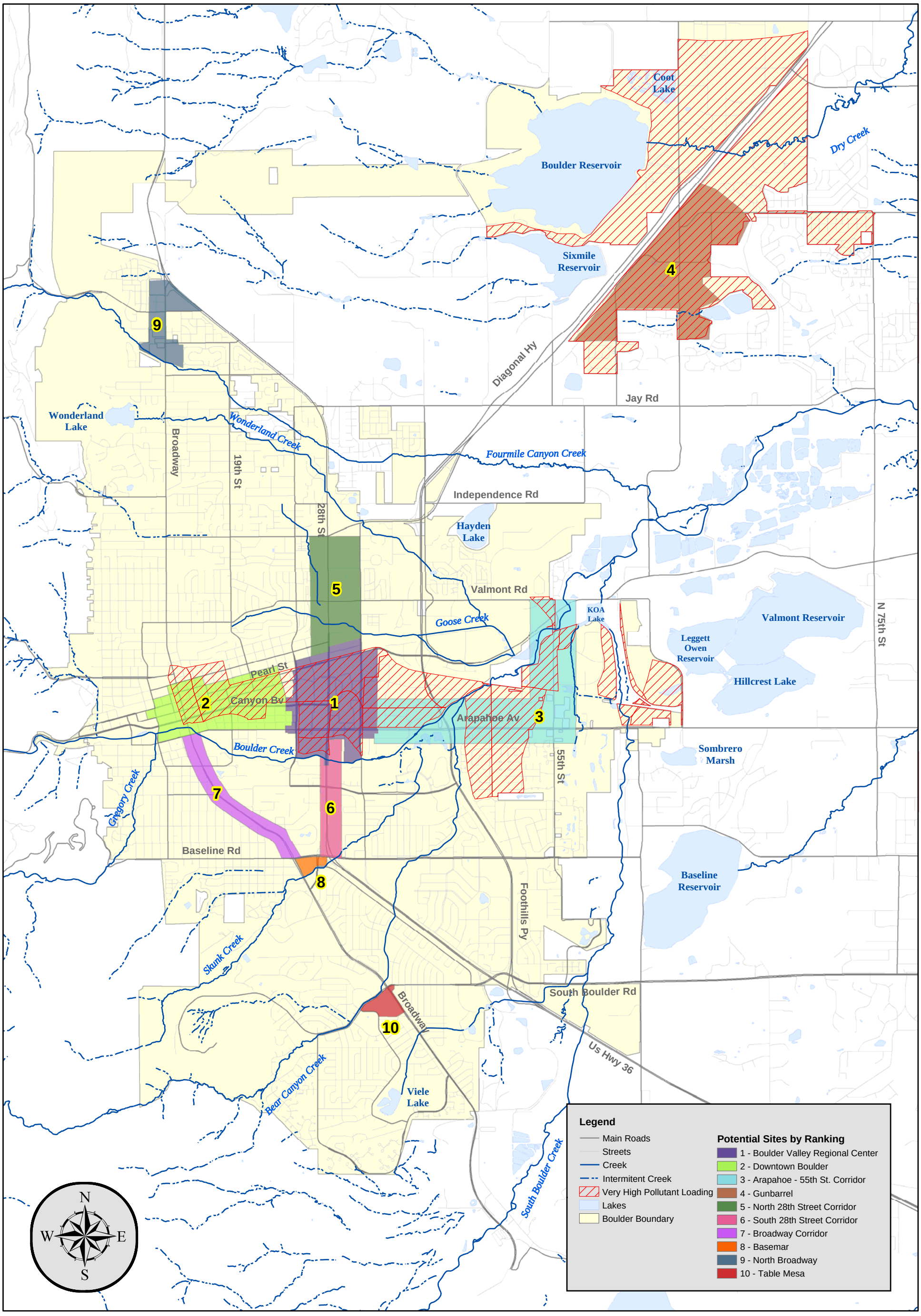
Currently, BMPs identified as options in the City's DCS are geared more toward new development than toward re-development. Boulder is predominantly "built-out", and guidelines focused toward new development have limited applicability in denser, redeveloping areas such as the Boulder Valley



City Of Boulder

Subbasin Pollutant Loading

Figure 4-1



City Of Boulder

Potential Redevelopment and Water Quality Improvement Sites

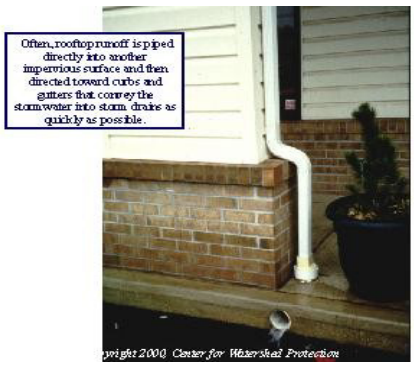
Figure 4-2

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.

- Minimize Runoff, Imperviousness and Directly Connected Impervious Areas *(Preventing Runoff)*

Currently, the City has programs that help minimize imperviousness and directly connected impervious areas. These include buying land through the Open Space and Mountain Parks Department. The City also encourages new development to minimize imperviousness and directly connected impervious areas according to guidelines of the UDFCD. These include grass swales, buffers, and porous pavement design guidelines (see Figure 4-3).

Boulder is nearing build-out and has limited opportunities to impact water quality with the current requirements. Redevelopment offers the opportunity to integrate pervious areas where stormwater can infiltrate and be used in landscape areas. The use of public lands and easements to treat stormwater is another option to explore when evaluating limited options for our built-out community.



Connected Imperviousness

- Utilize natural features and processes

Vegetated landscapes absorb large quantities of rainfall and filter out pollutants from stormwater. Using natural process can be a very cost effective way to improve water quality. There are a number of ways to encourage vegetation in an urban environment. Landscape standards, an urban forestry program, and management of public land all present opportunities to address vegetated areas.

The City's DCS outline a number of requirements for vegetative cover through landscape standards. However, these requirements are minimal and address more aesthetic qualities of landscaping, but do not focus on the potential for water quality treatment.

In addition, our urban forest contributes greatly to the reduction of runoff. The City's Urban Forestry section of the Parks and Recreation Department is responsible for the management of trees located on City property. The program goal is to foster a healthy urban forest, but again, aesthetics is more of the focus for this program.

Information from Other Communities

A number of communities have begun to look at innovative approaches to stormwater quality control. Examples include the following:

Seattle Public Utilities began to actively promote restoration of local creek habitat and citizen stewardship while improving creek drainage systems. However, they have recognized that in-stream restorations alone cannot sustain long-term health of fragile ecosystems. Therefore, Seattle has implemented the Natural Drainage Systems Project. The goals of the project are to infiltrate and slow stormwater flow, filter and bio-remediate pollutants by soils and plants, reduce impervious surface, increase vegetation, and improve the pedestrian experience. The project uses natural features - open, vegetated swales, stormwater cascades, and small wetland ponds - to mimic the functions of nature lost to urbanization. New technologies like porous pavement are also being employed and tested.

Portland, Oregon is considering a discount program that would reduce the stormwater utility fee by one third for managing stormwater on-site. They also have a small grant ($5,000) program for community groups to retrofit existing development and/or restore natural areas.

In the San Francisco area, the Bay Area Stormwater Management Agencies Association has produced a booklet that outlines BMPs for homeowners and developers. Some of the more innovative BMPs included in this booklet are yard "cisterns" with permanently open outlets that drain to grass areas, gardens, or other landscaped surfaces. It is questionable whether or not cisterns would be legal in Boulder, however.

Austin, Texas development regulations have relatively stringent limits on impervious cover for the more sensitive watersheds (as low as 15% to 20%). There are no impervious cover limits in the urban watersheds, while suburban watersheds have limits as high as 80% for commercial sites.

Public Input

The issue of "Best Management Practices for Redevelopment and Implementing BMPs in Existing Development Sites" was reviewed and discussed as part of the CRG meeting on August 14, 2003. During this meeting, there was a general preference expressed for performance-based requirements that would be flexible and provide financial incentives for developers. It was suggested that the City should consider a point system similar to the Leadership in Energy and Environmental Design (LEED) program. One participant raised the concern that considerable cost for BMPs would be borne by property owners and developers and, therefore, the cost of additional requirements and associated water quality benefits should be carefully assessed. However, this comment was countered by the point that it is indeed the responsibility of the property owner not to discharge pollutants from their property.

The issues of "Minimize Runoff, Imperviousness and Directly Connected Impervious Areas" was also discussed at the CRG meeting . There was a general preference expressed for performance-based requirements that are flexible and provide financial incentives. There was concern that the goal to minimize imperviousness and directly connected

impervious areas (MDCIA) might conflict with another department's requirement/objectives such as the City's "new urbanism" objectives. Some felt that supporting more density and minimizing imperviousness may be conflicting objectives for the City in general. However, staff feels that MDCIA and "new urbanism" do not have to be mutually exclusive.

Recommendations and Action Items

Based on analysis and public input, and in following the guiding principals set out in this chapter, the following sub-basin management actions are recommended.

- 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.
- Review the City's landscape standards from the perspective of increasing water quality benefits. Vegetated landscapes absorb large quantities of rainfall and filter out pollutants from stormwater.
- Integrate multiple objectives including water quality enhancement on City-owned land and in decisions regarding future property acquisition.
- Develop GIS tools 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 *Boulder Creek Watershed Study*.
- Update development and re-development regulations and standards to expand runoff reduction and water conservation requirements.

4.3.3 Stream Enhancement

The quality of an urban stream is defined by the nature of the contributing watershed, and specifically the degree of imperviousness. Hydrology, channel morphology, water quality,

habitat, and biodiversity are all strongly influenced by watershed imperviousness. The activities included in the program elements outlined in the previous section of this chapter describe efforts to address the amount of imperviousness and its impacts. Stream enhancement focuses on the stream corridor itself.

In an urban stream, pre-development conditions may be impossible to achieve. However, by focusing on stabilizing the stream environment, an "ecological equilibrium" or "best attainable conditions" may be achieved. Stable stream environments are necessary for fish and other aquatic species to survive. Changes in urban streams and watersheds may be so significant that stream stability may be difficult to achieve or maintain. The goal of stream enhancement is to achieve this stability. Stream enhancement activities may include minimizing channel erosion and sedimentation, and preserving riparian habitat and the hydrologic connection between surface and groundwater.

The City has a number of programs in place to address preservation and enhancement of the stream corridor, including the Greenways Program, the Wetlands Protection Ordinance, and Major Drainage-way Planning Process.

The *Greenways Master Plan* (2001) presents an inventory of future opportunities for areas, designated as "reaches," along Boulder Creek and six of its tributaries. The Reach Inventory, which identifies these future opportunities, also presents the existing riparian and aquatic habitat conditions along the stream corridors. A process for considering and implementing these opportunities is outlined in the plan. Greenways objectives are prioritized by reach to provide guidance in considering these opportunities. The reaches and project opportunities are also summarized in the *Greenways Master Plan* (2001) map.

The City's Land Use Regulations include a Wetland Protection Ordinance, which defines wetlands and their buffer areas and outlines the requirement for development within or adjacent to these areas. In addition, the code requires the use of the Wetlands Protection Ordinance BMP guidance document. The regulations and BMP guidance are excellent resources to address stream enhancement issues.

Periodic updates of floodplain mapping and risk assessment for Boulder's creeks is accomplished through the Major Drainageway Planning Process. In the past, inclusion of water quality and/or stream enhancement concerns in this process has been inconsistent.

Issues and Analysis

Several issues related to stream enhancement were identified during the CFS process and are listed below for consideration and for use in future efforts.

- Protect and enhance stream corridors and riparian habitat.

In their natural state, streams contain deep pools alternating with more shallow riffles. In urban streams this pattern is disrupted, leading to a more uniform channel which provides less varied habitat and thus less varied aquatic communities. In addition, development often encroaches on the riparian habitat adjacent to stream systems. Riparian habitat provides a number of water quality and ecosystem functions including pollutant filtration and shading, and provides food and shelter for aquatic communities.

Protecting and enhancing the stream corridors and riparian habitat may include the following activities:

- Developing stream buffers to protect the function of riparian habitat.
- Enhancing the stream channel.
- Mitigating flows and providing channel structures to minimize erosion and sedimentation.

Currently, the Greenways Program includes stream restoration projects. In addition, the *Greenways Master Plan* (2001) calls for the development of greenways design guidelines to outline standards for construction projects in or near waterways. In addition, the Wetlands Protection Ordinance has a number of provisions that address protection of riparian areas and stream channels.

- Focus on Small Streams

By focusing on smaller "headwater" streams, downstream water resource protection goals can be more effectively met. It is also important to address not only perennial streams but those streams with only ephemeral or seasonal flows. These streams provide a number of ecological benefits and contribute to the overall stability of a stream system.

- Preserve the hydrologic connection between surface and groundwater

Stream flow is made up of both groundwater and surface water. Stream enhancement activities must address preserving groundwater re-charge areas and groundwater quality in the watershed, and maintaining the hydrological connection in the stream channel.

Public Input

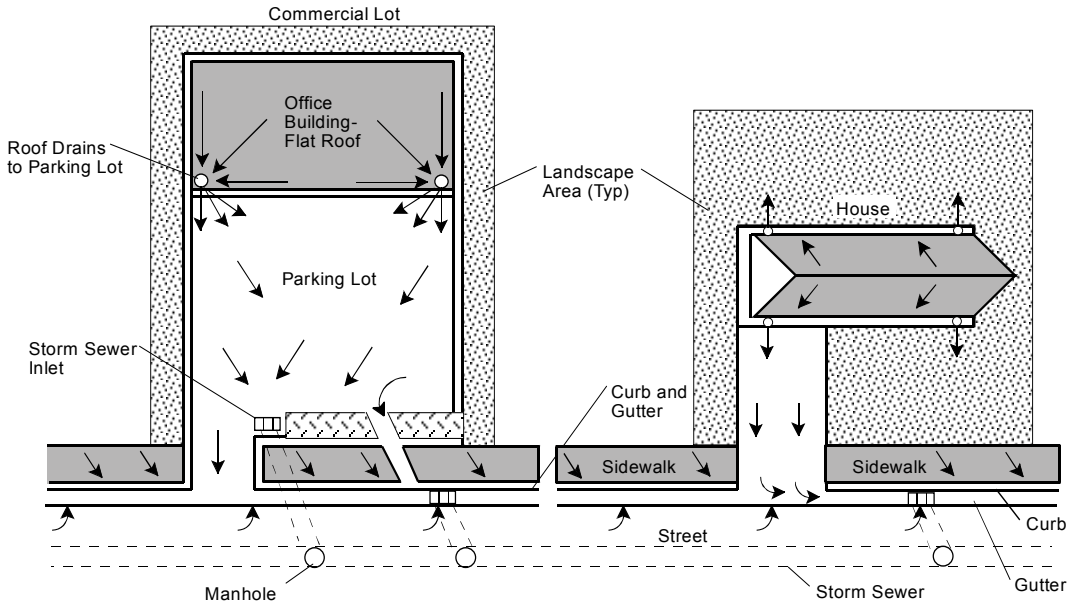
The issues related to stream enhancement compliance were discussed at the July 15, 2002 WRAB meeting. At that time WRAB generally accepted the principals outlined in the discussion and directed staff to proceed in the development of these issues in the CFS master planning process.

Recommendations and Action Items

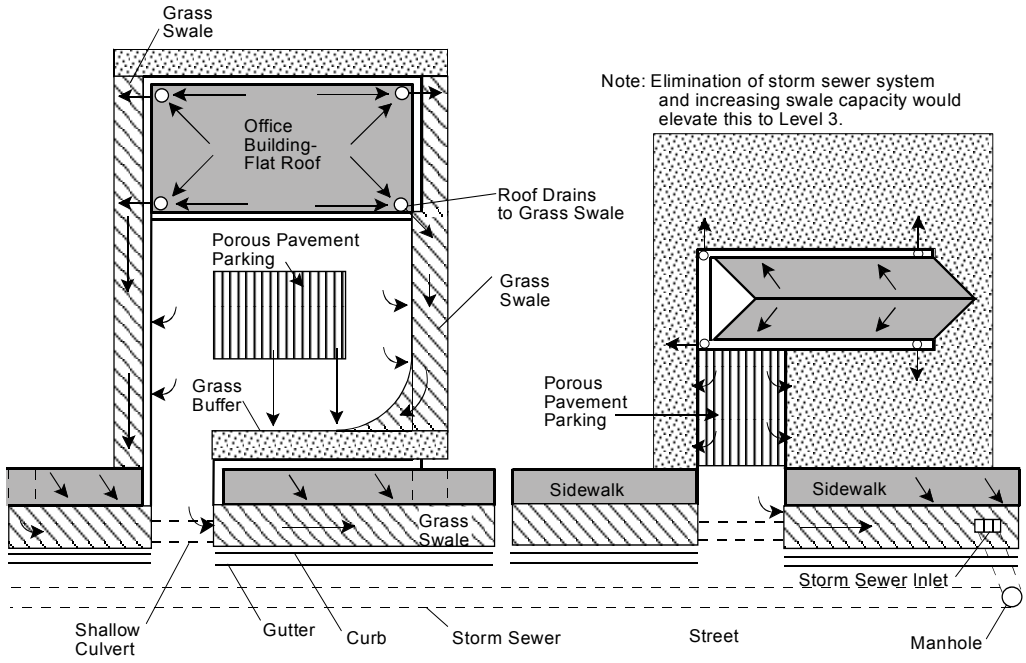
Based on analysis and public input, and in following the guiding principals set out in this chapter, the following stream enhancement activities are recommended.

- 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.



TRADITIONAL SITE & STREET DRAINAGE DESIGN



MINIMIZING DIRECTLY CONNECTED IMPERVIOUS AREAS (LEVEL 2 PRACTICES SHOWN)

Figure 4-3

CHAPTER 5 – STORMWATER DRAINAGE

5.1 OVERVIEW

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. Figure 5-1 shows the irrigation ditches located within the City's stormwater system.

The stormwater collection system is documented in the City's geographic information system (GIS). The GIS database is maintained by the City's Mapping and Records

Example of Storm Sewer Discharge into an Irrigation Ditch

5.2 GUIDING PRINCIPLES FOR STORMWATER DRAINAGE

Guiding principles for the stormwater drainage program component are proposed as follows:

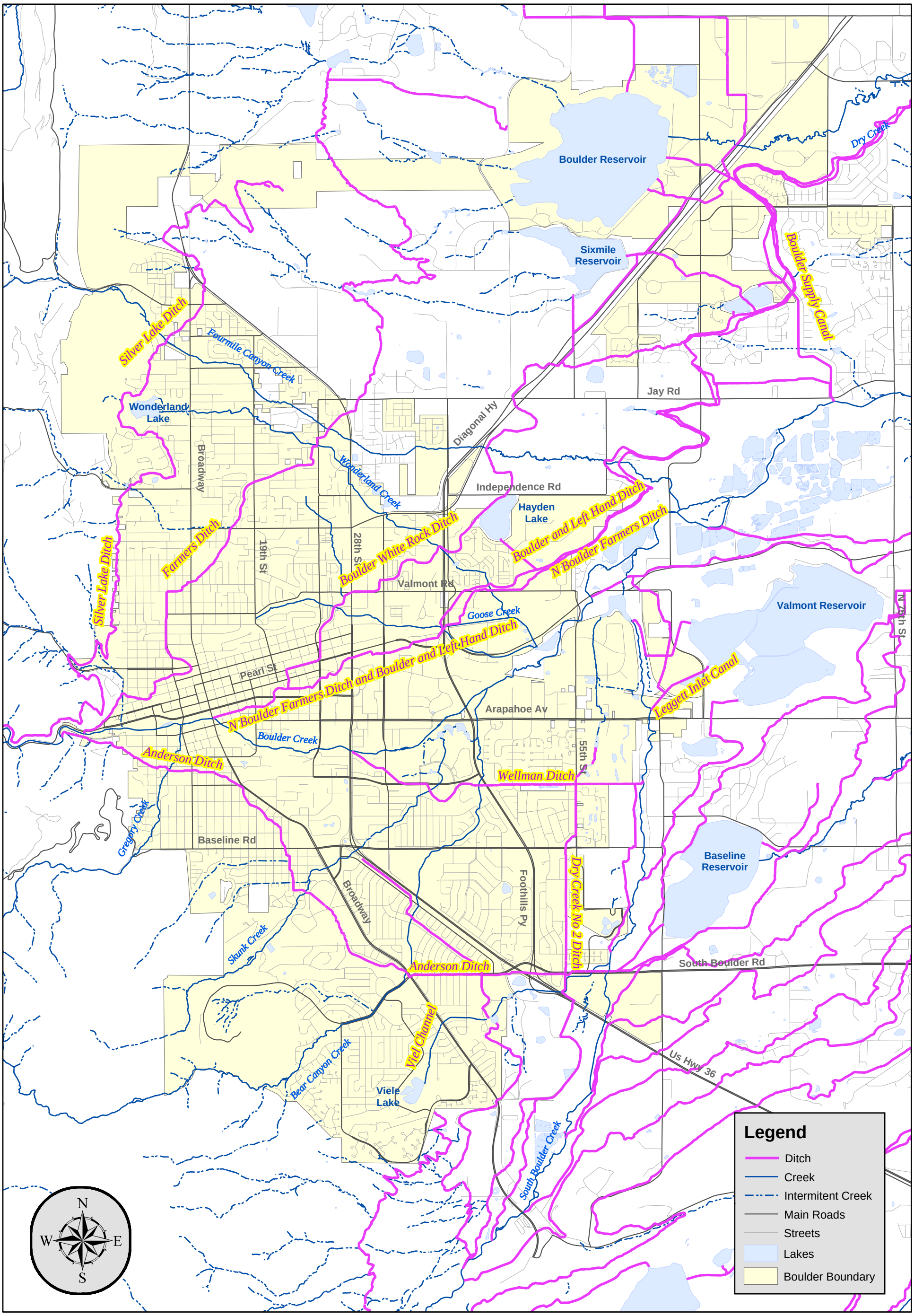
1. ***"Maintain and preserve existing and natural drainage systems."***
2. ***"Reduce and manage developed runoff."***
3. ***"Eliminate drainage problems and nuisances."***

It is with these guiding principles in mind that the following key issues were developed and recommendations and action items were formulated.

5.3 RECOMMENDED STORMWATER DRAINAGE PROGRAM ELEMENTS

The following sections in this chapter outline the program elements necessary to meet the guiding principals. Focus areas include:

- Stormwater Collection System and Planning
- Design and Construction Standards
- Maintenance
- Detention
- Groundwater



City Of Boulder

Irrigation Ditches

Figure 5-1

5.3.1 Stormwater Collection System and Planning

In 1984 WRC Engineering Inc. completed the *Stormwater Collection System Master Plan*. It provided the City of Boulder with a guide for Capital Improvement Project (CIP) development. The master plan included three phases of development:

- To review and develop hydrologic data and create a model to analyze the existing storm drainage system.
- To evaluate the existing system, identify problems within the study area and develop a matrix of alternatives to solve the problems.
- To complete preliminary design of selected improvement alternatives.

Detention was evaluated, but was considered only when undeveloped land was available, and when it could reduce the initial storm flood peaks to the capacity of the existing system. The final list of recommended projects did not include any detention ponds.

The stormwater collection system improvement alternatives were evaluated in terms of cost and whether or not they provided a higher level of flood protection (i.e., 5-year). For commercial and industrial areas, and for lines which parallel or cross arterial streets, the alternatives were evaluated by their ability to reduce or minimize street flow in areas where the existing storm drainage system was inadequate. They were also evaluated on whether or not they provided stormwater release points for irrigation ditches within the City. Preliminary designs were completed for 54 storm sewer improvement projects, a waste way, one culvert and an area inlet. A total of 57 different projects were identified.

Over the past 19 years there have been 12 projects either completed or initiated. Usually, these projects are associated with major roadway improvements such as the Broadway project from University to Pine. The lack of citizen complaints and observed problems have reduced the priority of much of this work. The *Stormwater Collection System Master Plan* (1984) continues to serve as the City's primary guide to allocate resources for stormwater drainage (storm sewers) purposes. In addition to this plan the City of Boulder, Boulder County and the Urban Drainage and Flood Control District (UDFCD) completed the *Outfall System Planning - Boulder Gunbarrel Area* (1987).

Issues and Analysis

Updating the existing 20-year old plans should be considered for a number of reasons.

Several assumptions regarding the imperviousness associated with certain land-uses were made when the hydrology was last modeled. These assumed values differ from those shown in the updated UDFCD manual. Also, several land-use changes have occurred that will affect hydrology calculations. This may change the size and location of recommended storm sewer systems.

The original plans assumed a greater amount of future development than occurred or is likely to occur in Boulder. Therefore, the future condition flows calculated may be greater than what would be estimated today. Rainfall estimates within the original plans appear to meet current UDFCD criteria.

The National Oceanic and Atmospheric Administration (NOAA) plans to update the precipitation data for most of the western United States in the future. When the updates are completed the UDFCD may update their associated data. However UDFCD has no plans at this time to update the rainfall data for the district. If there is a significant difference in this future revised data, then the City of Boulder should consider updating the hydrology for all plans.

None of the other communities contacted have developed a separate storm drainage plan to define drainage problems and solutions for frequent storm events. Most communities have only designed systems for less frequent (100-year) storm events, and developed solutions for more frequent events on a concurrent basis. However, the City and County of Denver has a master plan. Denver recommends updating their plan every few years. They last updated their plan in 1989.

The *Stormwater Collection System Master Plan* (1984) prioritized projects using several sets of criteria. Other communities generally have similar criteria that prioritize projects based on extent, magnitude and damage caused by the storm event and the cost of the proposed solution. However, several communities also take into consideration public needs based on tracking requests within a maintenance program, as well as a more specific assessment of risk and effectiveness of a project. It is recommended the City review the criteria for prioritization as part of the update to this plan, including the following considerations.

Public Need:

- Assessment of public need (database of maintenance issues and concerns.)

Prior Master Planning:

- Coordination with other master plans (Greenways etc.)

Urgency of Risk:

- Type of Risk as well as severity
- Frequency of Risk
- Preventative action

Effectiveness and Cost:

- Cost effectiveness
- Funds available
- Percent of problem solved
- Design life of solution

Erosion Control:

- Risk
- Potential Damage

Public Input

This issue was reviewed and discussed as part of the Citizen Review Group (CRG) meeting on August 14, 2003. It was suggested that the City not spend money on remodeling and restudying those areas we know about, but to concentrate on known problem areas and areas that are going to be developed in the future.

Regional detention may have some real benefits; however for a City as "built-out" as Boulder, opportunities may be limited. The exception might be detention which could be integrated with park development or expansion of existing private detention basins.

Recommendations and Action Items

The existing stormwater collection system master plan should be updated to include

drainage and stormwater quality issues considering current and future development and redevelopment.

Update the City's Stormwater Collection System Master Plan addressing the following issues:

- Current and future land use and associated imperviousness.
- Update hydrology/hydraulic models.
- Consider groundwater flows when evaluating existing capacity.
- 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.
- 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.
- Develop prioritization criteria and re-prioritize recommended projects.
- Review design storm criteria including selected recurrence interval.

5.3.2 Design and Construction Standards

The City's *Design and Construction Standards* (DCS) (2000) regulate the design and construction of public infrastructure, improvements, and landscaping within the City's public rights-of-way and public easements. The DCS has undergone several updates in recent years including a complete rewrite in 1998 to replace the *1982* specifications. The DCS was most recently updated in 2000. Both the 1998 and 2000 updates have included significant changes in the area of stormwater management. In 1998, a requirement for major storm detention was added to the previous minor storm requirement. Also, the methodology for pond volume calculation was changed from a standard formula to a routed hydrograph method, and stormwater quality requirements were introduced. Further refinements to stormwater standards occurred in the 2000 update including the introduction of more detailed minimum standards for water quality best management practices.

The DCS requirements for stormwater management are primarily based on the UDFCD drainage criteria manuals. Some tables and charts have been adjusted to account for local differences. Other references have also been used where they provide a clearer methodology or superior performance. Requirements for stormwater quality best

management practices refer almost entirely to the UDFCD manual.

Stormwater issues related to land development and redevelopment are addressed through a variety of review processes coordinated by the Planning and Development Services Workgroup. Most development and redevelopment projects are required to submit a Stormwater Report and Plan prepared by a licensed professional engineer. The report and plan address how the project will maintain historic runoff rates and mitigate water quality impacts.

Issues and Analysis

The DCS requirements for stormwater management are primarily based on the UDFCD *Drainage Criteria Manual – Volumes 1&2 (2002-2004)*. Consistency between the DCS and the UDFCD manuals is an issue that should be reviewed in future updates of the DCS. The City, as part of the UDFCD, should maintain consistency except in cases where other references provide a clearer methodology or superior performance.

Another subject is the integration of stormwater drainage and stormwater quality issues. Because of their close interrelationship, it is important that the associated standards be reviewed, based on a good understanding of both issues.

Public Input

This issue was not discussed at the CRG meeting on August 14, 2003 since it was considered an internal issue to the City's Public Works Department.

Recommendations and Action Items

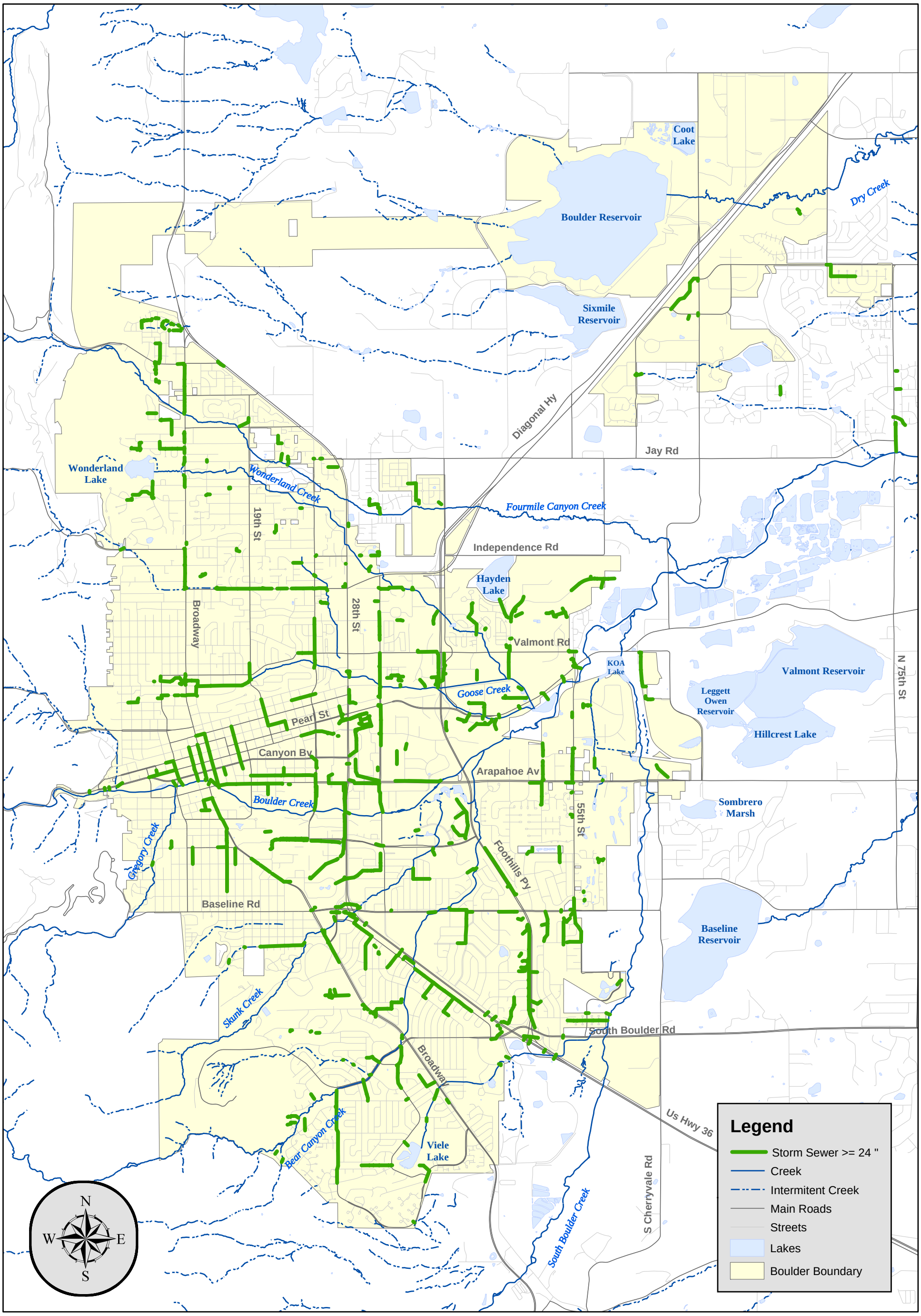
- The current standards were last updated November 16, 2000 and need to be consistent with the most current versions of UDFCD.
- Integrate stormwater drainage and stormwater quality standards.

5.3.3 Maintenance

The stormwater collection system maintenance program is currently funded and staffed for an approximate 2-year maintenance cycle. Maintenance on open drainageways is performed on an as-needed basis.

Stormwater and flood management maintenance activities are currently scheduled and tracked using the Utilities Maintenance Management System (UMMS), a Microsoft Access database. The database is designed to record information related to a variety of factors including employees, equipment, materials, observations and maintenance activities. UMMS is integrated with the City's GIS. The GIS data includes all publicly owned stormwater facilities such as storm sewer, manholes, inlets and small diameter culverts. A typical GIS application indicating the location of existing storm sewer mains greater than 24-inch diameter is shown on Figure 5-2.

The system does not currently integrate above grade facilities associated with the major drainageways. However, these facilities were recently inventoried as part of the Drainageway Information Management System (DIMS) and are now available as a GIS layer. Maintenance responsibility for these facilities is



City Of Boulder

Storm Sewer Mains

Figure 5-2

shared with the Urban Drainage and Flood

Broadway Bridge at Boulder Creek

In addition, the Call-Log database is a stand alone system that has the ability to assign tasks to a selected list of individuals and can accommodate multiple tasks assigned to multiple persons for any given problem. Staff is working on integrating these systems in order to have information available in one database.

Issues and Analysis

Maintenance issues include frequency and tracking of maintenance activities.

The frequency of removing excessive vegetation and debris along open drainageways is an issue. Excessive vegetation and debris increases the potential for flooding. A yearly inspection and maintenance cycle should be considered.

Surveyed communities generally have an automated system that tracks incoming complaints and requests. These database systems are often used for the prioritization of projects as well as the determination of the timing and development of the best course of action to eliminate the problems, track the follow-up, and inspections. Most databases are also connected to a map (GIS) inventory system.

Public Input

This issue was not discussed at the CRG meeting on August 14, 2003 since it was considered an internal issue to the City's Public Works Department.

Recommendations and Actions Items

- Integrate above grade facilities associated with the major drainageways (DIMS) into UMMS.
- Integrate maintenance performed by the UDFCD into UMMS.
- 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.

5.3.4 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. 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. Most of these facilities are privately owned and maintained. The inventory of existing detention facilities is shown on Figure

Dakota Ridge Detention Facility

Issues and Analysis

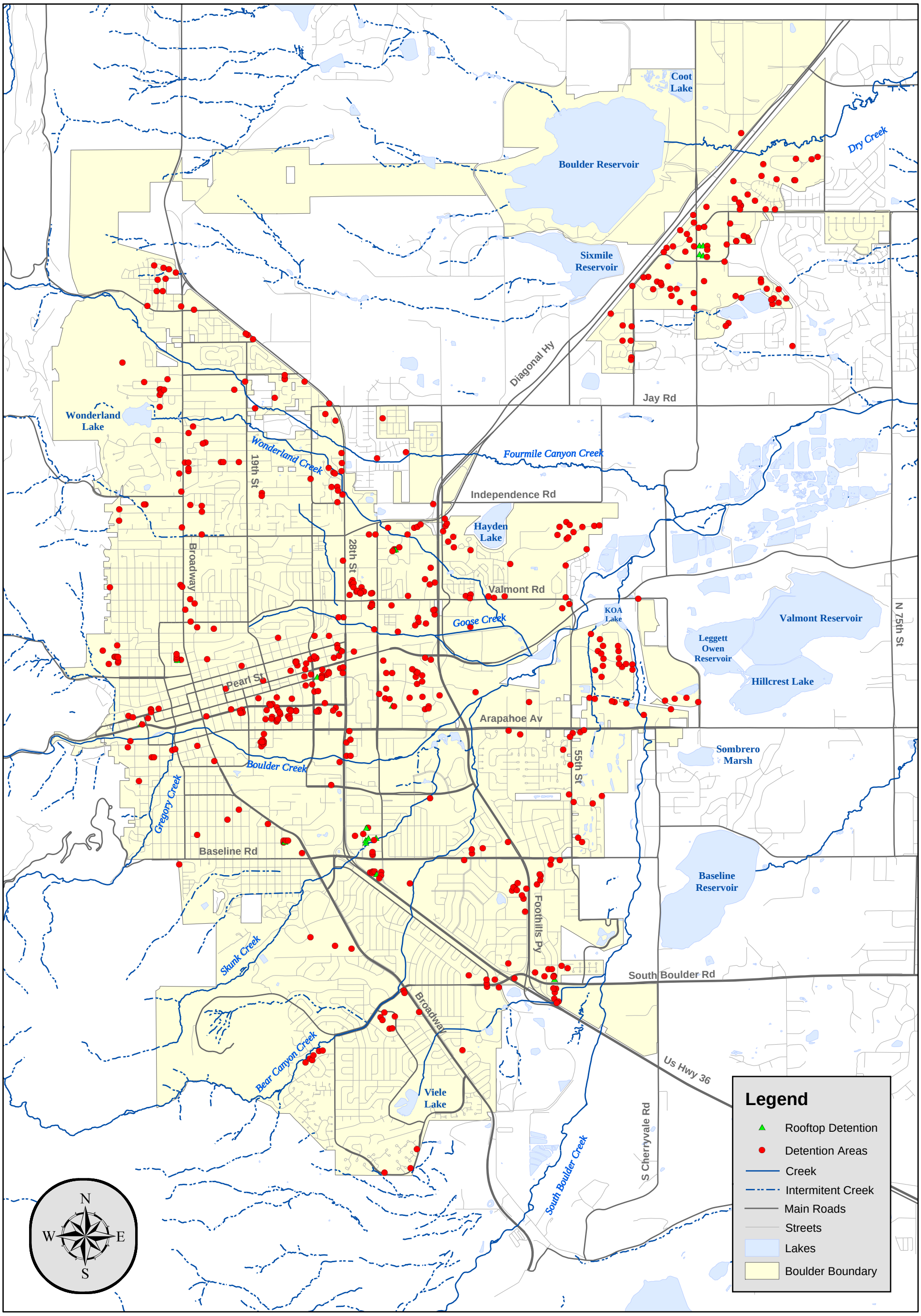
For redevelopment, only the increment of difference between the existing developed and new developed conditions is required to be detained. This often leads to a missed opportunity to further reduce peak stormwater flows and improve water quality.

Most communities interviewed have the same requirements as Boulder. One community (Fort Collins, Colorado) requires that redeveloped sites comply with current criteria if the site is completely redeveloped. Current criteria is detention of the 100-year event, released at the existing 2-year rate with 40-hrs of detention time (for water quality purposes).

The existing detention facilities issues are:

- Maintenance
- The opportunity to reduce peak stormwater flows and improve water quality
- The opportunity to implement multi-objective projects using detention
- The opportunity to maintain existing capacity of an existing system
- Private ownership
- No post construction/use inspections

Some municipalities have requirements or programs for inspecting and maintaining existing detention facilities. For example, Fort Collins, Colorado conducts annual inspections and maintenance of 82 City-owned detention facilities. Some of these are regional facilities originally constructed by the City as a capital improvement project. The other facilities are associated with residential subdivisions. They also have over 500 privately owned detention facilities, for which there is no inspection and maintenance program at this time.



City Of Boulder

Inventoried Detention Facilities

Figure 5-3

The City of Overland, Kansas has required annual inspections and certifications of private detention facilities since the late 1980s. The inspection must be stamped by a professional engineer. It must certify that the outlet structure is functioning and that the detention facility continues to provide its design storage.

King County, Washington takes ownership of detention facilities associated with residential subdivisions (approximately 1,000) and they inspect/maintain these facilities once every 2-3 years. They also inspect new detention facilities associated with new residential subdivisions once each quarter during the 2-year bond period. The frequency is greater because this is the time period when erosion causes the greatest problems in the detention facility. In 2003 their work program called for a total of 550 inspections and follow-up.

In addition, King County inspects approximately 800 private (commercial/ industrial/multi-family/government) facilities on a 2-3 year rotating basis. If they find a problem they send a letter notifying the property owner of non-compliance and that correction is needed. They also provide an incentive discount on the utility bill if the facility is in compliance, however they do not think this incentive has been large enough. As a result, they will begin taking enforcement action next year.

Public Input

On-site detention was reviewed and discussed as part of the CRG meeting on August 14, 2003. It was suggested that incentive-based performance standards should be used instead of fixed regulatory schemes, particularly for retrofitting where most situations are unique. There are concerns of the tremendous potential for considerable cost to be borne by property owners. Therefore, prior to moving from a non-degradation based approach to an approach that contemplates improving stormwater quality and detaining additional peak flows, there needs to be careful consideration of the associated costs and benefits.

Evaluation of existing detention facilities was reviewed and discussed as part of the CRG meeting on August 14, 2003. Although no consensus was reached, it was suggested that the City should inventory and periodically inspect these facilities but not necessarily assume maintenance responsibility. The City should consider requiring the owners of existing water quality and detention ponds to be made financially responsible for returning their facilities to their original design conditions and maintaining them to keep them functioning in accordance with their original design.

Recommendations and Action Items

On-Site Detention

- 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.

Existing Detention Facilities

- 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.

5.3.5 Groundwater

Groundwater and sump systems create nuisance drainage in the public rights-of-way and potential hazards due to build-ups 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 the current DCS.

Construction Dewatering at 9th & Canyon

Issues and Analysis

The City needs to be pro-active rather than reactive in dealing with groundwater issues when they may not have reliable data on discharge needs until a structure is complete.

Most communities do not have a requirement to control groundwater discharge after construction. Generally, communities require a Soils Report and a Stormwater Pollution Prevention Plan as part of development. The City of Fort Collins, Colorado, requires the identification of groundwater levels and/or a development plan to control groundwater. Cities like Portland require a mitigation plan if high groundwater is suspected. Portland has different groundwater discharge criteria for disposal of groundwater for each area (infiltration conditions) within their jurisdiction.

Public Input

This issue was reviewed and discussed as part of the CRG meeting on August 14, 2003. Comments included support for groundwater mitigation requirements. It was also recommended that the City have good inspection of check dams. Another commenter didn't support performance-based standards or regulations that would require everyone to locate the groundwater table. Although this may be appropriate for certain zones of the City, there are other areas where it would not be of concern.

Recommendations and Actions Items

- 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.

CHAPTER 6 – PROGRAM INTEGRATION AND IMPLEMENTATION

6.1 OVERVIEW

The City Charter provides for a Council/Manager form of government administration. The Council chooses and appoints a City Manager, a City Attorney, a Police Magistrate, and an Auditor, as well as advisory boards and commissions. The Council considers all recommendations by the City Manager, and by any of the advisory commissions or the City departments. Policy direction for the Stormwater and Flood Management Utility (Utility) is set by the City Council and administered by the City Manager.

6.2 CURRENT PROGRAM

Public Works is the City's largest department. Its mission is to plan, build, and maintain the City infrastructure, manage public investments, protect the public health and safety, promote environmental quality, and plan for future needs and changes. To accomplish this mission the Department is organized into three divisions: Transportation, Utilities, and Planning and Development Services.

Figure 6-1 presents the organization and allocation of full time employees (FTE) and positions funded by the Stormwater and Flood Management Utility within the various Public Works Department work groups. As shown, elements of the various Utility programs are dispersed, both functionally and physically, throughout the Public Works Department.

6.2.1 Utilities Division

Within Public Works, the Utilities Division is managed by the Director of Public Works for Utilities. The Utilities Division includes the Water, Wastewater and Stormwater and Flood Management Utilities. The mission statement of the City's Department of Public Works, Utilities Division 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 Water Resources Advisory Board (WRAB) serves to review Utilities Division programs and projects, especially capital improvement projects and priorities, and provides advice and recommendations to City Council. Projects within the City's Greenways are reviewed by the Greenways Advisory Committee (GAC).

The majority of the program functions are within the Utilities Division including:

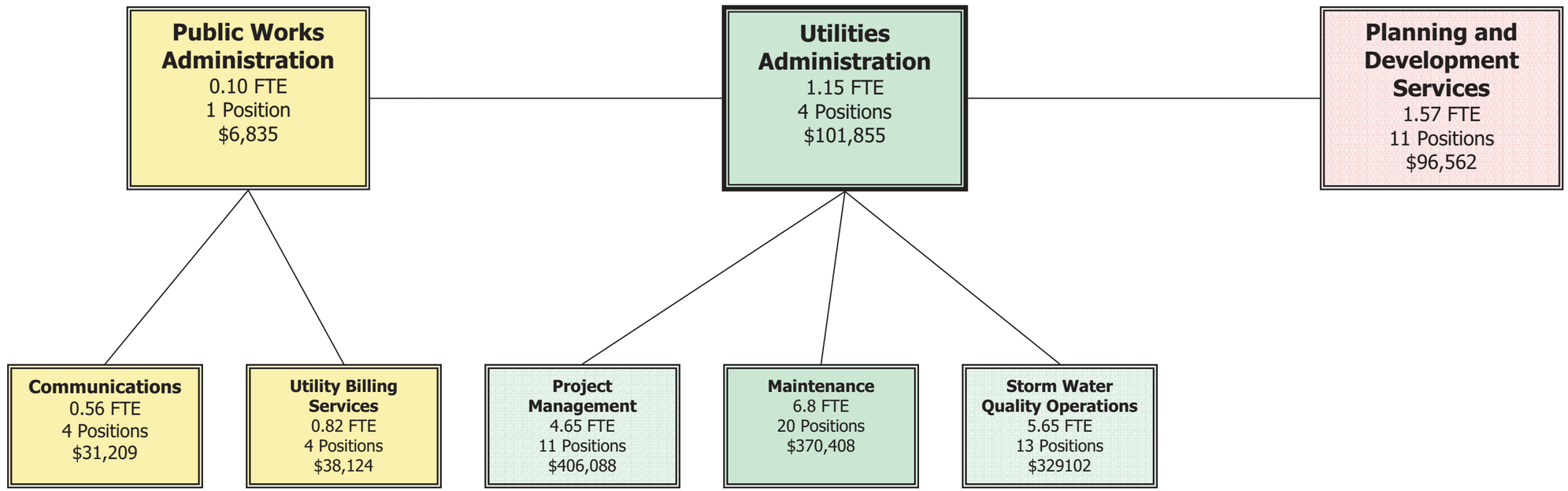
- Utilities Administration
- Utilities Engineering
- Water Quality and Environmental Services
- System Maintenance

Administration is responsible for overall budgeting, management and supervision of the Utilities Division, billing services and finance and analysis.

Utilities Engineering is responsible for the implementation of the Utilities Division Capital

Storm Water and Flood Management Utility
Organizational Staffing

21.3 Full Time Equivalents
(FTE)
Distributed Among 68
Positions
$1,380,183



City Of Boulder
Organizational Staffing

Figure 6-1

Improvement Program (CIP), Flood Management Program, Greenways Program, associated planning and other special projects.

Water Quality and Environmental Services is responsible for laboratory, industrial pretreatment, stormwater quality and water conservation programs.

System Maintenance is responsible for the maintenance of the City's water distribution, wastewater collection, stormwater drainage systems and major drainageways.

6.2.2 Planning and Development Services

The Development Support Services Division has partnered with the Planning Department to integrate service delivery. The result of that operational effort is "Planning & Development Services (P&DS)". This effort provides important support to the Stormwater and Flood Management Utility in the following areas:

- Information Resources
- Project Review – Engineering
- Floodplain and Wetland Management

Information Resources provides support to the development and maintenance of geographic information. This geographic information system supports engineering project management as well as development review services.

Project Review – Engineering provides review and inspection of private development and work in the City's right-of-way in accordance with the City's *Design and Construction Standards*.

Floodplain and Wetland Management provides review and enforcement of both public and private projects related to the City's floodplain and wetland regulations.

6.3 KEY ISSUES AND ANALYSIS

As mentioned earlier, the organizational structure provides both opportunities and challenges to integrating various program interests and other multi-objectives. The opportunities represented by this organizational structure include:

- Efficiencies based on personnel working together with similar professional expertise and experience. For example, engineers working on capital project are more likely to benefit from shared knowledge of construction techniques and methods. In a similar manner, water quality professionals are more likely to benefit from shared knowledge of pollutant sources and laboratory techniques.
- Maintenance workers can share equipment used for a variety of public works functions such as snow plowing, cleaning and repair.
- Workers can be assigned to various maintenance functions based on seasonal needs. For example, snow plowing can be accommodated by drawing from the personnel of other maintenance crews during the winter.
- It is more likely that projects and programs are better coordinated among the various public works department programs including water, sewer, stormwater and transportation.

- There is a single point of contact for the public regarding development review and related questions. There is a wide range of development issues including water, sewer, stormwater and transportation.

The challenges represented by the organizational structure include:

- There is no single point of contact for the stormwater and flood management program which may lead to difficulties in both internal and external communications.
- It is more difficult to identify specific gaps in stormwater and flood management service because personnel are involved in a variety of public works programs.
- There is more difficulty in coordinating projects within the stormwater and flood management Utility that overlap the various workgroups.

6.3.1 Current Program Integration System

In recognition of the numerous programs and activities of City government, the following institutional opportunities for integration are currently defined:

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

Annual Budget Process

The annual budget process provides an opportunity to integrate workgroup budget requests across the Utility. Staff discussions of budget proposals occur at different management levels and between workgroups. Final Utility budget proposals are based on the results of these discussions. The annual budget includes operating and capital budgets.

Annual operating budget proposals are developed by the first-line operating supervisors of each functional group in the utilities division. These proposals are compiled by the workgroup coordinators. Typically, work group coordinators provide budget recommendations to the Utilities Director and these recommendations are discussed in a group meeting. These proposals are reviewed and modified by successive levels of management within the division until a final proposal is approved by the Utilities Director.

The Capital Improvement Program (CIP) budget for the coming five years is a part of the Annual Budget Process. The CIP budget is developed by the Utilities Engineering work group and coordinated by the City's Planning Department. The definition of a capital improvement project is outlined in the Project Planning and Approval Process (PPAP) as follows:

- CIP projects must be major items. $50,000 is the minimum threshold to be

part of the CIP Budget (as opposed to the operating budget).

- Capital projects have to be durable and have a long useful life.

- Capital improvements should not include consumable items or short-lived equipment or services.

The Utilities Division selects capital projects for inclusion in the CIP based on priorities identified in the appropriate master plans. At the staff level, project needs are discussed in a meeting attended by work group coordinators and supervisors. Projects are prioritized and reconciled with funding. Recommendations are reviewed by the Director of Public Works for Utilities and the City Manager.

Utility recommendations are reviewed by the Water Resource Advisory Board. The Planning Department reviews all proposed CIP projects for consistency and accuracy and compiles the citywide CIP for Planning Board and City Council review. The CIP covers a 6-year time period and is updated annually.

Greenways Program

The *Greenways Master Plan* builds on policies outlined in several existing adopted plans and policies including:

- Boulder Valley Comprehensive Plan

- Comprehensive Drainage Utility Master Plan

- Transportation Master Plan

- Parks and Recreation Master Plan

- City Open Space Charter

- North Boulder Subcommunity Plan

Greenways projects are designed and constructed in compliance with the City's floodplain regulations and wetlands protection regulations, and Clean Water Act Section 404 permits. The master plan serves as a tool to coordinate and integrate the recommendations of these master plans and policy documents.

The purpose of the Greenways Program is to extend the stewardship of the City of Boulder to the important riparian areas along the tributaries of Boulder Creek. In order to achieve this purpose, it is necessary to integrate floodplain management techniques which preserve open space, protect existing vegetation, wetlands and wildlife habitat, and support recharge of ground water through interconnections with surface waters.

Through the Greenways Program, stormwater and flood management objectives are evaluated with the competing and sometimes conflicting goals of transportation, recreation, preservation of natural ecosystems, and water quality management. Greenways projects may include stormwater drainage improvements as well as flood control and water quality enhancements. The *Greenways Master Plan* integrates these objectives as a special resource to allow coordinated action involving multiple departments.

The *Greenways Master Plan* outlines the process for the Greenways working group staff to discuss on-going budgets and projects. Additionally, the *Greenways Master Plan* established the Greenways Advisory Committee which consists of a representative from each of the City's advisory boards:

Transportation, Water Resources, Parks, Open Space, Planning and Environmental. The Greenways Advisory Committee provides recommendations to their respective boards regarding Greenways projects and budget.

This review process is intended to assure integration of the Greenways program objectives.

Thus, the *Greenways Master Plan*, and the opportunities and process associated with implementation, represent a tool for integration of these City policies and standards. The Stormwater and Flood Management Utility provides $150,000 annually, which represents approximately one third of the Greenways Program funding.

Stormwater Quality Program

The Stormwater Quality Program was created as part of the CDUMP. Local recognition of the importance of clean water quality along Boulder Creek and other stream corridors followed the development of linear parks, now referred to as Greenways, and increased public awareness about the value of protecting water quality and the riparian habitat along our drainage systems.

The program currently administers the City's stormwater quality permit and WASH in addition to public education and source controls.

Project Planning and Approval Process (PAPP)

All City capital improvement projects are subject to the Project Planning and Approval Process (PPAP). The Project Planning and Approval Process (PPAP) is the process for the review and approval of City master plans and public capital improvement projects in Boulder. The PPAP Handbook describes, in detail, the procedures for each phase in the review and approval of major City projects.

The PPAP was originally developed and approved in 1992. In 2001, the City Council Environmental Sustainability Task Force directed improvements to the capital project planning and approval process. As a result the PPAP was updated to more effectively balance multiple City goals and objectives in the early stages of planning major capital improvement projects. The purpose of the update to the PPAP was to:

- Assure that City projects balance Boulder Valley Comprehensive Plan (BVCP) goals to the best extent possible;
- Assure that City projects meet City PACE goals;
- Improve interdepartmental communication and coordination;
- Improve early coordination and public input on projects prior to final design and construction; and
- Assure consistency between public and private development projects.

The revised PPAP was adopted in 2003. It emphasizes up-front review of City projects at the conceptual planning phases, improving interdepartmental coordination and early assessment of potential impacts.

Community and Environmental Assessment Process (CEAP)

The Community and Environmental Assessment Process (CEAP) is a formal review process to consider the impacts of public development projects. The CEAP was instituted by City Council in 1987 and is referenced in the Boulder Revised Code (B.R.C. Section 2-1, Appendix IX, "Procedure in Handling Major Capital Improvement Projects"). The CEAP process and standards are outlined in the PPAP.

The purpose of the CEAP is to assess potential impacts of conceptual project alternatives in order to inform the selection and refinement of a preferred alternative. Projects that will require the CEAP review are identified during the annual CIP and budget process. A department first suggests projects that will need to follow the CEAP with their CIP and budget submittal to the PPAP Coordinator. The Project Coordination Group reviews all projects listed in the annual Capital Improvement Program and identifies the appropriate review and approval process for each project. The list is then reviewed by the Planning Board and adopted by the City Council with the budget.

The CEAP provides the opportunity to balance multiple community goals in the design of a capital project by assessing a project against the policies outlined in the BVCP and departmental master plans. The CEAP allows "fatal flaws" inherent in the concept design of a project to be discovered, thereby suggesting elimination of certain alternatives.

Design and Construction Standards

The Design and Construction Standards are periodically updated to address changes in engineering practices, construction technology, state and federal regulations, and City policies. Updates are coordinated by the P&DS Project Review Engineering workgroup. The update process provides a number of opportunities for participation by workgroups within the utilities division as well as by other City departments and the public. P&DS maintains an annotated copy of the *Design and Construction Standards* where issues and recommendations can be recorded for consideration. Prior to drafting updates, Engineering Review formally solicits feedback from City staff, design professionals, and the public through meetings, phone conversations, and email. Finally, the draft update is reviewed in detail by key Utility staff and made available on the internet for review and comment by staff and the public.

6.3.2 Information from Other Communities

In order to evaluate the current functional structure and budget for the flood Utility, comparison with other similar communities provides information about where Boulder's program fits within national trends.

Mecklenburg County, North Carolina – Mecklenburg County has a Floodplain Program with three sub-groups, Engineering Group, Planning Group, Operations & Maintenance Group. They have a "major" and "minor" floodplain system. Major floodplains are basically the FEMA floodplains and minor floodplains are areas that drain less than 1 square mile. There are 300 miles of major and 5000 miles of minor, and there are 4000 structures in the floodplain according to future conditions hydrology.

City of Tulsa, Oklahoma – The City of Tulsa has everything related to floodplain work under public works. Public works is comprised of 1500 staff, 120 of which are dedicated to operation and maintenance. Upper management has a Director of Public Works that makes the calls on what projects are going to be done. Once a decision is made they take a look at what other projects can be piggy-backed onto that project, and then the Assistant Director of Public Works "finds the money" for the project. They are really proud of their system, and they say that it eliminates "turf wars" and "achieves synergy". They also have a master plan for everything that they do, which makes the evaluation of which projects can be "piggy-backed" together easier.

City of Fort Collins, Colorado – An outline of Fort Collins' organizational structure is included below.

- Water Engineering and Field Services Department
  - Master Planning
  - Water Field Operations
  - Utility Development Review
  - Project Design and Management Division
- Four other Departments
  - Similar Structure for Each Department

A side by side comparison of the three municipalities with Boulder's characteristics is provided in Table 6-1.

This comparison shows that Ft. Collins provides the best comparison for Boulder due to its population and regional similarity. Boulder's flood Utility budget is substantially less than Ft. Collins. The communities differ in the number of structures in the 100 year flood plain and the date of the most recent major flood events. Ft. Collins experienced a major flood event in 1997, while Boulder's most recent flood event was experienced 35 years ago.

	Mecklenburg	Tulsa	Fort Collins	Boulder
Annual budget	$28 million, $8.2 of which is for the 300 miles of FEMA floodplains	$12 million	~$6 million for the Storm Drainage Fund	$ 4.2 million annual revenues for Stormwater & Flood Utility
Population	650,000	397,000	120,000	101,500 (Annexed area)
Area of jurisdiction (Square miles)	500	200	14	25.4 (Annexed area)
Structures in floodplain	4000 according to future conditions, excluding the minor system. 2000-2500 get "water in them"	3000 according to future conditions and for 40 acres or greater areas	2600	4000 structures in 100-year flood plain
Major flood dates	1995 and 1997 were 100-year flood events	Memorial day, 1984	1997	1876 1894 1914 1921 1938 1969

Table 6-1
Comparison with Other Communities

6.4 RECOMMENDATIONS

6.4.1 Program Integration

The structure of a dispersed City staff across functional program areas will continue to provide benefits to flood and storm drainage program management. But in order to continue to gain these benefits, it is important to continue to identify and implement coordination systems and processes.

This master plan recommends maintaining existing coordination and integration processes which are outlined in this chapter. 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)
- Stormwater Quality Program
- Boulder Valley Comprehensive Plan Land Use Map
- Water Quality Master Plan
- Maintenance Program
- Annual Budget Process

Board and Council Review and Discussion of the CFS Master Plan

Both the Water Resource Advisory Board (WRAB) and the Planning Board make recommendations to City Council regarding the adoption of the CFS *Utility Master Plan*.

The Planning Board reviews the City's operative master plans to look for consistency with the Boulder Valley Comprehensive Plan (BVCP) goals and policies before the plans are adopted by the City Council. Because of its role in reviewing the Capital Improvement Projects (CIP), the Planning Board also reviews master plans to ensure that they identify service standards, capital funding needs, and funding sources. The questions that are the focus of the board's review are:

- Is the master plan consistent with the goals, policies, and growth projections of the BVCP?
- Are the capital needs and funding sources outlined in the master plan?

The City Council makes a motion to accept or not accept the master plan through the public hearing process. Information compiled by all board reviews and staff recommendations are used by the Department project manager to present to City Council. A master plan summary and policy changes are considered as part of the next update to the BVCP.

Interactive web site

The City's web site provides information concerning various stormwater and flood management programs and projects. This web site's address is: www.ci.boulder.co.us

The site will be reorganized and expanded to be more accessible, user friendly and informative. The web site will include:

- Stormwater and Flood Management Utility Program and Projects.
- Interactive "Map It" application allowing anyone with a web browser to explore stormwater and floodplain maps and system components.
- CFS Utility Master Plan document and products including information presented at public forums and background other background material.
- Development issues including regulations and permits.
- Information concerning flood hazards in Boulder and how to prepare and respond in the case of a flood.

- Links to related stormwater and flood management agencies, activities, and information including the UDFCD, FEMA CDPHE, USEPA and the Colorado Water Conservation Board (CWCB).

- Opportunities to communicate with City staff.

The City of Boulder promotes all community education information and web releases both through announcements in the local newspaper and by directing citizens to the web information in materials published to accompany community meetings and Board hearing processes. The City also manages a number of e-mail lists to which issue-specific information can be directed.

Stormwater Management Plan Update

The anticipated update to the *Stormwater Management Plan* (formerly the Stormwater Collection System Master Plan) provides an opportunity to integrate various program interests and other multi-objectives. The scope of this plan update is defined in Chapter 5 and will focus on the City's drainage system including detention, storm sewers and the quality of water being directed to major drainageways. The plan is not intended to address major drainageways and associated flood issues.

The Stormwater Management Plan update will address smaller storms and their hydrologic impacts. The smaller storms dominate both the number of storms and the volume of runoff. It is the smaller storms (those of less than 1 inch) which change the most in characteristics between natural and urbanized areas. Therefore, these storms present the most opportunities to address water quantity and quality issues.

The Stormwater Management Plan will incorporate a watershed management approach to balance quantity and quality issues. The first step of this approach is to develop criteria for prioritizing various objectives within each subbasin of the watershed. Criteria may include existing storm drainage problems, water quality pollutant loading, cost-effectiveness, environmental impacts and ability to coordinate with other City projects.

This approach allows for the development of solutions with multi-faceted benefits to the stream corridor and the drainage basin of the subbasin. Application of the following principles during development of the plan will support integration and achievement of multiple benefits:

Apply Conservation Principles -Shift focus from stormwater "disposal" to prevention and conservation. Approach stormwater management as a resource to enhance natural systems and processes.

Use Multiple Objectives Approach - Develop solutions which coordinate management of peak rates and volume, water quality, and maintenance.

Integrate BMPs into Site Design Process - Determine appropriate application of BMPs in prioritized sub-basins in order to integrate BMPS into the first stages of site planning and overall subbasin planning.

Prevention First, Mitigation Second – Prevent stormwater excessive runoff and pollution at the source using techniques tailored to each subbasin.

Coordination of drainage and water quality priorities by subbasin will then guide decisions on capital improvement projects and implementation of storm drainage and water quality improvements. Costs and resource needs to support implementation of subbasin priorities can be developed to provide estimates of timeframes for implementation. In addition to addressing the structural controls located within the stormwater systems such as streets, street drainage structures, and sewer system, the following stormwater management tools should also be considered in the plan:

CIP - Include non-structural solutions such as property acquisitions, BMP implementation and stormwater fee incentives, buffer areas, natural resources area and open channel drainage systems preservation.

Public/Private Solutions – Employ both public and private solutions to achieve cost-effective solutions to stormwater impacts.

Use existing City resources – Use the City's existing GIS systems and databases for prioritizing subbasins and tracking plan implementation. Coordinate City incentives for stormwater quality and drainage improvements with PDS land use project tracking to identify redevelopment opportunities in high priority subbasins.

Use existing City systems – Include maintenance changes and Design & Construction Standards as tools to address stormwater impacts.

The Stormwater Management Plan Update will be managed by the Utilities Engineering work group. To assure integration with various program interests and other multi-objectives the update will involve a multi-disciplined approach and involve staff from appropriate workgroups.

Major Drainageway Planning

Updates to the City's plans for major drainageways are an on-going effort. These are closely linked to associated floodplain mapping updates and risk assessments as discussed in Chapter 3. This planning provides an opportunity to integrate various program interests and address multiple objectives. Major drainageway plans will include the following components:

Introduction
- Purpose and Scope
- Mapping and Surveys
- Project History
- Public Process
- Independent Review Panel

Study Area Description
- Watershed Topographic Features
- Land Use
- Irrigation Ditches
- Greenways Opportunities
- Environmental Issues
- Historic Flooding
- Previous Studies

Hydrologic Analysis
- Spill Flows
- Hydrologic Models
- Future Land Use Hydrologic Predictions
- 500 Year Hydrology
- Summary of Analysis

Hydraulic Analysis
- Base Mapping
- Hydraulic Analysis

Damage Analysis
- Methodology
- Results of Analysis

Environmental Assessment
- Existing Habitat Conditions
- Environmental Goals & Objectives
- Channel Treatment Concepts
- Groundwater Conditions

Alternates Development
- Initial Alternatives
- Maintain Existing Floodplain Configuration
- Non-Structural Methods
- Natural type Waterway within Historic Channel Alignment
- Structural and Channel Improvements Options
- Detention and/or Retention Facilities
- Acquisition of Flood Prone Properties
- Trans-Basin Diversion of Flood Waters

Alternate Evaluation and Recommended Plan
- Identification of Viable Alternatives
- Evaluation Factors
- Damage Reduction with Implementation of Alternates
- Alternate Cost Estimates
- Cost Benefit Analysis
- Intangible Benefits
- Habitat Restoration Opportunities
- Consideration of Alternates
- Recommended Plan
- Future Planning and Design Considerations

Flood Management Program

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 that will continue to be the focal point for interactions with the development community.

The Flood Management Program will provide opportunities for staff from the various departments and work groups to meet and discuss on-going budgets and projects. The primary purpose of these meetings and discussions will be to assure integration of various program objectives.

Often the Greenways Program restoration opportunities are limited by the amount of City easement and property available for expansion of riparian corridor. Consideration of the Greenways restoration opportunities in conjunction with flood hazard acquisition program opportunities would serve to integrate these two programs. This master plan recommends specific coordination of the Flood hazard acquisition program in order to support Greenways restoration opportunities. The opportunity to coordinate these two programs might be most effective during major drainageway planning processes.

Design and Construction Standards

Updates to the *Design and Construction Standards* (DCS) also provide an opportunity to integrate various program interests and other multi-objectives. Update of these standards will include changes to storm drainage standards which address the requirements of the City's stormwater discharge permit. Utilities and PD&S staff is currently working to implement these requirements. All permit compliance activities must be complete by 2008, the end of the first 5-year permit cycle. The master plan recommends application of the DCS standards to internal City projects and activities in order to ensure compliance with the City's stormwater discharge permit.

This master plan has identified the need for a more pro-active stance on groundwater issues with respect to impacts on storm drainage. As the City redevelops and densifies, groundwater discharge will have an increasing impact on the City's storm drainage system. Inclusion of groundwater evaluation standards in the DCS is recommended. The evaluation should include identification of water table depth, groundwater discharge rates, effects on storm drainage capacity and dry weather discharge quality and effects on stream and wetland habitat.

Greenways Program

The Greenways Program will continue to provide a tool to integrate multiple objectives along designated drainageway corridors. Completed in 2001, the *Greenways Master Plan* provides a set of specific projects which are prioritized by objective. If conflicts between objectives exist on a particular project, these conflicts are worked out during the project design level. This two-phase, planning and implementation approach helps to maintain multiple objective benefits.

The WASH plan recommends development of a flood management guidance document. This document will address ways to ensure that new flood management projects assess the impacts on water quality and examine existing projects for incorporation of additional water quality protection practices. The *Greenways Design Guidelines* can serve as this guidance document. Update of these guidelines is proposed in the *Greenways Master Plan*. The update of these guidelines can serve to further integrate flood construction and maintenance practices with stream restoration and preservation and best management practices for water quality. This master plan supports development and application of the *Greenways Design Guidelines* to City flood projects along the Greenways tributaries.

It is recommended that the Greenways Program be expanded to take advantage of the opportunities afforded to integrate multiple objectives along all major drainageways corridors. The Stormwater and Flood Management Utility provides approximately one third of Greenways Program funding. This funding will be continued at its current levels and is provided for continued integration of habitat restoration with flood and storm drainage and transportation projects.

Utility funding will be continued at its current levels and is provided for continued integration of habitat restoration with flood and storm drainage and transportation projects.

Stormwater Quality Program

The Stormwater Quality Program will continue to administer the City's stormwater quality permit and WASH in addition to public education and source controls. The program will also take the lead in implementing many of the recommendations contained in Chapter 4.

Maintenance Program

In addition to current responsibilities, the Maintenance Program will work to better integrate maintenance activities with UDFCD.

Water Quality Master Plan

This master plan is currently under development by the Utility Water Quality and Environmental Services workgroup. The plan will propose comprehensive water quality goals

which are intended to coordinate and integrate the Utility approach to management of City water quality issues. City water quality goals to be proposed will address protection of environmental health. City master plans, including this master plan and the *Greenways Master Plan*, will inform the *Water Quality Master Plan*.

Boulder Valley Comprehensive Plan

The City periodically updates the *Boulder Valley Comprehensive Plan*. A major update is anticipated in 2005 and will provide an opportunity to review land use and zoning designations from the perspective of flood hazard, water quality and drainage issues.

On-Going Budget Process

The CFS *Utility Master Plan* recommendations will be reviewed as part of the annual budget process. The City currently implements a two-year budget process. The intent of the two-year approach is to simplify the overall budget process by providing an extended outlook and by emphasizing a multi-year strategy and financial plan for each fund. The two-year process allows for the longer-range goal projections. Budgets are also reviewed annually for any necessary revisions.

6.4.2 Program Implementation

The integration work previously discussed will be implemented by City staff. Various work groups will take the lead on different elements as follows:

Utilities Administration

- Annual Budget Process
- Utilities Staff Meetings
- Interactive Website

Utilities Engineering

- Board and Council Review and Discussion of CFS Utility Master Plan
- Stormwater Management Plan Update
- Major Drainageway Planning
- Flood Management Program
- Greenways Program (including Greenways Design Guidelines)

Water Quality and Environmental Services

- Water Quality Master Plan
- Stormwater Quality Program
- Boulder Valley Comprehensive Plan Land Use Map

P&DS – Project Review – Engineering

- Design and Construction Standards

System Maintenance

- Maintenance Program

To assure integration of various program interests and inclusion of multiple-objectives, these programs and projects will be coordinated with the following work groups:

- Utilities Administration
- Water Quality and Environmental Services – Stormwater Quality Program
- Utilities Engineering – Greenways Program, Flood Management Program, Capital Improvement Program
- System Maintenance
- Transportation Division
- P&DS - Information Resources, Project Review – Engineering, Floodplain and Wetland Management
- Parks Department

CHAPTER 7 – FINANCIAL CONSIDERATIONS

The following discussion provides a summary of the City's current stormwater and flood management funding sources, utility fees, budget, and a breakdown of the projected expenditures as it relates to the updated master plan provided herein.

The Stormwater and Flood Management Utility is funded primarily through service charge fees. 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. These alternatives will be considered as part of the City's on-going budget process.

7.1 FUNDING SOURCES

The Stormwater and Flood Management Utility served a customer base of 23,205 properties as of December 31, 2003. Stormwater and flood management fees are reviewed periodically by staff and consultants to ensure that adequate revenues are collected to meet all obligations of the Stormwater and Flood Management Utility.

City utility rates are computed through an analysis of revenues compared to revenue requirements. The projection of revenue requirements is based upon an examination of historical costs incurred in providing utility service and anticipated changes in the future level of costs. Increases in future costs are primarily due to replacements and additions to the system, growth and inflationary conditions.

Projections of revenue also reflect the estimated future number of customers to be served. Comparison of projected revenue requirements with projected revenue under existing rates measures the degree of adequacy of the overall level of current charges.

Rates and fees are annually assessed to fund activities of the Utility and to ensure that required reserves are maintained and debt service coverage requirements are met. Currently, the City strives to maintain a 20-25% operating reserve over a six-year planning period. Reserves are required for current bond issues and for the outstanding liability associated with employee leave benefits. In addition the Utility maintains a $1,000,000 reserve available for post-flood property acquisitions.

Debt service coverage requirements are established as part of the Utility's bond covenants. On an annual basis the Utility is required to generate net revenues before debt service, equal to 1.25 times its annual debt service requirements.

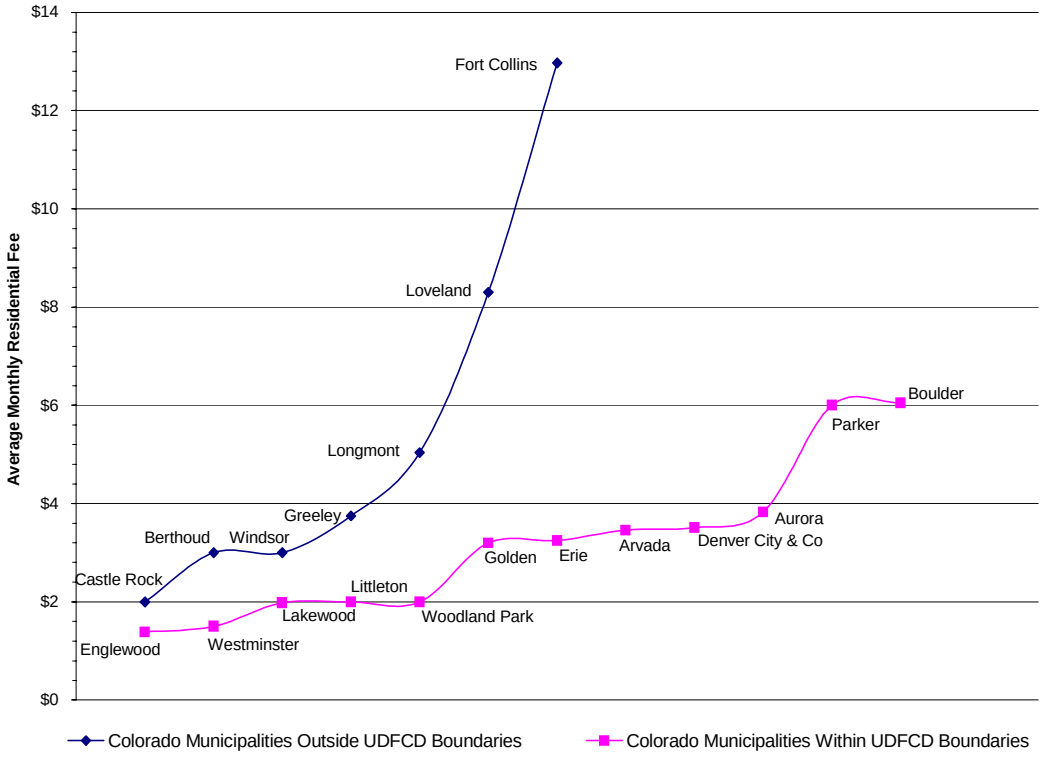
In addition to the City's annual review of rates and fees, a financial and rate consulting firm is hired approximately every five years to conduct a comprehensive rate and fee review. The last rate review was conducted in 2001 by Integrated Utilities Group, Inc.

A comparison of monthly stormwater utility fees for Colorado Municipalities is presented in Figure 7-1.

7.1.1 Monthly User Fees

Monthly user fees were introduced when the Stormwater and Flood Management Utility was established in 1973. These fees were intended

Figure 7-1
Monthly Stormwater Utility Fees for Colorado Municipalities (Inside and Outside the UDFCD Boundaries)



Note: Rates are from January 2003 survey.

City Of Boulder
Monthly Stormwater Utility Fees for Colorado Municipalities
Figure 7-1

to cover operations, maintenance and replacement costs of the existing system and construction of new storm drainage and flood management facilities. In the early years, since the total revenue collected was not adequate to fund all of these purposes, the revenues generated were reserved for new construction and General Fund revenues were used for routine maintenance. Boulder's stormwater and flood management fee remained at the base rate of $1.00 per month from 1973 through 1981. In 1982 and 1987 such fees were increased. With the adoption of CDUMP in 1989, the Utility initiated fee increases, raising the base rate from $1.67 per month to $3.00 per month in 1989 and to $4.03 per month in 1990.

The stormwater and flood management fee is a fixed monthly charge assessed to all properties inside the City limits except those with no impervious areas. The fee is based on the amount of runoff each property contributes to the overall flow. A base rate for single-family residential customers is established and, for all other customers, the fee is individually calculated. The formula for all commercial, industrial, multi-family and trailer park customers is constructed to be in proportion to the base rate assessed to single-family dwellings. The base fee for a 15,000 square foot lot increased from $6.05 to $6.20 on January 1, 2004. A comparison of a survey of monthly stormwater utility fees for Colorado municipalities (January 2003) provides another comparison of Boulder's program with other programs. Figure 7-1 shows that Loveland, Parker, Boulder and Ft. Collins are assessed the highest flood utility fees in comparison with other Colorado municipalities. The relatively lower fees in Boulder and Parker reflect the benefits of participation in the Urban Drainage and Flood District. Of all these jurisdictions, Ft. Collins has the highest flood utility fees. This reflects the lack of an opportunity to participate in a regional flood management district and the recent date of a major flood event (1997).

7.1.2 Plant Investment Fees

In 1989, the City adopted a Stormwater and Flood Management Plant Investment Fee (PIF) to assist in the funding of growth-or expansion related facilities for the collection and conveyance of stormwater runoff. PIF is a one-time fee collected when a property is annexed, developed or redeveloped and requires access to (capacity from) the existing water, wastewater, or flood control infrastructures. It is used to provide equitable allocation of costs between existing and new customers.

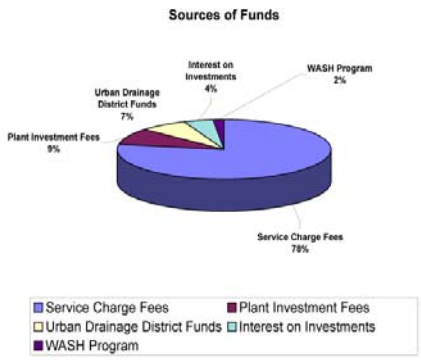
From 1989 to 1996, the PIF was calculated in a manner similar to the non-residential monthly user fees. In 1998, the PIF calculation was adjusted to more accurately reflect the wide range of residential development happening in the community. Whereas, prior to 1998, residential property paid a PIF using a sliding scale dependent only upon property size, now each residential property pays a PIF based upon both its calculated runoff coefficient and property size.

Plant investment fees (PIFs) were also recalculated as part of the 2001 rate and fee review. The PIFs are calculated based upon the new replacement value of the Utility assets less depreciation. On January 1, 2004 the PIF base rate was revised from $1,620 to $1,665.

7.1.3 Other Funding Sources

In addition to the monthly user and plant investment fees, funds to the Stormwater and

Flood Management Utility are obtained through intergovernmental reimbursements (primarily UDFCD), interest on investments, and the WASH Program. A general breakdown of the funding sources is shown below.



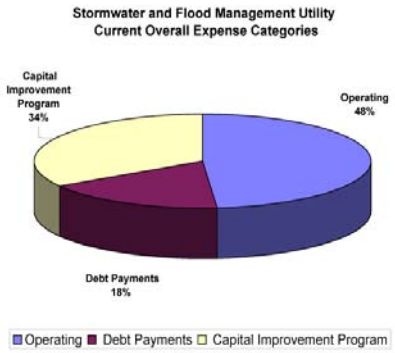
7.2 BUDGET

Annual operating budget proposals originate from the first-line operating supervisors of each work group in the utilities division. These proposals are reviewed and modified by successive levels of management within the division until a division proposal is approved by the Utilities Director. Budget proposals are then submitted to the City Manager and City Council for fund approval. The water, wastewater, and stormwater and flood management budgets are separate enterprise funds. Each fund is established to finance and account for facilities and services that are predominantly supported by user charges.

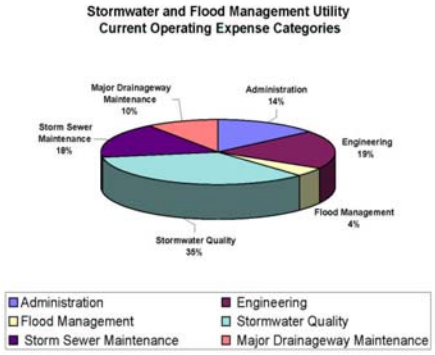
The City currently implements a two-year budget process. The intent of the two-year approach is to simplify the overall budget process by providing an extended outlook and by emphasizing a multi-year strategy and financial plan for each fund. The two-year process allows for the longer-range goal projections. Budgets are also reviewed annually for any necessary revisions.

Furthermore, the Capital Improvement Project (CIP) process is coordinated by the City's Planning Department. The Utilities Division selects capital projects for inclusion in the CIP based on priorities identified in the appropriate master plans. The Planning Department reviews all Department CIP lists for consistency and accuracy and compiles the citywide CIP for Planning Board and City Council review. The CIP covers a 6-year time period and is updated annually.

The Utilities Division budget is developed with the objective of providing quality and reliable water services involving drinking water, wastewater and flood control/drainage that meet regulatory requirements and community desires. The Utilities Division emphasizes efficient management of fiscal and natural resources and the protection of human and environmental health. A summary of the current breakdown of the Utility's budget/expense categories is shown below.



As shown above, the current budget is primarily utilized for operating and capital improvement program expenses. A further breakdown of the utilities current operating budget/expenses is shown below.



7.3 PROGRAM FUNDING RECOMMENDATIONS

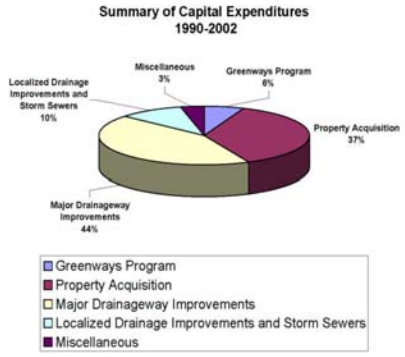
In general, existing programs are adequately funded. However, increases to existing program funding are recommended in the following areas.

Flood Management

It is recommended that annual funding for the on-going flood management program be increased from $100,000 to $350,000 per year. This funding better reflects the importance of these on-going flood management issues and balances structural and non-structural activities.

To support this funding proposal, money will need to be reallocated from the existing budget or a rate increase will be required. These alternatives will be considered as part of the City's on-going budget process. This recommended budget adjustment represents a shift to balance structural and non-structural solutions for flood management within the City of Boulder.

Over the years, the CIP program has emphasized major drainageway improvements and property acquisition resulting in a general breakdown of budget as shown below.



7.3.1 Stormwater Management

It is recommended 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* to acknowledge the significant stromwater quality aspects that will need to be addressed.

It is recommended that additional annual funding of $50,000 should be allocated to begin an inspection and maintenance program for stormwater quality and existing private property on-site detention facilities. This inspection program would include post construction erosion control as required by the new stormwater permit.

It is also recommended additional annual funding of $50,000 should be allocated to GIS tools development and support. GIS tools have become a valuable resource of the stormwater and flood management program. These tools will need on-going updates and maintenance.

To support these funding proposals, money will need to be reallocated from the existing budget or a rate increase will be required. These alternatives will be considered as part of the City's on-going budget process.

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.

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GLOSSARY OF TERMS

ASFPM	Association of State Floodplain Managers
BMP	Best Management Practices
BRC	Boulder Revised Code
BVCP	Boulder Valley Comprehensive Plan
BVRC	Boulder Valley Regional Center
CAG	Citizen Adivsors Group (South Boulder Creek Flood Study)
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
CEAP	Community and Environmental Assessment Process (City of Boulder)
CFS	Comprehensive Flood and Stormwater Utility Master Plan
CIP	Capital Improvement Program (City of Boulder)
CECEP	Corps of Engineers Committee on Environmental Planning
CRS	Community Rating System (Federal)
CRG	Community Review Group (CFS Utility Master Plan)
CTP	Cooperating Technical Partners
CWA	Clean Water Act (Federal)
CWCB	Colorado Water Conservation Board
DCS	Design and Construction Standards (City of Boulder)
CWA	Clean Water Act (Federal)
DIMS	Drainageway Information Management System (City of Boulder)
EPA	Environmental Protection Agency (Federal)
FEMA	Federal Emergency Management Agency
FHAD	Flood Hazard Area Delineation (UDFCD)
FIRM	Flood Insurance Rate Map (Federal)
FTE	Full Time Employee
GAC	Greenways Advisory Committee (City of Boulder)
GMP	Greenways Master Plan (City of Boulder)
GIS	Geographical Information System
HAP	Hydrology Advisory Panel (South Boulder Creek Flood

	Study)
IRP	Independent Review Panel
LEED	Leadership in Energy and Environmental Design
LOMR	Letter of Map Revision (Federal)
MDCIA	Minimizing directly connected impervious areas
NFIP	National Flood Insurance Program (Federal)
NOAA	National Oceanic and Atmospheric Administration (Federal)
NPDES	National Pollutant Discharge Elimination System (Federal)
OEM	Office of Emergency Management (Boulder County)
P&DS	Planning and Development Services (City of Boulder)
PIF	Plant Investment Fee
PPAP	Project Planning and Approval Process (City of Boulder)
RBP	Rapid Bio-assessment Protocols
TMDL	Total Maximum Daily Load
UDFCD	The Urban Drainage and Flood Control District
UMMS	Utilities Maintenance Management System (City of Boulder)
WASH	Watershed Approach to Stream Health
WQCC	Water Quality Control Commission (Colorado State)
WRAB	Water Resources Advisory Board (City of Boulder)

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