CITY OF BOULDER

COMPREHENSIVE FLOOD AND STORMWATER MASTER PLAN

DRAFT

TECHNICAL MEMORANDUM #4

Stormwater Drainage

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Technical Memorandum Summary

The following policy recommendations are included in this Technical Memorandum:

Stormwater Drainage System

- Provide a comprehensive and integrated stormwater drainage system for existing and future development to adequately convey and manage stormwater runoff. This includes systems to mitigate safety hazards, protect property, and minimize disruption during and after minor and major storm events.
- Manage a GIS database related to stormwater collection and conveyance assets to be maintained in a format that is directly compatible with the hydraulic model for the stormwater drainage system and current asset management software.
- The stormwater drainage system is not a standalone network but is a subsystem of the city's overall stormwater and flood management system. Stormwater system planning and design should include evaluation of broader impacts to interrelated systems and functions, such as stormwater quality, protection of natural drainageways, and flood mitigation. Multifunctional solutions should be considered to benefit the quality and performance of the overall drainage infrastructure.
- The city will strive to minimize flooding, stream bank and channel erosion within the major drainageway system by controlling the rate and volume of stormwater runoff from development and redevelopment projects.
- Continue to regularly monitor the local effects of climate change in coordination with federal, state, and regional agencies based on the best available scientific data. The design of stormwater management systems requires a risk management approach whereby the design life of infrastructure and the use or occupancy of buildings and structures served by the drainage infrastructure are considered.

Stormwater Master Plan

- For the purposes of evaluating and improving the stormwater drainage system's performance during both the minor and major storm events, the Utility will maintain and update a stormwater master plan, also known as a master drainage plan. This plan must identify the infrastructure required to provide for the drainage and management of surface waters within the city's watersheds in a way that protects people, prevents property damage, minimizes interference with traffic, mitigates increases in stormwater runoff due to land use changes, and prevents increases in flooding, by carrying such waters to designated points without overflow or discharge.

Technical Memorandum Summary

Operations and Maintenance

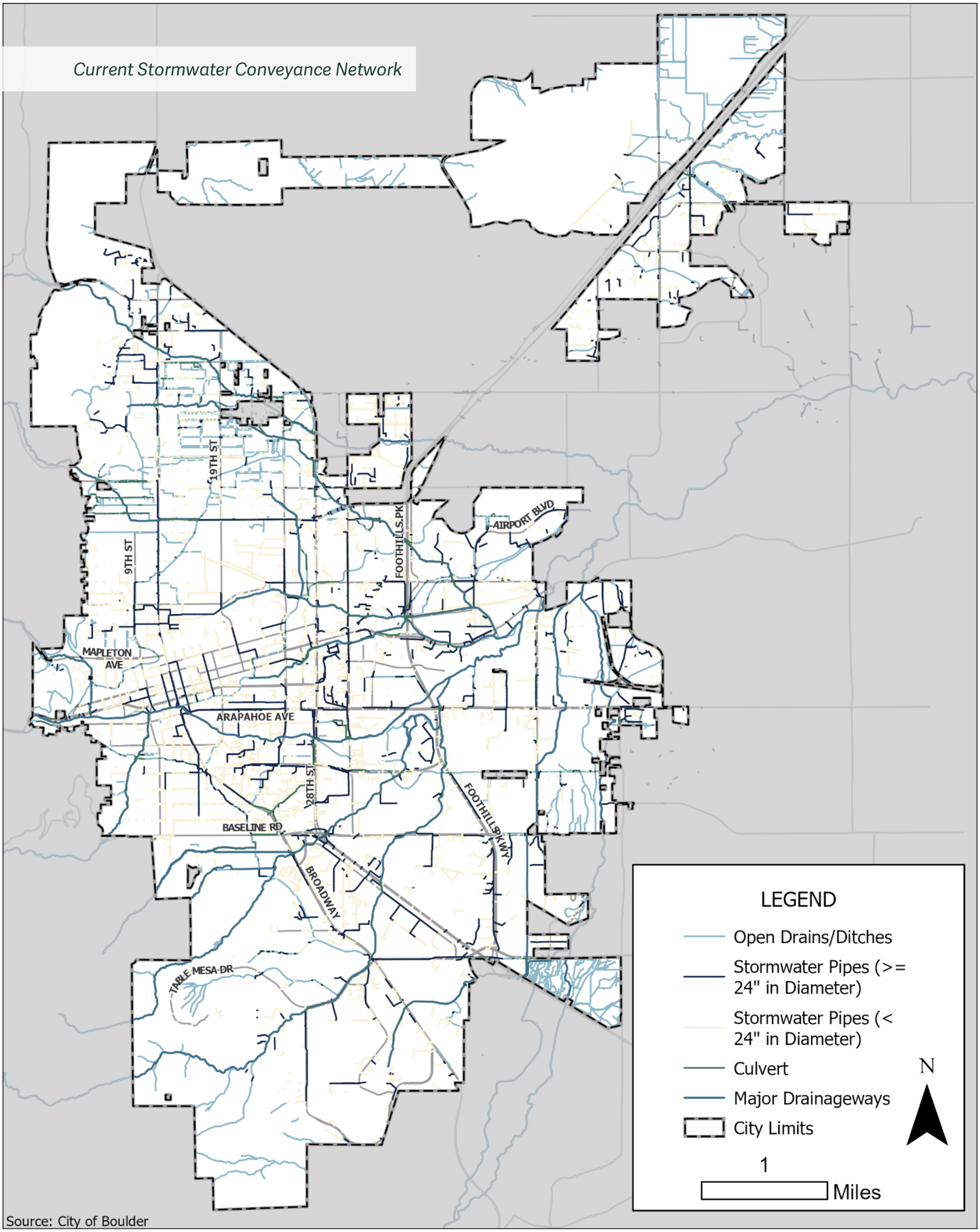
- Public stormwater drainage infrastructure consisting of stormwater inlets including catch basins, storm sewers, and storm sewer appurtenances such as manholes, junctions, etc., are considered part of the public stormwater system and shall be maintained by Utilities. Staff shall conduct periodic inspections and routine maintenance of the public stormwater drainage infrastructure at a frequency necessary to ensure its continuing and proper function. Privately owned stormwater drainage infrastructure, the major drainageway system, irrigation ditches, and irrigation laterals are not part of the public stormwater drainage infrastructure and are to be maintained by others except in the case of a contractual obligation.
- Information collected during inspection and maintenance activities will be used to support the Utility's asset management system, by evaluating the condition of the assets and setting priorities for operational and maintenance work, as well as identifying capital improvement project needs.
- Property owners are required to maintain culverts that extend under private driveways and natural or artificial drainageways conveying open channel flow contained within drainage easements or within public rights-of-way free from obstruction to ensure maximum designed flow may pass at all times. Property owners may not alter drainage improvements, drainageways contained within drainage easements or within public rights-of-way. Under current practice, property owners are required to maintain the roadside ditches adjacent to their properties in areas without curb and gutter and should not block such drainages. (B.R.C. 9-12-12(c)).
- The Utility may perform emergency maintenance on privately owned stormwater drainage systems when necessary to protect the common good. Emergency maintenance applies to conditions which may be potentially damaging to life, property, or public roads and rights-of-way. Emergency maintenance should not be construed as the city accepting maintenance obligations for privately maintained infrastructure.
- Reports for maintenance requests received by phone or through Inquire Boulder will be relayed to on-call personnel for response and recorded for use by the Utility's asset management system. Maintenance necessary during large-scale events with high volumes of maintenance requests may be contracted to private contractors through existing service contracts to respond to situations that require immediate attention.
- The city may elect to not respond to complaints regarding privately owned drainage systems, e.g. a detention or retention basin that is the responsibility of a subdivision or neighborhood. From a public relations standpoint it is often good to respond to these types of complaints and a phone call should be sufficient over an on-site visit.

1 Introduction

Urbanization increases direct stormwater runoff caused by land use change and must be actively managed to minimize local flooding and impacts to streams and drainageways. Stormwater drainage systems traditionally consist of a *minor system* for modest size rainfall events and a *major system* for emergency flows. The City of Boulder follows Mile High Flood District policy for the sizing of stormwater drainage systems. This includes sizing the minor system to convey the 2-year storm event in residential areas and the 5-year storm event along collector and arterial roads and in commercial areas. The minor system is the conventional drainage system designed to minimize disruptions and safely allow the movement of pedestrians and traffic. This system includes gutters, roadside ditches[1], culverts, catch basins, storm drains, detention basins, and open channels. Minor systems have been expanding in recent years to include green infrastructure elements such as bioretention practices and porous pavements. Green infrastructure components are often focused on meeting water quality improvement objectives; however, many communities also include meeting hydrologic objectives for small storms.

Boulder's history of flash flooding associated with the major drainageways often overshadows the fact that flooding can happen anywhere, regardless of proximity to water bodies. When extreme rainfall events occur, stormwater runoff can cause localized flooding on streets and in neighborhoods that happens independent of an overflowing water body. Major systems are designed to convey flows from the 100-year storm event in Boulder and include the use of streets, urban streams and drainageways, and larger detention ponds. While the major system is intended to direct and route these emergency flows, residents and businesses also have a role in protecting their properties and ensuring the safe flow of water around structures when storm events result in unusually long or intense rainfall.

[1] Sometimes called a "borrow" ditch, a roadside channel is dug for drainage purposes. These are different from irrigation ditches, which deliver water associated with water rights to a downstream beneficial use.


Current Stormwater Conveyance Network
19TH ST
9TH ST
FOOTHILLS PK
AIRPORT BLVD
MAPLETON AVE
ARAPAHOE AVE
28TH ST
FOOTHILLS PKWY
BASELINE RD
BROADWAY
TABLE MESA DR
LEGEND
Open Drains/Ditches
Stormwater Pipes (>= 24" in Diameter)
Stormwater Pipes (< 24" in Diameter)
Culvert
Major Drainageways
City Limits
N
1
Miles
Source: City of Boulder

2 Policy Analysis

The current policies related to stormwater drainage are mostly contained within the Boulder Valley Comprehensive Plan and in the Stormwater Master Plan. Since the Mile High Flood District sets policy standards for the communities it serves, variations between the two sets of policies will be evaluated and updated where necessary. To accomplish this, improvement actions related to stormwater drainage have already been identified during the earlier policy and program evaluation. The following section discusses issues and approaches to address the identified improvement actions from a policy perspective.

Identified Improvement Actions

- Evaluate current level of service being provided
- Evaluate current detention pond design standards
- Identify irrigation ditches with insufficient capacity to receive stormwater runoff
- Address routine maintenance needs

Policy and Program Goals

Technical Memorandum #2 identified a set of goals and objectives that could be used to evaluate the existing programs within the Utility. As part of the analysis on stormwater drainage policy, these goals and objectives were reviewed and refined where necessary to meet the current and future needs of the Utility.

Stormwater Collection System

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

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

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

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

Objective: **Limit post-development peak flow conditions to match pre-development[2] peak flow conditions**

[2] Pre-development peak flow conditions refer to existing conditions prior to redevelopment, versus green field conditions.

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

Objective: Identify stormwater connections into irrigation ditches

Objective: Identify irrigation ditches having insufficient capacity for stormwater conveyance

Objective: Identify and manage modifications that may impact irrigation ditches in partnership with irrigation ditch companies

Operations and Maintenance

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

Objective: Provide routine inspections and assessments of the entire system

Objective: Provide routine maintenance of pipes, structures, natural and man-made channels including irrigation ditches, and public detention facilities

Objective: Provide minor repairs to existing pipes and structures

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

Objective: Identify reaches of the stormwater collection and conveyance system **lacking adequate maintenance access**

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

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

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

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

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

Level of Service Standards

It is often not economically feasible to design stormwater collection and conveyance systems to fully manage extreme precipitation events without overflow. For that reason, it is necessary to determine what level of service this system will provide. During storm events that occur frequently but result in moderate and more manageable flow rates, it is expected that the stormwater system will collect and convey excess stormwater runoff in a way that provides public convenience, minimally interferes with traffic, and prevents property damage caused by excess ponding of stormwater runoff. This system is often referred to as the initial drainage system, or the minor system. When larger storm events occur, some degree of flooding is expected, and major systems then convey runoff that exceeds the capacity of the minor system. Major systems are not always intentionally designed and are often incorrectly assumed to consist only of the major drainageways. During major storm events, flooding can occur anywhere in the watershed when emergency overflows are not intentionally designed to safely convey excess runoff to the major drainageways. When this happens, flooding impacts property and can threaten the health, safety, and welfare of the community. Major drainage systems, regardless of type, should be capable of conveying water without flooding buildings or impacting life safety and remain relatively stable during major runoff events. Major systems should provide the same level of service irrespective of whether the cause of flooding is rainfall or out-of-bank river flooding.

Design storm frequencies are selected to determine the peak flow rate that should be managed by various parts of the stormwater drainage system for both the minor storm and the major storm. It is recommended that design storm frequencies be reported in the city's Design and Construction Standards.

Stormwater Master Plan

The city's Stormwater Master Plan (SMP), last updated in 2016, serves as a long-term guide to address existing and future stormwater drainage and stormwater quality issues. It develops a master plan for the stormwater drainage system to alleviate current capacity and flooding problems. It also evaluates the existing stormwater infrastructure with respect to system analysis criteria created as part of the master plan. The SMP also recommends further improvements to address future conditions more thoroughly and evaluate the impacts of stormwater runoff on the entire watershed.

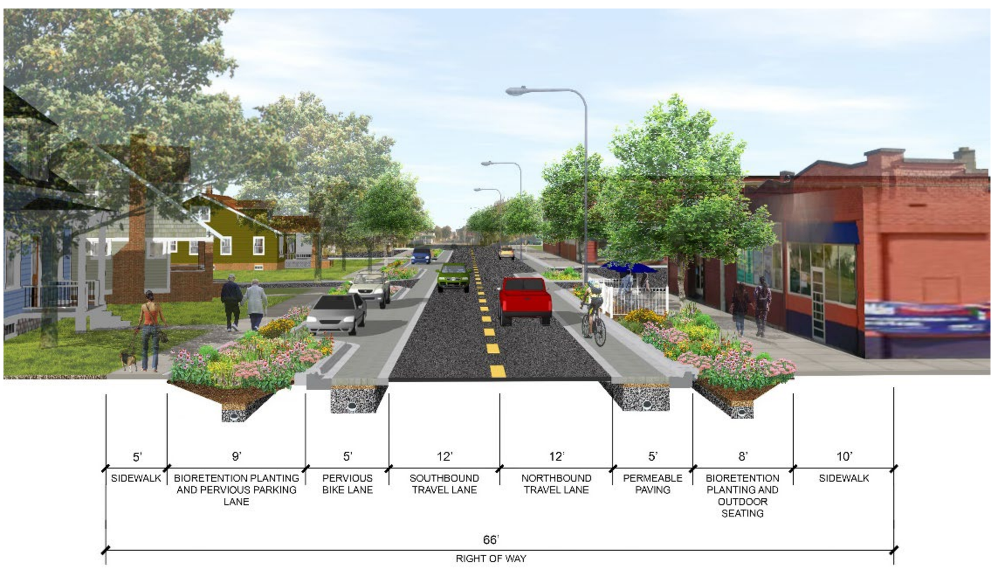
Data Collection and Continuous Improvement. Section 3 of the 2016 Stormwater Master Plan notes several limitations with the input data. For example, limited survey information was available for the major roadside ditches and the irrigation ditches. Today's hydrologic and hydraulic models are highly integrated with geographic information systems. It is recommended that a GIS database containing the conveyance assets be continuously improved in a format directly compatible with the hydraulic model. Updates to the model can then be processed quickly and efficiently and become a continuous improvement process as well. The recommended long-term goal should be to include the entire collection system and irrigation ditches in the model.

Model Calibration. Calibration of the hydrologic and hydraulic model to both measured flow data in the collection system and reported flooding complaints is strongly recommended. Data collection and calibration efforts can be costly. However, when the estimated investments needs are over $114M, consideration of model calibration may be warranted. Synergies with outfall monitoring efforts conducted by the stormwater quality program could be explored to use collected flow data for environmental monitoring and model calibration purposes.

Model Approach. Incorporate a 2-dimensional (2D) modeling approach to combine a 1D model of the minor conveyance system (storm sewer pipes) and a 2D surface model which routes overland flow. There are several benefits to using a 2D stormwater model. The primary benefit is to map the overland flow like a floodplain along a river. Mapping the overland flow improves the overall understanding the system which leads to better alternative improvement analysis. Mapping the overland flow is also beneficial for communicating with decision makers and the community to convey risk. Additionally, areas of the city which do not have storm sewers, and hence are not included in typical 1D model analyses, are easily included in a 2D model approach. This approach would also allow for the incorporation of irrigation ditches into the model to improve the understanding of the relative importance of irrigation ditches for urban drainage and alternatives analysis. Furthermore, knowledge of irrigation ditch conveyance would inform stormwater carriage agreement negotiations with irrigation ditch companies.

Analyze a Range of Scenarios. As part of the hydraulic analysis, a range of design storms up to and including the 1-percent chance recurrence interval (100-year) should be modeled. The resiliency of the system should also be evaluated over a range of scenarios. This could include modeling a range of tailwater conditions as part of a sensitivity analysis and evaluating the system response to historical storm events either as discrete events or as a continuous simulation. In the evaluation of alternatives, increasing the level of service provided should be evaluated. Often going up a single pipe size for conveyance of the minor storm event has a significant impact on the level of service provided but only results in a marginal impact on the capital costs.

Multifunctional Solution Approach. Look for ways to provide community benefits beyond just drainage, such as recreational value, biodiversity, social resilience, improved microclimates, environmental sustainability, and vibrant economic growth. Look for synergistic solutions with other projects in the city. The identified water quality improvement projects in the Stormwater Master Plan are predominantly manhole treatment devices that prevent pollutants from entering into the stormwater system but do not incorporate multifunctional benefits like low impact development and green infrastructure approaches and should be revisited.



Climate Change and Resilience

Climate model projections for Colorado generally agree on a warming average annual temperature. However, these models indicate a high level of uncertainty in hydrologic projections. Urban drainage systems are predominately designed based on rainfall intensity. That means if rainfall intensity increases in the future, the effective level of service designed into the system will decrease. Reliably forecasting changes in intensity-duration-frequency estimates is an evolving science. Evaluating the impacts associated with the variability of rainfall (both the natural variability and the potential variability from climate change) is practical and wise and is one approach to designing resilient infrastructure.

Example tactics from around the country and world include:

- Analyzing the impacts of historical storm events on the future designs. Lexington-Fayette Urban County Government, KY, makes use of historical events (in addition to traditional design storms) when designing flood control structure.
- Changes to the level of service criteria. Madison, WI, increased their target level of service standards for culverts, drainage of enclosed depressions, detention basins, and road surfaces as an interim step while a state initiative evaluates climate change impacts. Another similar approach is to add an additional level of service criteria, for example Copenhagen, Denmark, added a criterion for considering cloudbursts (defined as a 100-year storm event for Copenhagen).
- Another approach which relies only on historical rainfall data is to consider the confidence intervals associated with the precipitation frequency estimates rather than just the most frequently occurring number. For example, NOAA publishes 90% confidence intervals with the estimates (NOAA, 2013).
- The American Society of Civil Engineers (ASCE) promotes a risk-based approach whereby the type of climate analysis is based on the design life of infrastructure and the use or occupancy of buildings and structures served by the drainage infrastructure. Communities like Boston, MA, New York, NY, and Washington, DC, have incorporated the risk management components into their programs and commonly associate this with the critical infrastructure or critical facilities.

There is currently significant uncertainty associated with impacts on precipitation patterns due to climate in the Front Range. While there are some indications that an increase in smaller storms may be possible, the range of projected changes is not quantifiable to the degree necessary for incorporation into rainfall probability distributions (Lukas, et al, 2014). These rainfall probability distributions result in the precipitation frequency estimates published by the National Oceanic and Atmospheric Administration (NOAA). Both MHFD and the City of Boulder utilize the most current version of Atlas 14 as the basis for design storm rainfall.

Due to significant uncertainty and variability in climate change science along the Front Range, best professional *consideration* of climate change impacts is recommended over specific design requirements for all stormwater drainage infrastructure. A risk management approach that considers the design life of infrastructure and the use or occupancy of buildings and structures served by the drainage infrastructure is recommended. This approach places increased analysis and informed decision making in areas where the consequences of flooding are high and are commonly associated with critical infrastructure.

Operation and Maintenance

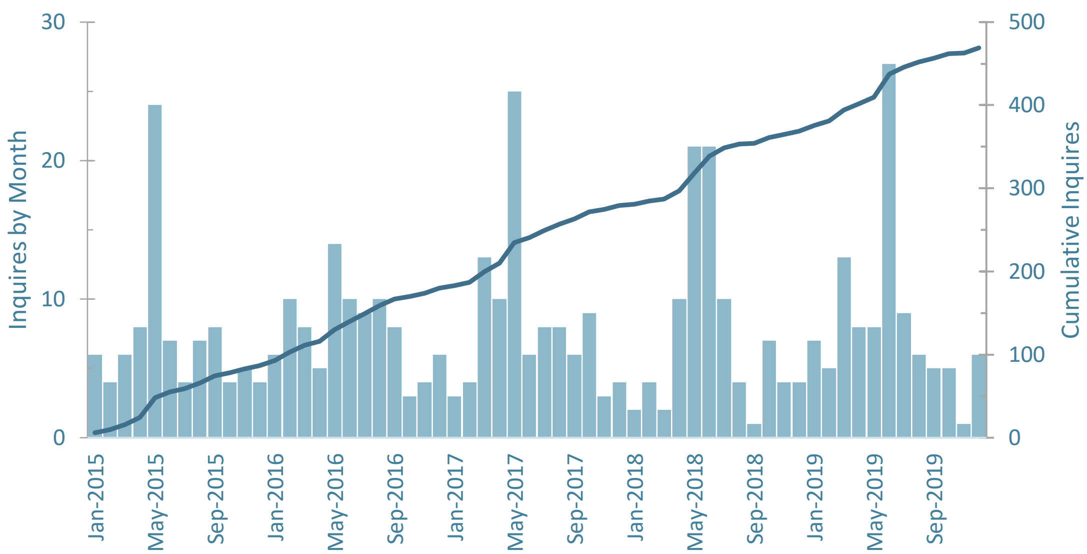
All infrastructure requires maintenance. However, there is no industry standard on the recommended frequency of maintenance within a stormwater collection system. Rather inspection and maintenance should be done at a frequency that is necessary to keep the system functioning as intended. This may start at a set schedule but is often adjusted based on repeated findings through the use of an asset management system. In 2021, Boulder's Utilities Maintenance work group continued to make major changes to increase maintenance efficiency and frequency by splitting into two separate groups, one of which is solely responsible for the maintenance of the stormwater drainage infrastructure. Additional staffing resources were dedicated to support this area of maintenance, which also includes responding to customer complaints related to the stormwater drainage system. Current policies do not definitively define all roles and responsibilities related to operations and maintenance of the stormwater drainage system, including defining what constitutes public maintenance responsibilities and what constitutes private maintenance responsibilities in some cases. It is recommended that operations and maintenance policies be included in the CFS Master Plan to achieve the following:

- Define what constitutes the public stormwater drainage system versus a privately owned stormwater drainage system
- Support the city staff in making maintenance and capital improvement decisions related to the city's stormwater system
- Define public and private maintenance responsibilities for stormwater drainage systems
- Clarify that the city may conduct emergency maintenance operations when warranted
- Ensure that property owners understand their operation and maintenance responsibilities

The specification of detailed maintenance activities, including frequency of occurrence, is best discussed in an operation and maintenance manual instead of at the policy level.

Customer Input from Inquire Boulder

Resources needed to address customer inquiries is a significant demand on many communities. Records of comments and complaints should be centralized into one dataset, which the city has done with the Inquire Boulder system. For the five-year period from 2015 through 2019, a total of 469 storm drain problems were recorded in the Inquire Boulder system. The frequency of records is highest in May (18 per month) and June (14 per month) and the least frequent in September thru February (averaging 3 to 6 per month). It is recommended that a policy be included in the Master Plan to specify how inquiries will be handled and what response will be provided. Target times for response to inquiries will vary based on the volume and severity of issues raised.



It is recommended that Inquire Boulder be expanded to include links for more information like upcoming storm conditions, what residents need to do to prevent local flooding, quick facts, requesting assistance, opportunities to volunteer, and general education about stormwater which is tied to the MS4 permit. This could also include information such as where to route downspouts and sump pump discharges along with legal implications if runoff is mismanaged. The city's website for snow and ice removal already contains examples of this, as does Seattle Public Utilities' website focused on Wet Weather Preparation Tips.

Continuous Improvement

Maintaining information on the stormwater infrastructure is best thought of as a continuous improvement process. All data associated with surveys, inspections, assessments, hydrologic and hydraulic modeling, design, construction, and maintenance should have a process by which data is continuously updated in a master database. To accomplish this, contracts with outside agencies should include provisions of deliverables to provide the data in a compatible format. To aid with this process, it is beneficial to have a standardized data format. Coordination with Planning and Development Services (P&DS) will be required for development projects related to private development projects.

Additionally, hydrologic, and hydraulic models should be the property of the Utility and clearly stated as such in all contract documents. It's often beneficial for a community to adopt modeling guidelines which specify modeling requirements, methods, naming conventions, submittal requirements, and other technical details. The Metropolitan Sewer District of Greater Cincinnati (MSDGC) has a robust example of modeling guidelines (https://msdgc.org/doing_business/capital_project_resource_library/index.html).

Hydrologic and hydraulic modeling software packages are continuously evolving and updating. Standardizing the software package(s) used is often desirable, but can be challenging. Most of the modeling software makes use of GIS data, often directly linking with the GIS files. Data collected as part of the model analysis (e.g. surveyed pipe and channel data) should be updated in the master database. Model results such as pipe capacity information, peak flow rates from design storms, and other pertinent data should also be included in the GIS database format for sharing and storing information.

Staggering and Sequencing Project Work

The existing Stormwater Master Plan is a good overarching plan with conceptual designs and project prioritization. Prior to construction of the prioritized projects, additional modeling will be necessary to refine the designs. Oftentimes, the accepted approach is to collect the data necessary to understand the condition of the existing infrastructure followed by a period of monitoring to refine and calibrate the hydraulic and hydraulic models, which then become the basis for design. Not every project will require model calibration. However, based on the substantial investments needs, collecting monitoring data to calibrate the model is often cost effective. Additionally, the collected data can also be used to update the city's asset management database. Since these phases can take a significant amount of time, it is prudent to stagger multiple projects at different points within their individual sequence. By developing a formal sequence, projects can be staggered to account for public engagement, coordination between departments, budget cycles, and typical timeline required for each project phase. A formal project flowchart may be beneficial which identifies all the various steps and coordination required.

Project	Time						
1	Data Collection	Monitoring	Model	Design	Construction		
2		Data Collection	Monitoring	Model	Design	Construction	
3			Data Collection	Monitoring	Model	Design	Construction

3 Recommendations

The following stormwater drainage policies and general suggestions are being recommended for incorporation into the Master Plan:

Stormwater Drainage System

- Provide a comprehensive and integrated stormwater drainage system for existing and future development to adequately convey and manage stormwater runoff. This includes systems to mitigate safety hazards, protect property, and minimize disruption during and after minor and major storm events.
  - Design storm frequencies for the minor and major storm events and associated design criteria shall be as defined in the latest edition of the Design and Construction Standards.
  - Minor storm event criteria are designed to maintain travel on public streets and provide public convenience, minimally interfere with traffic, and prevent property damage during frequently occurring storms.
  - Major storm event criteria are designed to prevent building flooding and minimize danger to human life when the rate or volume of runoff exceeds the capacity of the system designed for the minor storm event.
- Manage a GIS database related to stormwater collection and conveyance assets to be maintained in a format that is directly compatible with the hydraulic model for the stormwater drainage system and current asset management software.
  - Develop guidelines related to data quality
  - Identify necessary information needed to update the GIS database to be requested upon completion of construction projects, inspections, or repairs to the system.
  - Require projects that include modifications or additions to the public or a private stormwater drainage network to provide updated GIS stormwater network files conforming the city's GIS database guidelines as part of project closeout information.
- The stormwater drainage system is not a standalone network but is a subsystem of the city's overall stormwater and flood management system. Stormwater system planning and design should include evaluation of broader impacts to interrelated systems and functions, such as stormwater quality, protection of natural drainageways, and flood mitigation. Multifunctional solutions should be considered to benefit the quality and performance of the overall drainage infrastructure.
- The city will strive to minimize flooding, stream bank and channel erosion within the major drainageway system by controlling the rate and volume of stormwater runoff from development and redevelopment projects.
- Continue to regularly monitor the local effects of climate change in coordination with federal, state, and regional agencies based on the best available scientific data. The design of stormwater management systems requires a risk management approach whereby the design life of infrastructure

and the use or occupancy of buildings and structures served by the drainage infrastructure are considered.

Stormwater Master Plan

- For the purposes of evaluating and improving the stormwater drainage system's performance during both the minor and major storm events, the Utility will maintain and update a stormwater master plan, also known as a master drainage plan. This plan must identify the infrastructure required to provide for the drainage and management of surface waters within the city's watersheds in a way that protects people, prevents property damage, minimizes interference with traffic, mitigates increases in stormwater runoff due to land use changes, and prevents increases in flooding, by carrying such waters to designated points without overflow or discharge.
  - Include the entire collection system and irrigation ditches in a hydrologic-hydraulic model that is calibrated to both measured flow data in the collection system and reported flooding complaints.
  - Model the system with a 2-dimensional (2D) approach, which combines a 1D model of the minor conveyance system (storm sewer pipes) and a 2D surface model which routes overland flow.
  - Analyze a range of design storms up to and including the 1-percent chance recurrence interval (100-year event).
  - Adopt modeling guidelines which specify modeling requirements, methods, naming conventions, submittal requirements, and other technical details. Require that the hydrologic and hydraulic models become the property of the Utility as part of submittal requirements.

Operation and Maintenance

- Public stormwater drainage infrastructure consisting of stormwater inlets including catch basins, storm sewers, and storm sewer appurtenances such as manholes, junctions, etc., are considered part of the public stormwater system and shall be maintained by Utilities. Staff shall conduct periodic inspections and routine maintenance of the public stormwater drainage infrastructure at a frequency necessary to ensure its continuing and proper function. Privately owned stormwater drainage infrastructure, the major drainageway system, irrigation ditches, and irrigation laterals are not part of the public stormwater drainage infrastructure and are to be maintained by others except in the case of a contractual obligation.
  - Clearly define infrastructure that shall be maintained by the Utilities Maintenance work group.
  - Clearly define infrastructure that shall be maintained by private property owners.
- Information collected during inspection and maintenance activities will be used to support the Utility's asset management system, by evaluating the condition of the assets and setting priorities for operational and maintenance work, as well as identifying capital improvement project needs.
  - Inspection, cleaning, and maintenance frequencies will be updated as needed based on system needs, the probably of failure, and the consequence of failure.
  - Identify the information to be included in the stormwater drainage GIS database and when it is to be updated
- Property owners are required to maintain culverts that extend under private driveways and natural or artificial drainageways conveying open channel flow contained within drainage easements or within

public rights-of-way free from obstruction to ensure maximum designed flow may pass at all times. Property owners may not alter drainage improvements, drainageways contained within drainage easements or within public rights-of-way. Under current practice, property owners are required to maintain the roadside ditches adjacent to their properties in areas without curb and gutter and should not block such drainages. (B.R.C. 9-12-12(c)).

- The Utility may perform emergency maintenance on privately owned stormwater drainage systems when necessary to protect the common good. Emergency maintenance applies to conditions which may be potentially damaging to life, property, or public roads and rights-of-way. Emergency maintenance should not be construed as the city accepting maintenance obligations for privately maintained infrastructure.
- Reports for maintenance requests received by phone or through Inquire Boulder will be relayed to on-call personnel for response and recorded for use by the Utility's asset management system. Maintenance necessary during large-scale events with high volumes of maintenance requests may be contracted to private contractors through existing service contracts to respond to situations that require immediate attention.
  - Stormwater problem investigations (i.e. local ponding or flooding). City crews will investigate reported problems. Develop a timeline for contacting the individual regarding the complaint and schedule an investigation time as appropriate. Problems originating in the public drainage system are addressed by the city in a prioritized fashion. Some solutions may be the property owner's responsibility. When solutions are the responsibility of the property owner, city staff may offer available resources for more information.
  - Street flooding during, or immediately after, a storm event. City crews will respond and alleviate maintenance-related street flooding as soon as possible. Residents should be informed that they may not be contacted directly or observe crews working on problems during heavy storm events, as crews are moving quickly to resolve issues.
  - Dry weather conditions problem reporting, such as blocked storm drain inlet, or broken, dislodged or missing inlet grates and manhole covers. City crews will respond and address problems as necessary. Residents may not receive a call-back.
- The city may elect to not respond to complaints regarding privately owned drainage systems, e.g. a detention or retention basin that is the responsibility of a subdivision or neighborhood. From a public relations standpoint it is often good to respond to these types of complaints and a phone call should be sufficient over an on-site visit.

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