STORM DRAINAGE
AND
TECHNICAL CRITERIA MANUAL

Prepared For:
City of Louisville

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CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

PREFACE

This Louisville *Storm Drainage Design and Technical Criteria Manual* updates and supersedes the previous manual, published April 1982. Major changes include:

- Extensive cross referencing to the Urban Drainage and Flood Control District (UDFCD) *Urban Storm Drainage Criteria Manual, Volumes 1-3* (USDCM). Volumes 1 and 2 of the USDCM were updated in June 2001, and Volume 3 was updated in November 2010. Additional periodic updates are expected in the future. The most current version will be applicable in design. This cross referencing eliminated many duplicate equations, tables, figures and text from the 1982 Louisville *Storm Drainage Design and Technical Criteria Manual*. The purpose of this change is to be certain the Louisville Manual stays consistent with the USDCM as technical updates are expected in the future. Also, any redundancy between the manuals has been minimized or eliminated.

- Addition of Downtown Louisville Overlay District boundary map and criteria.

- Addition of a City of Louisville specific Time-Intensity-Frequency curve.

- Addition of a reference to the City's major watersheds and floodplain regulations.

- Addition of Chapter 6.0, Water Quality, including discussion of Low Impact Development criteria and practices.

- Addition of Chapter 7.0, Sediment and Erosion Control Criteria, including discussion of the Colorado Discharge Permit (CDPS) and requirements for preparation of a Stormwater management Plan (SWMP) for projects disturbing 1 acre or more.

- Addition of Chapter 8.0, Operation and Maintenance of Stormwater Facilities.

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INTRODUCTION

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

Presented in this document are the minimum design and technical criteria for the analysis and design of storm drainage systems. All subdivision plats, planned unit developments, or any other proposed construction submitted for approval shall include adequate storm drainage system analysis and appropriate drainage system design. Such analysis and design shall conform to the criteria set forth herein.

The criteria presented in this document are applicable to areas within the City of Louisville corporate boundaries. Major drainageways, tributaries and their watersheds are presented in the *City of Louisville Basinwide Major Drainageway Planning Study* (Water Resources Consultants 1982) and the *Lafayette-Louisville Boundary Outfall System Plan* (McLaughlin Water Engineers 2011). Additional basin and/or outfall system studies may be referenced in the future as approved and adopted by the City of Louisville and the Urban Drainage and Flood Control District. Areas of policy and technical criteria not specifically covered in this document shall be addressed in accordance with the provisions of the Urban Drainage and Flood Control District's *Urban Storm Drainage Criteria Manual* (USDCM), which is incorporated in this document by reference.

1.2 AMENDMENTS AND REVISIONS

The policies and criteria presented in the City of Louisville *Storm Drainage Design and Technical Criteria* are basic guidelines which may be amended in the future as new technology is developed and/or the experience gained in the use of this document indicate a need for revision. Amendments and revisions will be published by the City of Louisville as needed. However, the provisions contained in the most current version of this document shall be in force until such amendments or revisions are published.

1.3 ACKNOWLEDGEMENTS

This revised document was prepared by WHPacific, Inc. under guidance of and coordination with City of Louisville and Urban Drainage and Flood Control District staff. The development of these storm drainage design and technical criteria was funded jointly by the City of Louisville and Urban Drainage and Flood Control District (UDFCD). Special acknowledgement is made to the advisory staff including:

David Thompson, P.E., City of Louisville
Cameron Fowlkes, P.E., City of Louisville

Gavin McMillan, AICP, City of Louisville
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The following individuals on the staff of WHPacific, Inc. have contributed to the preparation of the completion of this manual:

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John Pflaum, P.E., Project Manager
Laura Hagstrom, EI, Project Engineer

1.4 STATUTORY POWERS AND AUTHORITIES

The inherent police powers of a municipality enable it to enact ordinances that serve the public health, safety, or general welfare. The power to establish, improve, and regulate infrastructure such as drainageways is pursuant to state statutes CRS 31-15-701 and 31-15-714. Other statutes cover the assessment, taxation, and financing of drainage facilities. Similar powers granted to the Counties are presented in CRS 30-20-401, 30-20-422, 30-20-541, 30-20-626, 30-20-501, and 30-20-601. Additional information on the powers of the City to regulate drainage improvements can be found in USDCM Volume 1, Drainage Law.

The City of Louisville has enacted a number of ordinances (Ordinances 423, 609, 639, and 692) covering subdivision development of which drainage related improvements and regulations are a part. The provisions of these ordinances have been incorporated into the City of Louisville Subdivision Regulations within the municipal code. The *City of Louisville Storm Drainage Design and Technical Criteria* has been prepared in accordance with the City regulations.

CHAPTER 2.0
DRAINAGE POLICY

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 2.0 DRAINAGE POLICY

2.1 INTRODUCTION

An adequate storm drainage system for the urban areas is an integral part of a total urban system needed to preserve and promote the general health, welfare, and economic well-being of the community and the region. Drainage system requirements often extend beyond individual community boundaries and can affect many governmental jurisdictions and parcels of property. This characteristic of drainage requires a program that balances both public and private involvement. Overall coordination and master planning should be provided by the local governments in cooperation with one another and must be integrated on a regional level. However, implementation of the system will often be the responsibility of an individual community.

When planning drainage facilities, certain underlying principles provide direction. These principles are made operational through a set of policy statements. The application of the policy is in turn facilitated by technical criteria and data. When considered in a comprehensive manner, drainage facilities can be provided in an urban area in a manner that will avoid property losses and disruption of use, enhance the general health and welfare of the region, and assure optimum economic and social relationships.

For additional discussions of drainage policy and principles, refer to the *Urban Storm Drainage Criteria Manual* (Urban Drainage and Flood Control District) which by reference is an integral part of the City of Louisville *Storm Drainage Design and Technical Criteria*.

2.2 DESIGN CRITERIA

The design criteria presented and referenced herein are the most current standard practices for storm drainage engineering. The criteria are intended to establish guidelines, standards, and methods for effective planning and design. The criteria will be revised and updated as necessary to reflect advances in the field of urban drainage engineering and urban water resources management.

The City of Louisville's policy is to require that storm drainage facility planning and design shall follow the criteria as set forth in the City of Louisville *Storm Drainage Design and Technical Criteria* and the most current version of the *Urban Storm Drainage Criteria Manual* (USDCM) where not covered by this document.

2.3 INITIAL AND MAJOR DRAINAGE SYSTEM

Every urban area has two separate and distinct drainage systems, whether or not they are actually planned for and designed. One is the Initial Drainage System and the other is the Major Drainage System.

The Initial Drainage System is designed to transport the runoff from storms of frequencies from 2 to 10 years, with a minimum of disruption to the urban system. Initial storm drainage can be conveyed in the curb and gutter area of the street (subject to street classification, and capacity as defined herein) or by storm sewer, channel or other conveyance facility.

The Major Drainage System is designed to convey runoff from the 100-year recurrence interval storm, while minimizing health and life hazards, damage to structures, and interrupted traffic and services. Major storm flows can be carried in the urban street system (within acceptable depth criteria), channels, storm sewers or other facilities.

The City of Louisville's policy is, for all land uses, to plan, design, and implement the Initial Drainage System for the 2-year design storm and the Major Drainage Systems for the 100-year design storm.

2.4 LOCAL AND OUTFALL DRAINAGE SYSTEM

For urbanized areas, the total drainage system can be further divided into Local Drainage System and Outfall Drainage System. This division is similar to street classifications for control of traffic flow. Outfall Drainage System is defined as the drainage system required for basins of 1/5 square mile (130 acres) or more of tributary area. The remaining portion of the drainage system that collects the runoff and feeds the Outfall Drainage System is referred to as the Local Drainage System. The policies governing these systems are discussed in the following sections.

2.4.1 Local Drainage System

The Local Drainage System consists of curb and gutter, inlets and storm sewers, culverts and bridges, swales, ditches and channels, detention areas, and other drainage facilities required to convey the initial and major storm runoff from areas less than 130 acres to the Outfall Drainage System. The design storm requirements shall be in accordance with Section 2.3. On-site detention and water quality control shall be required as set forth in Section 2.7.

2.4.2 Outfall Drainage System

The Outfall Drainage System includes those drainage facilities as defined in the *Basinwide Major Drainageway Planning Study, City of Louisville and Boulder County* (Water

Resources Consultants 1982) and in the *Lafayette-Louisville Boundary Outfall System Plan* (McLaughlin Water Engineers, 2011).

The City of Louisville's policy is to require all new development to design and construct that portion of the Outfall Drainage System within the development as defined in the *Basinwide Major Drainageway Planning Study* and in accordance with criteria and policies presented in this document.

2.5 STREETS

Streets are an integral part of the urban drainage system and can be used for transporting storm runoff up to reasonable limits. However, the engineer should recognize that the primary purpose of streets is for traffic, and therefore reasonable limits for the use of streets for storm runoff must be followed.

The City of Louisville's Policy is to permit the use of streets for the Local Drainage System within the following limitations:

Allowable Use of Streets for Initial Storm Runoff

Street Classification	Maximum Theoretical Street Encroachment *
Local	No curb overtopping. Flow may spread to crown of streets.
Collector	No curb overtopping. Flow spread must leave at least one 10 foot lane free of water.
Arterial	No curb overtopping. Flow spread must leave at least one 10 foot lane free of water in each direction.
Freeway	No encroachment is allowed on any traffic lanes.

* Where no curbing exists, the encroachment shall not extend past the property line. The maximum allowable street flow shall be the product of the flow calculated at the "Maximum Theoretical Street Encroachment" and the required reduction factor.

Allowable Use of Streets for Major Storm Runoff

Street Classification	Maximum Theoretical Depth *
Local and Collector	Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line, unless buildings are floodproofed. The depth of water at the gutter

Street Classification	Maximum Theoretical Depth *
	flowline shall not exceed 18".
Arterial and Freeway	Residential dwellings, public, commercial, and industrial buildings shall not be inundated at the ground line, unless buildings are floodproofed. To allow for emergency vehicles, the depth of water shall be 0" at the street crown and shall not exceed 12" at the gutter flowline

* The maximum allowable street flow shall be the product of the flow calculated at the "Maximum Theoretical Depth" and the required reduction factor.

Allowable Cross Street Flow *

Street Classification	Initial Storm Runoff Maximum Depth	Major Storm Runoff Maximum Depth
Collector/Local	Where cross pans allowed, depth of flow shall not exceed 6" at gutter flowline	18" of depth at gutter flowline
Arterial	None	6" or less over crown
Freeway	None	6" or less over crown

* Cross street flow can occur in an urban drainage system under two separate conditions. One condition occurs when the runoff in a gutter flows across the street crown to the opposite gutter. The second condition occurs when the flow in an open drainage channel exceeds the capacity of a road culvert and subsequently overtops the crown of the street.

2.6 STORM RUNOFF DETERMINATION

The City of Louisville's policy is to permit the determination of storm runoff by either the Rational Method or the Colorado Urban Hydrograph Procedure (CUHP), within the limitations as set forth in this document. The Rational Method may be used for all basins less than 90 acres. For basins between 90 and 130 acres, the Rational Method or CUHP may be used. For basins of 130 acres and larger, the peak flows and volumes shall be determined by the CUHP method. However, peak flow rates shall be obtained from the report *Basinwide Major Drainageway Planning Study for Louisville and Boulder County* (Water Resources Consultants 1982a) and the *Lafayette-Louisville Boundary Outfall System Plan* (McLaughlin Water Engineers 2011) for all outfall drainageways contained in that report.

2.7 STORM RUNOFF DETENTION AND WATER QUALITY

The City of Louisville's policy is to require onsite detention and water quality enhancement measures for all new development and any re-development. The required minimum detention volume and maximum release rates at these volumes for the 10-year and 100-year recurrence interval storm shall be determined in accordance with the procedure and data set forth in this document. Refer to Chapter 6.0 for water quality criteria.

2.8 IRRIGATION FACILITIES

There are many irrigation ditches and several reservoirs in the Louisville area. The ditches and reservoirs have historically intercepted the storm runoff from the rural and agricultural type basins, generally without major problems. With urbanization of the tributary basins, however, the storm runoff has increased in quantity and frequency of occurrence and has changed in water quality. As the result, irrigation facilities will no longer accommodate additional increases in stormwater runoff. The following policies have therefore been established:

2.8.1 Drainage Interaction

To evaluate the interaction of irrigation ditches with a major drainageway for the purpose of basin delineation, the irrigation ditch shall not be utilized as a basin boundary to eliminate the contribution of the upper basin area. The ditches are expected to be flowing full or near full during storms, therefore, all the tributary basin runoff is assumed to flow across the ditches.

The City of Louisville's policy is to require all drainage runoff analysis to assume that the irrigation ditches do not intercept the storm runoff.

2.8.2 Transmission Facilities

Irrigation ditches and canals are constructed with flat longitudinal slopes and limited carrying capacity, which generally decreases in the downstream direction. The ditches should not be used as an outfall point for the storm drainage system because of the physical limitations. In addition, certain ditches become abandoned with urbanization and, therefore, cannot be successfully utilized for storm drainage.

The City of Louisville's policy is to separate irrigation and storm runoff flow for all new construction and reconstruction. Irrigation ditches shall not be used as outfall points for the Initial or Major Drainage Systems.

2.9 OPERATIONS AND MAINTENANCE

The City of Louisville's policy is to require that maintenance access be provided to all storm drainage facilities to assure continuous operational capability of the system. Refer to Chapter 8.0 "Operation and Maintenance of Stormwater Facilities."

CHAPTER 3.0
SUBDIVISION PLANNING AND SUBMITTAL REQUIREMENTS

CITY OF LOUISVILLE
STORM DRAINAGE AND TECHNICAL CRITERIA

CHAPTER 3.0 SUBDIVISION PLANNING AND SUBMITTAL REQUIREMENTS

3.1 OVERVIEW

Presented in Chapter 3.0 is the rationale and requirements for developing and redeveloping land within the City of Louisville.

3.2 REGULATIONS

The criteria set forth in this document are pursuant to the City of Louisville Municipal Code (LMC) (16.12.050 and 16.12.090) requiring that drainage be addressed in accordance with specific criteria and procedures. A Preliminary Drainage Report shall be submitted (3 copies) at the time of preliminary platting (LMC 16.12.020). A Final Drainage Report shall be submitted (3 copies) with the final plat (LMC 16.12.060). When specific site improvements are required, the construction drawings and specifications must be submitted for review and approval prior to construction (LMC 16.020.010). All construction drawings and specifications shall be in conformance with the approved Final Drainage Report and this Criteria Manual. The City will review the reports, plans, and specifications and provide written review comments and/or approval within 30 days of the submittal. The plans must be updated for "as built" conditions prior to the City's acceptance (LMC 16.20.050). The detailed requirements for these submittals are presented in the following sections.

3.2.1 Floodplain Regulations

The City of Louisville lies within the boundaries of the following watersheds:

- Coal Creek Basin
- Rock Creek Basin
- Bullhead Gulch Basin

Portions of the City of Louisville lie within the delineated floodplains for Coal Creek, Rock Creek, and Bullhead Gulch. Floodplain Development Permits may be required for areas within the Flood Regulatory District. Regulations governing activities or development within these floodplains are contained in the Municipal Code, Title 17 Zoning, Chapter 17.56 Floodplain Zoning.

3.3 DOWNTOWN LOUISVILLE OVERLAY DISTRICT/SMALL AREA PLANS

The area designated in Figure 3-1 will be categorized as the Downtown Louisville Overlay District and Small Area Plans as shown. Much of the development in the area will be redevelopment or infill. Overlay districts may be subject to additional requirements and/or waivers based upon

specific sub area plans and planned unit development review because of the broad range of limits and constraints that are associated with redevelopment or infill.

Projects in this area shall adhere to the following requirements:

a) The project shall adhere to the Storm Drainage and Technical Criteria Manual for the City of Louisville to the maximum extent practicable as determined by the City.
b) Water quality requirements must be met by all projects (Chapter 6). Stormwater management should incorporate BMP's specifically designed for infill projects (space limitations). Low Impact Development is encouraged to improve water quality and reduce stormwater runoff. Projects may be able to use regional facilities depending on the project location and constraints if allowed by the City.

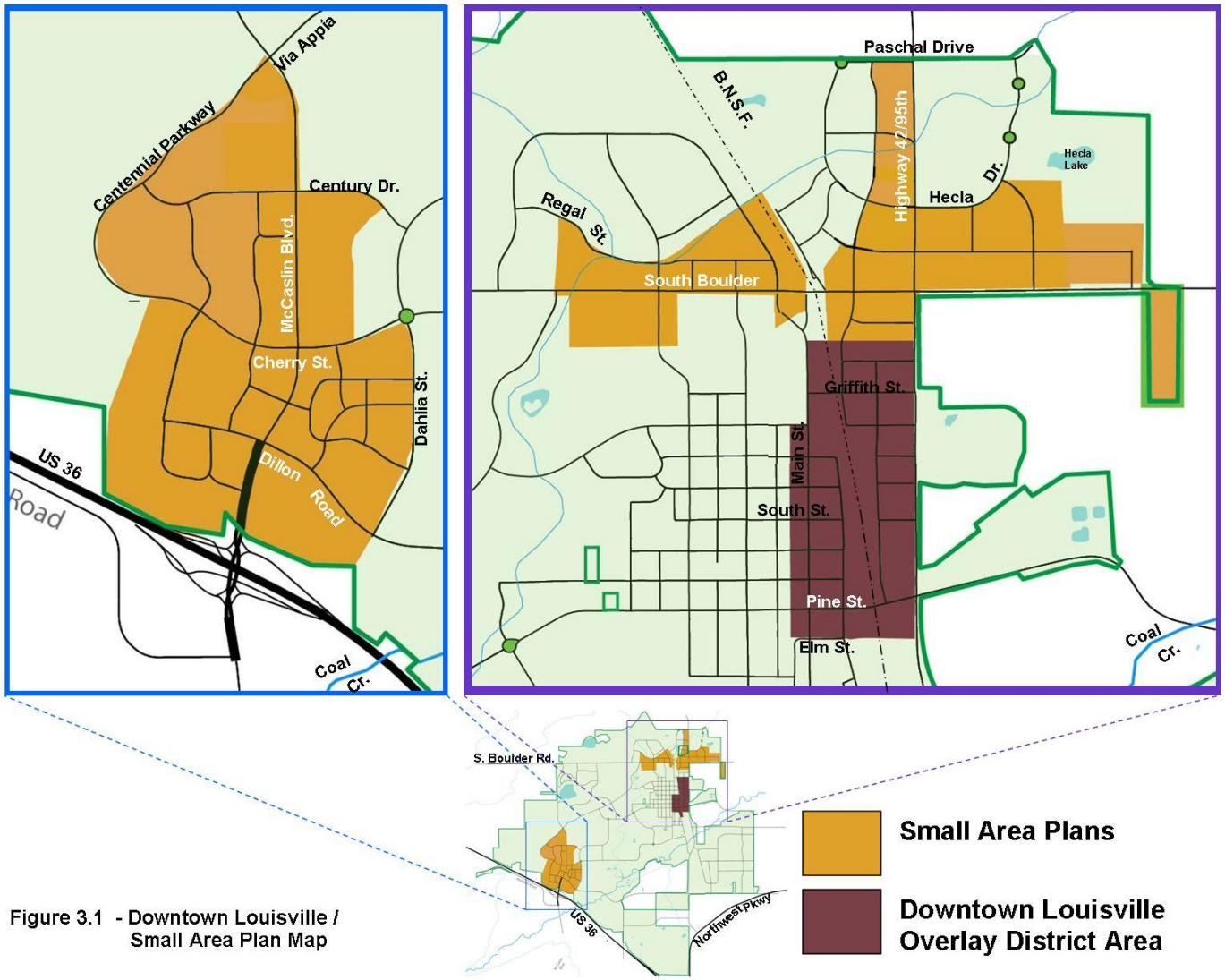

Figure 3.1 - Downtown Louisville / Small Area Plan Map

Figure 3.1 – Downtown Louisville Overlay District Map

3.4 PRELIMINARY DRAINAGE REPORT

The purpose of the Preliminary Drainage Report is to identify and define conceptual solutions to the problems that will occur onsite and offsite as a result of the development. In addition, problems that exist on site prior to development must be addressed during the preliminary phase. All reports shall be submitted on properly bound 8 ½" x 11" paper. The drawings, figures, and tables shall be bound with the report or included in a folder/pocket attached to the report. The report shall include a cover letter presenting the preliminary design for review and shall be prepared by an engineer licensed in Colorado. See the Appendix for the Drainage Report Submittal Checklist that should be used as a guide for completeness prior to submittal of the report. The report shall be certified as follows:

"I hereby certify that this report [plan] for the preliminary drainage design of [Name of Development] was prepared by me (or under my direct supervision) in accordance with the provisions of City of Louisville Storm Drainage Design and Technical Criteria for the owners thereof."

_____

Registered Professional Engineer
State of Colorado No. [P.E. number]
[Affix Seal]

The Preliminary Drainage Report shall be in accordance with the following outline and contain the applicable information listed. Failure to comply with the provisions of this section may result in the report being rejected for review.

3.4.1 Report Format and Required Information

The following format and appropriate information shall be followed for the Preliminary Drainage Report:

I. GENERAL LOCATION AND DESCRIPTION
   A. Location
      1. City and County
      2. Township, Range, Section, ¼ Section
      3. Major Drainage Facilities
      4. Surrounding Developments
   B. Description of Property

1. Area
2. Ground Cover (trees, shrubs, vegetation)
3. Hydrologic Soil Group (NRCS Type A, B, C or D)
4. Major Drainage Channels
5. General Topography

II. HISTORIC DRAINAGE

A. Major Basin Description

1. Reference to Basinwide Planning Study, if any
2. Major Basin Drainage Characteristics
3. Identification of all nearby irrigation facilities which will influence or be influenced by the local drainage

B. Sub-Basin Description

1. Discussion of historic drainage patterns of site
2. Discussion of offsite drainage flow patterns and impact on development
3. Identify historic flows and volumes for all sub-basins.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

1. Reference to City and County subdivision regulations
2. Discussion of compliance with or deviation (including a request for variance from the standard) from the City of Louisville *Basinwide Major Drainageway Planning Report* (Water Resources Consultants 1982a), the *Lafayette-Louisville Boundary Outfall System Plan* (McLaughlin Water Engineers 2011) and *Urban Storm Drainage Design and Technical Criteria Manual*

B. Development Criteria Reference and Constraints

1. Discussion of previous drainage studies for the site that influence or are influenced by the drainage design
2. Discussion of the drainage impact of site constraints such as streets, irrigation ditches, utilities, railroads, existing structures, and development or site plans

C. Hydrological Criteria

1. Identify design rainfall source
2. Identify design storms recurrence intervals
3. Identify runoff calculation method
4. Identify detention and water quality volumes and discharges and storage calculation method

5. Discussion and justification of other criteria or calculation methods used that are not presented in or referenced by the *Storm Drainage Design and Technical Criteria.*

D. Hydraulic Criteria
    1. Identify various capacity references
    2. Identify detention and water quality outlet design method
    3. Identify check/drop criteria used
    4. Discussion of other drainage facility design criteria used that are not presented in or referenced by the *Storm Drainage Design and Technical Criteria*

IV. DRAINAGE FACILITY DESIGN

A. General Concept
    1. Discussion of concept and typical drainage patterns
    2. Discussion of compliance with offsite runoff considerations
    3. Discussion of the content of tables, figures, or drawings presented in the report

B. Specific Details
    1. Discussions of drainage problems encountered and solutions at specific design points
    2. Discussion of detention storage, water quality enhancement, and outlet design
    3. Comparison of historic flows and all developed flows released from the site (detained and undetained)

V. CONCLUSIONS

A. Compliance with Standards
    1. *Storm Drainage Design and Technical Criteria*
    2. *Basinwide Major Drainageway Planning Study*
    3. *Lafayette-Louisville Boundary Outfall System Plan*
    4. City of Louisville Subdivision Regulations
    5. *Urban Storm Drainage Criteria Manual*
    6. Other master drainage reports

B. Drainage Concept
    1. Effectiveness of drainage design to control damage from storm runoff

VI. REFERENCES

Reference all criteria and technical information used

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    1. Land use assumptions regarding adjacent properties
    2. Initial and major storm runoff at specific design points
    3. Historic and fully developed runoff computations at specific design points
    4. Hydrographs at critical design points
    5. Detention volume and peak discharge computations

B. Hydraulic Computations
    1. Culvert capacities (spreadsheets)
    2. Storm sewer capacity
    3. Street capacity
    4. Storm inlet capacity including inlet control rating at connection to storm sewer
    5. Open channel design
    6. Check and/or channel drop designs
    7. Detention area/volume capacity and outlet capacity calculations
    8. Water quality volume calculations

3.4.2 Report Drawings

The following drawings will be required for the Preliminary Drainage Report:

FIGURE-l General Location Map

A four foot contour interval map shall be provided delineating the major watershed, in which the development is located, tributary to Rock Creek, Coal Creek, or Bullhead Gulch. This map should be of sufficient detail to identify drainage flows entering and leaving the development, and should identify any major construction along the path of drainage such as other development. Typically this map should be at a scale of 1" = 400' to 1" = 2,000' on an 8 ½" x 11" or 11" x 17" drawing. A four foot contour interval map for most of the watershed around Louisville can be obtained from the City.

FIGURE-2 Drainage Plan

A map(s) of the proposed development at a scale of 1" = 20' to 1" = 100' on a 22" x 34" drawing shall be included. The plan should show the following:

1. A topographic map shall be provided with two foot existing and proposed contours tied to the Louisville/Boulder County control monuments which are based upon the USGS datum and the State Plane Coordinate System. Monument information may be obtained from the City. The mapping shall extend a minimum of 250 feet beyond the property lines.

2. Property lines
3. Streets
4. Existing drainage facilities and structures, including irrigation ditches, roadside ditches, drainageways, gutter flow directions, and culverts. All pertinent information such as materials, size, shape, slope, and location shall also be included
5. Overall drainage area boundary and drainage sub-area boundaries
6. Proposed type of curb and gutter (vertical or combination) and gutter flow directions, including cross pans
7. Proposed storm sewers and open drainageways, including inlets, manholes, culverts, and other appurtenances
8. Proposed outfall point for runoff from the developed area and facilities to convey flows to the final outfall point without damage to the downstream properties
9. Routing and accumulation of flows at various critical points for the initial storm runoff
10. Routing and accumulation of flows at various critical point for the major storm runoff
11. Details of detention storage and water quality facilities and outlet works
12. Location and elevations of all defined floodplains effecting the property
13. Location and elevations of all existing and proposed utilities affected by or effecting the drainage design
14. Routing of offsite runoff through the development
15. Delineation of all undetained basins, total undetained release from the site

3.5 FINAL DRAINAGE REPORT

The purpose of the Final Drainage Report is to update the concepts, and to present the design details for the drainage facilities presented in the Preliminary Drainage Report. Also, any changes to the concept must be presented. All reports shall be submitted on 8 ½" x 11" paper and properly bound. The drawings, figures, and or tables shall be bound with the report or included in a folder/ pocket attached to the report.

The report shall include a cover letter presenting the final design for review and shall be prepared by an engineer licensed in Colorado, certified as required for the preliminary report.

The Final Drainage Report shall be in accordance with the outline presented in Section 3.4.1. The requirements for the report drawings are presented in Section 3.4.2. Failure to comply with the provisions of this section may result in the report being rejected for review.

Once a Final Drainage Report is approved, two hard copies and a complete PDF shall be submitted to the City.

3.6 CONSTRUCTION DRAWINGS AND SPECIFICATIONS

Where drainage improvements are to be constructed in accordance with the approved Final Drainage Report, the construction plans and specifications shall be submitted for review and approval prior to construction (LMC 16.20.010). After approval of the drawings and specifications, 3 paper copies and 1 electronic file (PDF) of the approved plans will be submitted to the City for their files. The plans and specifications for the improvements will include, as necessary, but are not limited to the following:

1. Storm sewers, inlets, and outlets
2. Culverts, end sections, and inlet/outlet protection
3. Channels, ditches, and swales
4. Checks, channel drops, erosion control facilities
5. Hydraulic grade line profiles
6. Detention pond grading, trickle channels, outlets, and landscaping
7. Other drainage related structures and facilities

The information required for the drawings and specification shall be in accordance with sound engineering principles and the most recent edition of the City of Louisville Design and Construction Standards. Construction documents shall include geometric, dimensional, structural, foundation, bedding, hydraulic, landscaping, or other details as needed to construct the storm drainage facility.

3.7 "AS BUILT PLANS"

As constructed finished plans (“As Built") for all public improvements shall be attested by a professional engineer registered in Colorado and submitted to the City before the City will accept the improvements. The working plans as approved are acceptable if they remain true after construction and are attested to by a registered engineer to represent "As Built" conditions, (Louisville 16.20.050). As-built submittals shall also be completed in accordance with the most recent edition of the City of Louisville Design and Construction Standards.

A letter from the engineer of record stating the improvements have been constructed according to the approved plans and specifications must be submitted to the City prior to construction acceptance. See the Appendix for the Drainage and Grading Compliance Certification Requirements.

CHAPTER 4.0
HYDROLOGIC CRITERIA

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 4.0 HYDROLOGIC CRITERIA

4.1 INTRODUCTION

Presented in Chapter 4.0 are the criteria and methodology for determining the storm runoff design peaks and volumes to be used in the preparation of storm drainage studies, plans, and facility design. The details of the rainfall/runoff models are presented in the *Urban Storm Drainage Criteria Manual* (Urban Drainage and Flood Control District).

4.2 DESIGN RAINFALL

Rainfall data shall be in accordance with USDCM Volume 1, Rainfall. The USDCM provides incremental rainfall depths for various recurrence frequencies to be used as the design rainfall for the Colorado Urban Hydrograph Procedure (CUHP). The intensity-duration-frequency curves for use with the Rational Method are presented in Figure 4.1 – Intensity-Duration-Frequency Curves for Louisville, which is located at the end of this chapter.

4.3 RATIONAL METHOD

The Rational Method is a simplified storm runoff modeling technique. The method is acceptable for sizing sewers, culverts, and small drainageways when the contributing drainage basins are relatively small. The Rational Method shall be used in both the initial and major storm runoff computations for basins less than 130 acres. Refer to USDCM Volume 1, Runoff, Section 2.0: Rational Method.

4.4 COLORADO URBAN HYDROGRAPH PROCEDURE

The Colorado Urban Hydrograph Procedure (CUHP) was originally developed for the Denver area at the time the USDCM was created. The procedures for the CUHP, as explained in the USDCM, Volume 1, Runoff, Section 3.0: Colorado Urban Hydrograph Procedure, shall be followed in the preparation of drainage reports and storm drainage facility designs in the City of Louisville for watershed areas larger than 130 acres. Infiltration shall be based on the NRCS Hydrologic Soil Group of the soils present on site. Soils in Louisville predominately belong to NRCS Hydrologic Soil Group B with pockets of Group C. Refer to NRCS soil surveys (United States Department of Agriculture, Natural Resources Conservation Service 2011) to determine the soil classification present on the individual site.

4.5 HYDROGRAPH ROUTING PROCEDURE

The U.S. Environmental Protection Agency's Storm Water Management Model (SWMM), version5.0, is a rainfall-runoff simulation model used for runoff quantity from primarily urban

areas. SWMM is the preferred hydrograph routing program for use for watersheds within the UDFCD. The program is used to route hydrographs generated by CUHP through proposed and existing conditions conveyance elements. The free software and user manual can be downloaded through the UDFCD website at www.udfcd.org.

4.6 STORM FLOW ANALYSIS

When determining the design storm flows, the engineer must follow certain criteria and guidelines to assure that minimum design standards and uniformity of drainage solutions are maintained throughout the Louisville area. This section deals primarily with the land use assumptions for the proposed development (onsite flow analysis) and the adjacent contributing area (offsite flow analysis). The information presented herein shall be used by the engineer in the development of design storm flows.

4.6.1 Onsite Flow Analysis

When analyzing the flood peaks and volumes, the engineer shall use the proposed land use plan when determining runoff coefficients. In addition, the engineer shall take into consideration the change in flow patterns and pathways from undeveloped conditions due to the proposed street alignments. When evaluating surface flow times, the proposed lot grading shall be used when calculating the time of concentration or the CUHP parameters.

4.6.2 Offsite Flow Analysis

The analysis of storm runoff from existing developed areas lying outside of the property shall be based upon existing land use and topographic features. Available drainage reports for offsite developed areas shall be reviewed to properly coordinate the drainage facilities.

All undeveloped land lying outside of the property shall be considered as fully developed. Due to the required onsite detention for the 10- and 100-year storms, the offsite runoff peaks for the 10- and 100-year storms shall be determined based upon Table SO-1 in USDCM Volume 2, Storage. The offsite runoff peaks for the 2-year storm even shall be based upon the fully developed offsite basin without any reduction in peaks due to upstream detention.

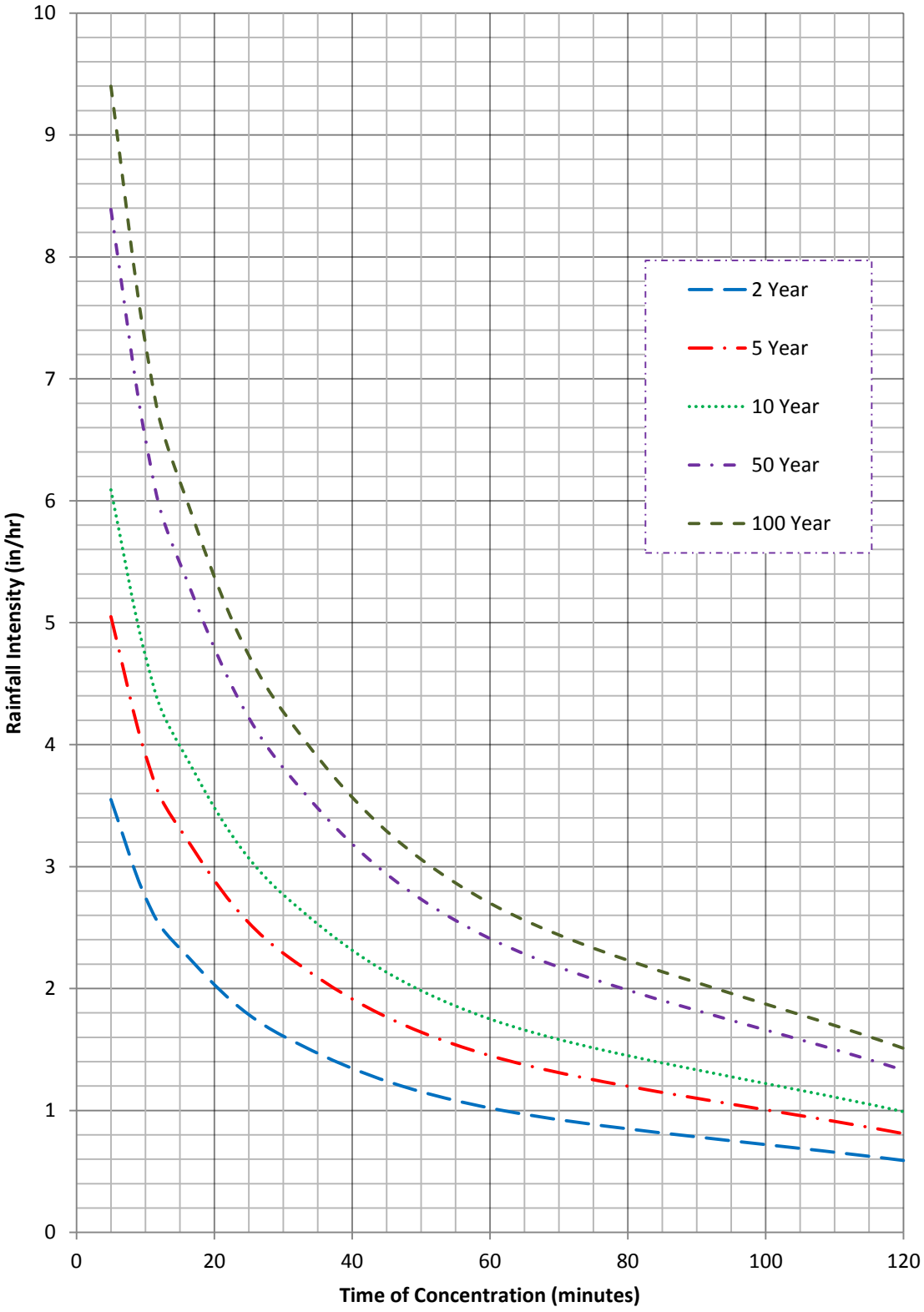

Figure 4.1 – Intensity-Duration-Frequency Curves for Louisville

CHAPTER 5.0
HYDRAULIC CRITERIA

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 5.0 HYDRAULIC CRITERIA

5.1 GENERAL

Chapter 5.0 presents the technical criteria for the hydraulic evaluation and hydraulic design of drainage facilities in the Louisville area. The drainage facilities include open channels, storm sewers and inlets, streets, culverts, riprap, check drops, energy dissipaters, bridges, detention sites, and irrigation ditch crossings. The information presented herein is intended to be used by the engineer for the design and evaluation of the various drainage facilities and is considered to be a minimum standard.

Except as modified herein, or required by the *Basinwide Major Drainageway Planning Report* (Water Resources Consultants 1982b), or the *Lafayette-Louisville Boundary Outfall System Plan* (McLaughlin Water Engineers, 2011), all hydraulic criteria shall be in accordance with the *Urban Storm Drainage Criteria Manual* (USDCM). Computer software programs available from the UDFCD website (www.udfcd.org) may be used for hydraulic evaluations; however, when used, the software input and output listings should be submitted in both electronic and hard copy formats.

5.2 OPEN CHANNELS

In conjunction with the specifications listed below, open channel design shall be in accordance with USDCM Volume 1, Major Drainage, Section 3.0: Open Channel Design Principles, and Section 4.0: Open Channel Design Criteria.

For all channels, computation of water surface profiles shall be completed utilizing standard backwater calculation methods. Backwater calculations shall be completed using the Corps of Engineers' HEC-RAS program.

5.2.1 *Natural and Bioengineered Channels*

The use of natural and bioengineered channels is encouraged because of the relatively lower maintenance cost and the potential multi-use natural and recreational benefits. The design criteria and evaluation techniques for natural and bioengineered channels are presented in USDCM Volume 1, Major Drainage, Section 4.0: Open Channel Design Criteria, Subsections 4.5 and 4.6.

For the design of a bioengineered or natural channel, provision for a stable stream gradient for the developed flow regime must be considered. Grade control structures should be designed at appropriate intervals to control the thalweg slope and to maintain non-erosive

velocities. Channel reaches between grade control structures should be left in as near a natural condition as possible, and for that reason extensive modifications should not be undertaken unless they are found to be necessary to avoid excessive erosion with subsequent deposition downstream.

The usual rules of freeboard depth, curvature, and other rules applicable to artificial channels do not apply for natural channels. However, all structures constructed along the channel shall be elevated a minimum of 1 foot above the 100-year water surface. There can be advantages which may occur if the designer incorporates into his planning the overtopping of the channel and localized flooding of adjacent, publicly-owned overbank areas which are laid out and developed for the purpose of being inundated during the major runoff peak.

If a natural channel is to be utilized as a drainageway for a development (i.e., historic 100-year flood peaks in excess of 100 cfs), then the engineer shall meet with the City of Louisville to discuss the concept and to obtain the requirements for planning and design documentation. Approval of the concept and design will be made in accordance with the requirements of Chapter 2.0 of this document.

5.2.2 *Grass Lined Channels*

Grass lined channels are also preferred within the City of Louisville. Design of grass-lined channels shall be completed in accordance with the guidelines and criteria in the USDCM Volume 1, Major Drainage, Section 4.0: Open Channel Design Criteria.

5.2.3 *Riprap Lined Channels*

If the project constraints dictate the use of riprap lining, the engineer must present the concept, with justification, to the City for approval. Soil Riprap is the preferred option instead of exposed option. USDCM criteria shall be used to size riprap.

5.2.4 *Concrete Lined Channels*

Concrete lined channels are discouraged and shall only be considered if project ROW or other constraints require a limited conveyance section. Concrete channels are generally not aesthetic, and can be dangerous during storm events. If the project constraints dictate the use of concrete channel, the engineer must present the concept, with justification, to the City for approval.

5.3 STORM SEWERS

In conjunction with the specifications listed below, storm sewer design shall be in accordance with USDCM Volume 1, Streets/Inlets/Storm Sewers, Section 4.0: Storm Sewers. The UD-Sewer software program (available to download free from the UDFCD website) may be used in the

hydraulic evaluation of storm sewers. City of Louisville staff approval shall be obtained before using other software for storm sewer hydraulic evaluation.

5.3.1 Construction Materials

Reinforced Concrete Pipe (RCP) in accordance with ASTM C-76, C-506, C-507 is acceptable for use in storm sewer construction. The minimum class of pipe shall be Class III subject to verification of the structural capabilities.

Other materials to be used for storm sewers shall be approved in writing by the City prior to final design.

5.3.2 Vertical Alignment

The sewer grade shall be such that a minimum cover is maintained to withstand AASHTO H-20 loading on the pipe. The minimum cover depends upon the pipe size, type and class, and soil bedding condition, but shall not be less than 18 inches at any point along the pipe.

Manholes will be required whenever there is a change in size, direction, elevation, grade or where there is a junction of two or more sewers. In addition, the maximum spacing between manholes shall be 400 feet for pipelines 15 to 36 inches in diameter, and 500 feet for pipelines 42 inches and larger in diameter.

The minimum clearance between storm sewer and water mains, either above or below, shall be 12 inches. Concrete encasement of the water line will be required for clearances of 12 inches or less.

The minimum clearance between storm sewer and sanitary sewer, either above or below, shall be 18 inches. However, when a sanitary sewer main lies above a storm sewer, or within 18 inches below, the sanitary sewer shall have an impervious encasement or be constructed of ductile iron pipe or C900 PVC pipe for a minimum of ten feet on each side of where the storm sewer crosses.

5.3.3 Horizontal Alignment

Storm sewer alignment between manholes shall be straight, except where approved in writing by the City.

5.3.4 Pipe Size

The minimum pipe diameter for main trunk is 18 inches and the minimum diameter for a lateral from inlet is 15 inches. The size of lateral shall also be based on the water surface inside the inlet or a minimum distance of 1 foot below the grate or throat. Pipe diameter shall not decrease from upstream to downstream, regardless of change in slope.

5.4 STORM SEWER INLETS

In conjunction with specifications listed below, storm sewer inlet design shall be in accordance with USDCM Volume 1, Streets/Inlets/Storm Sewers, Section 3.0: Inlets. The UD-Inlet software program (available free from the UDFCD website) may be used in the hydraulic evaluation of inlets, for both on-grade and sump conditions. City of Louisville staff approval shall be obtained before using other software for inlet hydraulic evaluation.

The inlets standards to be used for public streets shall be the curb opening inlet conforming to the CDOT Standard M-604-12 (Type R). Inlets with grated openings shall not be used within Louisville public streets. Grated or combination inlet openings may be used for parking areas, private storm sewer, open fields or other applications outside of the streets subject to approval by the City.

5.5 URBAN STREET EVALUATION

In conjunction with the specifications listed below, street drainage shall be in accordance with USDCM Volume 1, Streets/Inlets/Storm Sewers, Section 2.0: Street Drainage. The UD-Inlet software program (available free from the UDFCD website) may be used in the hydraulic evaluation of street and gutter flows. City of Louisville staff approval shall be obtained before using other software for street and gutter hydraulic evaluation.

5.5.1 Classification

The allowable encroachment of storm runoff in the streets is presented in Section 2.5 ("Drainage Policy-Streets") of this manual.

5.5.2 Hydraulic Evaluation

The allowable gutter capacity shall be in accordance with the policy presented in Section 2.5 of this manual.

5.6 CULVERTS

In conjunction with the specifications listed below, culvert design shall be in accordance with USDCM Volume 2, Culverts. The UD-Culvert software program (available free from the UDFCD website) may be used in the hydraulic evaluation of culverts. City of Louisville staff approval shall be obtained before using other software for culvert hydraulic evaluation.

5.6.1 Design Standards

5.6.1.1 Construction Materials and Pipe Size

Culverts shall be constructed from concrete (RCP Class III minimum). Corrugated metal pipe is not allowed. Other materials for construction shall be subject to approval by the City.

The minimum pipe size for culverts within public ROW shall be 18 inches diameter round culvert.

5.6.1.2 Inlet and Outlet Configuration

All culverts are to be designed with headwalls and wingwalls, or with flared-end sections at the inlet and the outlet. Additional protection in the form of riprap (designed in accordance with USDCM criteria) will also be required at the inlet and outlet due to the scouring velocities.

5.6.1.3 Hydraulic Data

Refer to USDCM, Volume 2, Culverts.

5.6.1.4 Velocity Considerations

The minimum velocity in a culvert is 2 feet per second, and the maximum outlet velocity is 12 feet per second with the proper protection.

5.6.1.5 Headwater Considerations

The maximum headwater for the 100-year design flows shall be 1.5 times the culvert diameter or culvert rise dimension for shapes other than round.

5.6.1.6 Structural Design

As a minimum, all culverts shall be designed to withstand an H-20 loading in accordance with the design procedures of AASHTO *Standard Specifications for Highway Bridges* and with the pipe manufacturer's recommendations.

5.6.2 Uniform Street Culvert Criteria

A significant portion of the flood damages occurring in urbanized drainage basins are related to the damages occurring at the various street crossings. The street crossings in the Louisville area fall into this category. Therefore, a uniform design and rating system for street culverts has been developed.

The design of the culvert is dependent upon two factors: the street classification (i.e., local, collector, arterial, and freeway) and the allowable street inundation. The allowable street inundation for the various street classifications is presented in Section 2.5 ("Policy-Streets") of this document. In addition to this policy, a criterion requiring that no street overtopping occur for a 10-year frequency storm has been established. Therefore, as a minimum design standard for street crossings, the following procedure shall be used:

1. Using the future developed conditions 100-year runoff, the allowable street overtopping shall be determined from rating curves developed from the street profile crossing the waterway.

2. The culvert is then sized for the difference between the 100-year runoff and the allowable overtopping.

3. If the resulting culvert is smaller than that required to pass the 10-year flood peak without overtopping, the culvert shall be increased in size to pass the 10-year flow.

These criteria are considered a minimum design standard and must be modified where other factors are considered more important. For instance, if the procedure still results in certain structures remaining in the 100-year floodplain, the design frequency shall be increased to lower the floodplain elevation. For railroad crossings, the 100-year flow shall be used to size the culvert without overtopping, since overtopping of the railroad embankment could result in the erosion of the track ballast and subsequently loss of the structure.

5.7 HYDRAULIC STRUCTURES

The criteria to be used in the design of hydraulic structures shall be in accordance with the USDCM Volume 2, Hydraulic Structures. The specific criteria to be used with the modifications for the Louisville area are presented herein.

5.7.1 Energy Dissipaters

Where riprap structures are insufficient or uneconomical to control the storm runoff, concrete energy dissipater structures (stilling basins) shall be provided. For culverts or storm sewers where the Froude number at the outlet is in excess of 2.5, the USBR Type VI impact stilling basin shall be used.

5.7.2 Irrigation Ditch Crossings

The City requires complete separation of storm flow and irrigation flow.

5.8 DETENTION STORAGE

Detention storage design shall be in accordance with USDCM Volume 2, Storage. In addition, extended detention for water quality enhancement of runoff shall be designed in accordance with Chapter 6.0 of this document and the USDCM Volume 3, Best Management Practices. Computer software (available free from the UDFCD website) is available for sizing of detention structures for quantity and quality control. City of Louisville staff approval shall be obtained before using other software for detention pond hydraulic evaluation.

5.9 MAINTENANCE ACCESS

All drainage facilities including channels, storm sewers, detention areas, irrigation ditch crossings, erosion control structures, and channel checks or drops shall include a 12 foot wide access road. The City may require that the access road be paved. If the facility parallels an existing public right-of-way, the maintenance access requirement may be waived.

Access roads shall have a maximum longitudinal slope of 10% and maximum cross slope of 3%.

CHAPTER 6.0
WATER QUALITY CRITERIA

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 6.0 WATER QUALITY CRITERIA

6.1 GENERAL

The Federal Water Pollution Control Act of 1972 is commonly known as the Clean Water Act and establishes minimum stormwater management requirements for urbanizing areas in the U.S. At the Federal level, the EPA is responsible for administering and enforcing the requirements of the Clean Water Act, and has also delegated authority to the State of Colorado. In 1973, the Colorado Water Quality Control Act established the Colorado Water Quality Control Division (CWQCD) within the Colorado Department of Public Health and Environment (CDPHE) to administer and enforce the Act and administer the discharge permit system. The Act requires that urban areas must meet requirements of Municipal Separate Storm Sewer System (MS4) permits, under which they are required to develop a Stormwater Management Program with measurable goals. Communities must also implement stormwater management control Best Management Practices (BMPs) intended to reduce the discharge of pollutants to the "maximum extent practicable."

6.1.1 Construction Site Stormwater Runoff Control

Under the Construction Program, permittees are required to develop, implement and enforce a pollutant control program to reduce pollutants from construction activities from land disturbances of one or more acres. Refer to Chapter 7 of this document for information on construction BMPs.

6.1.2 Post-Construction Stormwater Management

Under the post-construction stormwater management for new development and redevelopment, the MS4 General Permit requires permittees (communities) to develop, implement and enforce a program to address stormwater runoff from new development/redevelopment projects that disturb an area one acre or larger. The program must ensure that controls are in place that would prevent or minimize water quality impacts.

6.2 THE FOUR STEP PROCESS TO MINIMIZE ADVERSE IMPACTS OF URBANIZATION

Volume 3 of the USDCM recommends a Four Step Process for receiving water protection that focuses on:

1. Reducing runoff volumes by employing runoff reduction practices;
2. Calculating the Water Quality Capture Volume and implementing BMPs that capture and treat the WQCV and release this volume at a slow rate;
3. Stabilizing receiving drainageways to prevent bed and bank erosion due to the increases in frequency, duration, rate and volume of post-development runoff; and,

4. Implementing site specific source control BMPs.

6.3 CITY OF LOUISVILLE REQUIREMENTS

The City of Louisville requires that all development and redevelopment sites within the City prepare plans to address the adverse impacts of development, including plans relating to construction impacts (see Chapter 7 of this manual) and plans for implementation and maintenance of permanent treatment and source control BMPs for the site. All designs must conform to the requirements of the USDCM Volume 3.

Refer to Volume 3 of the USDCM for design guidance and specific criteria for:

- Calculating the WQCV (Chapter 3);
- Selecting/Designing Treatment BMPs (Chapter 4);
- Selection/Designing Source Control BMPs (Chapter 5); and
- Maintaining BMPs (Chapter 6).

The USDCM and the UDFCD website provide design guidance, free software, design details and examples for several detention basin outlet configurations to provide for extended detention for water quality enhancement. Use of computer software other than UDFCD software shall be approved by City of Louisville Staff prior to use for design.

6.4 LOW IMPACT DEVELOPMENT

Low Impact Development (LID) is a comprehensive approach that combines land/development planning with engineering design to manage stormwater. The goal is to replicate the pre-development hydrologic regime for a given site. This is accomplished by planning for management of stormwater from the very beginning rather than retrofitting stormwater facilities onto a development plan. Key components of Low Impact Development practices are:

1. Integration of a development into the site with consideration toward preservation of the site's natural features, including drainageways, open space, wetlands and areas where infiltration potential is high.

2. Site drainage design that addresses management of stormwater at the source, with controls distributed throughout the site in small elements. While this practice doesn't necessarily eliminate the need for a centralized facility such as a stormwater detention pond, it can reduce the volume (and space) required for such a facility.

3. Reduction of impervious surfaces through the use of grass swales, porous pavement, green roofs, downspout planters, vegetated buffer areas, rain gardens and other measures.

4. A focus on volume reduction as opposed to peak flow reduction as the primary hydrologic objective. This is in keeping with the LID philosophy of striving to achieve a post-development hydrologic regime that is closer to the duration and frequencies of the natural, pre-development regime.

Runoff management practices that are suited to Low Impact Development (LID) include:

- Filter/buffer strips and other multifunctional landscape areas
- Rain gardens
- Grassed swales and bioretention swales
- Pervious pavements

The City of Louisville encourages the design and implementation of Low Impact Development design techniques for all new development and redevelopment. LID techniques that employ infiltration are well-suited to the Type B soils that predominate within the City.

Volume 3 of the USDCM, Chapter 1, presents design guidelines and criteria for LID techniques to assist site planners and engineers with application of LID to new development or redevelopment within the City of Louisville.

CHAPTER 7.0
SEDIMENT AND EROSION CONTROL CRITERIA

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 7.0 SEDIMENT AND EROSION CONTROL CRITERIA

7.1 GENERAL

Control of erosion and sedimentation from land disturbance activities on a specific parcel of land is critical to the protection of adjacent offsite areas and ultimately the waterways that receive the runoff from that site. The Federal Clean Water Act and the Colorado Water Quality Control Act require stormwater discharge permits prior to construction at development and redevelopment sites where disturbance impacts one or more acres of land. These discharge permits are issued by the Colorado Department of Public Health and Environment (CDPHE) under the Colorado Discharge Permit System (CDPS). The City of Louisville also requires a permit for sites that disturb less than one acre.

7.2 EFFECTIVE EROSION AND SEDIMENT CONTROL

Erosion and sediment controls are necessary for effective stormwater management at construction sites, which includes materials management and site management practices. The ultimate goal is protection of waterways and adjacent properties from construction-related pollution.

7.3 EROSION AND SEDIMENT CONTROL – SITES LESS THAN ONE ACRE

For site with less than one acre of disturbance, the City of Louisville recommends that an Erosion and Sediment Control Plan be prepared and submitted. The Plan should include, at a minimum:

- A general location map to identify where the site lies within the City of Louisville.
- An overall plan that indicates any offsite flows entering and leaving the site, including flow routes.
- A site plan depicting existing conditions.
- A grading plan for construction activities, to include a basic phasing schedule, provisions for access and staging, identification and location of temporary construction BMPs, and notes regarding inspection and maintenance of temporary measures.
- A site plan for proposed conditions showing permanent BMPs.
- Specifications and details for temporary and permanent BMPs.
- Other information as may be requested by the City.

Standard details and specifications for temporary construction BMPs are provided in the USDCM Volume 3, Chapter 7. Erosion control measures shall remain in place and be kept in good, fully

functional condition until the erosion potential from the site no longer exists, or until permanent control measures (sod, seed, mulching) are deemed sufficient by the City.

7.4 EROSION AND SEDIMENT CONTROL – SITES ONE ACRE OR GREATER

Under Phase II of the State of Colorado's Stormwater Program (Regulation No. 61 Colorado Discharge Permit System (CDPS) Regulations (CWQCC 2009), activities that disturb one or more acres in area are required to obtain a Permit for Stormwater Discharges Associated with Construction Activity from the Colorado Department of Public Health and Environment (CDPHE). This includes projects less than one acre that are part of a larger common plan of development or sale.

7.4.1 The Stormwater Management Plan (SWMP)

The CDPS General Permit requires the property owner/developer to prepare a SWMP. The City of Louisville requires that the SWMP be submitted to the City for review and approval. The owner/developer should obtain the state permit application and guidance directly from the CDPHE to ensure that the most current requirements are met with the proposed SWMP for a site. The USDCM Volume 3, Chapter 7 Construction BMPs, provides general guidance for preparation of a SWMP, including

- General SWMP Recommendations
- SWMP Phases – Pre-Construction, Construction and Final Stabilization
- SWMP Elements, including Site Map, SWMP Controls, BMPs for Construction Stormwater Pollution Prevention, Final Stabilization and long term Stormwater Management
- Inspections
- Inspection Frequency
- Inspection Records
- Maintenance
- Disposition of Temporary Measures

Refer to the USDCM Volume 3 and CDPHE stormwater permit requirements for details and specifications for Construction BMPs, including guidance for selection and planning.

Contact the City for a SWMP template. Prior to City approval of the SWMP, the owner/developer shall obtain a CDPHE permit and provide a copy to the City.

CHAPTER 8.0
OPERATION AND MAINTENANCE OF STORMWATER FACILITIES

CHAPTER 8.0 OPERATION AND MAINTENANCE OF STORMWATER FACILITIES

8.1 GENERAL

Maintenance of stormwater facilities is critical for proper function of the facilities in accordance with their intended design. The City of Louisville Municipal Code under Chapter 13.36.16 paragraph 2 requires a signed maintenance agreement between the City and the owner of the property for all permanent BMPs installed after 2004 unless the BMP facility is dedicated and accepted by the City. There are two basic types of maintenance activities – regularly scheduled activities and non-scheduled activities, which typically are required following a storm event.

8.2 SCHEDULED MAINTENANCE ACTIVITIES

Examples of typical regularly-scheduled maintenance activities are:

- Removal of accumulated sediment for detention facilities;
- Removal of sediment and debris from inlets and storm sewers;
- Removal of debris from trash racks, outlet structures, culverts, etc.; and,
- Repair of erosion damage at pipe outlets, channel drop structures and other areas subject to high velocity flows.

8.3 NON-SCHEDULED MAINTENANCE ACTIVITIES

Non- scheduled maintenance activities are required usually during or following a storm event. For example, response may be required during a storm event where debris blockage at an inlet or other stormwater facility is causing ponding that threatens public safety, roadway traffic, emergency vehicle access, residences and other buildings.

8.4 USDCM GUIDELINES FOR MAINTENANCE

The USDCM contains general maintenance guidelines as follows:

Volume 2 – Hydraulic Structures – Section 8.0
Volume 2 – Storage – Section 4.10
Volume 2 – Revegetation – Section 3.4

Volume 3, Chapter 6 provides detailed guidelines for maintenance of Best Management Practices such as grass buffers and swales, bioretention facilities, extended detention basins, constructed wetland ponds and channels and permeable pavement systems. This chapter also contains

guidelines for defining maintenance responsibility for public and private facilities and developing a maintenance plan.

8.5 OPERATION & MAINTENANCE CONSIDERATIONS FOR LOW IMPACT DEVELOPMENT BMPS

Activities required for operation and maintenance of Low Impact Development (LID) BMPs are very similar to those detailed for infiltration BMPs in Volume 3 of the USDCM. However, the activities are multiplied by the number of BMPs typically required at an LID site. This is because an underlying concept of LID design involves breaking up drainage areas into very small catchments, each with its own interception and infiltration feature. For example, roof downspouts may be directed to small raised planters with subdrainage or infiltration disposal. Runoff from parking areas and other impervious zones may be directed to multiple infiltration swales and/or rain gardens.

A site employing LID technology requires a well-organized and scheduled plan for maintenance, so that the smaller, more numerous BMPs are given consistent attention on a routine schedule. Response during and after large storm events is also critical to monitor the effectiveness of LID BMPs and make any necessary modifications to improve their function. Maintenance responsibility of LID BMPs will be determined during the City's review process.

CHAPTER 9.0
REFERENCES

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CHAPTER 9.0 REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 2002. *Standard Specifications for Highway Bridges.*

American Concrete Pipe Association, June 2000. *Concrete Pipe Design Manual, Revised to Include Standard Installations.* Irving, TX: American Concrete Pipe Association.

Camp, Dresser and McKee, Inc., December 1980. *Major Basinwide Planning City of Lafayette/Boulder County Phase-B Development of Preliminary Plan*. Denver, CO. .

Camp, Dresser and McKee, Inc., August 23, 1980. *City of Lafayette and Surrounding Unincorporated Areas of Boulder County, Colorado, Storm Drainage Design and Technical Criteria*.

Chow, Ven Te, 1959. *Open Channel Hydraulics*. New York, NY: McGraw-Hill, Inc.

Mancini, Mark; Mikhailova, Olga; Hime, Walt; Sorrel, Alan; Wuertz, Jill, September 2010. *Aesthetically Enhanced Detention and Water Quality Ponds.*

McLaughlin Water Engineers, Ltd. 2011. *Lafayette-Louisville Boundary Outfall System Plan.*

Powell, Lisa; Rohr, Erica; Canes, Michael; Cornet, Jacqueline; Dzuray, Emil; McDougle, Lindsey, September 2005. *Low-Impact Development Strategies and Tools for Local Governments: Building a Business Case.* LMI Government Consulting,.

Prince George's County, Maryland, Department of Environmental Resources, Programs and Planning Division, June 1999. *Low-Impact Development Design Strategies, An Integral Design Approach.* Largo, MD.

United States Department of Agriculture, Natural Resources Conservation Service, March 2011. *Web Soil Survey.* http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

United States Environmental Protection Agency, February 2009. *Stormwater Wet Pond and Wetland Management Guidebook.*

Urban Drainage and Flood Control District, 2001. *Urban Storm Drainage Criteria Manual Volumes 1, 2, and 3*. Latest versions available online at http://www.UDFCD.org.

Washington State University and AHBL, January 2007. *Maintenance of Low Impact Development Facilities.*

Water Resources Consultants, Inc., 1982a. *Basinwide Major Drainageway Planning Study City of Louisville and Boulder County*

Water Resources Consultants, Inc., 1982b. *Storm Drainage Design and Technical Criteria*

APPENDIX A

CITY OF LOUISVILLE
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

APPENDIX A
Contents

1. **Drainage Report Submittal Checklist.** This checklist is to be used as a guide for submittals of preliminary and final drainage reports. The applicant does not need to fill out the form when submitting reports. However, any exception or exemption granted by the City to the items listed should be clearly identified in a report cover letter. The City will use this form as part of the review process.

2. **Drainage and Grading Compliance Certification Requirements**. These requirements shall be used to prepare a Grading Compliance Certification Report to be submitted after project completion.

CITY OF LOUISVILLE
DRAINAGE REPORT SUBMITTAL CHECKLIST

PREPARED BY: _____ DATE: _____

The drainage report for the development as noted below has been received and found to lack the information noted. This information must be submitted before the report will be accepted for review. Please provide the required information.

DEVELOPMENT: _____
LOCATION: _____
DATE SUBMITTED: _____
SUBMITTED BY: FIRM _____
CONTACT _____
PHONE _____ FAX _____

☐ Preliminary Report ☐ Final Report

CHECKLIST

ITEM	DESCRIPTION	RECEIVED OR NOT APPLICABLE	TO BE SUBMITTED
1.	Typed, Bound Report with Cover Letter		
2.	Professional Engineer's Certificate		
3.	General Location and Description		
	(a) Location Map		
	(b) Existing Site Description		
	(c) Description of Existing Drainage Patterns and Facilities		
4.	Drainage Basins and Sub-Basins		
	(a) Major Basin Description		
	(b) Sub-Basin Description		
5.	Design Criteria		
	(a) Discussion of Basinwide Planning Studies		
	(b) Hydrologic Criteria Discussion		
	(c) Hydraulic Criteria Discussion		
	(d) Hydrologic/Hydraulic Computations		
6.	Drainage Facility Design		
	(a) Discussion of proposed Facilities		
	(b) Discussion of Drainage Patterns		
	(c) Impact on Offsite Facilities		
	(d) Impact on Master Plan		
7.	Drainage Plan		
	(a) Topographic Contours		
	(b) ROW and Easements		
	(c) Delineation of Basin and Sub-Basins		
	(d) Existing Drainage Patterns and Facilities		
	(e) Proposed Drainage Patterns and Facilities		
	(f) Proposed Outfall Points		
	(g) Routing of Offsite Drainage		
8.	Other As Stated:		

City of Louisville
COLORADO • SINCE 1878 | Department of Public Works

DRAINAGE AND GRADING COMPLIANCE CERTIFICATION REQUIREMENTS

DEVELOPER or ENGINEER/PROJECT NAME: _____

PUBLIC WORKS CONTACT/PHONE: _____

DATE: _____

To better serve Louisville Developers, the City's Public Works Department has prepared an outline of requirements that need to be addressed in a Drainage and Grading Compliance Certification Report, which is necessary prior to the Department of Public Works granting Construction Acceptance of public improvements. These requirements are provided below:

1. Identify the engineer who prepared the approved Final Drainage Report and Construction Plans, and the date of each document.

2. Provide certification that the as-built drainage improvements and grading for the site conform to the intent of the approved Final Drainage Report for the project (please refer to No. 9). A site inspection and topographic survey is required to complete this.

3. Identify and describe construction plan changes approved by the City during construction that impact drainage improvements.

4. Show Detention Pond volume calculations and the water surface elevations for the design storm events, and compare these with the requirements of the approved Final Drainage Report and Construction Plans.

5. Identify the as-built discharge volumes for the design storm events and compare these with the volumes shown in the approved Final Drainage Report.

6. Identify and describe all as-built drainage and grading improvements that do not conform to the approved Final Drainage Report and Constructions Plans.

7. Identify recommended work to correct construction deficiencies so that the as-built improvements will meet the requirements of the approved Final Drainage Report and Construction Plans.

8. Include any additional information required by the Public Works Department, specific to the project.

9. The report shall be certified as follows: On behalf of "(Project Owner)" I hereby certify that this Drainage and Grading Compliance Report for (Name of Development) was prepared by me (or under my direct supervision) and that the as-built drainage improvements and grading are in conformance with the approved Final Drainage Report and Construction Plans for (Name of Development), in accordance with the provisions of the City of Louisville's Storm Drainage Design and Technical Criteria Manual for the owners thereof.

_____

Registered Professional Engineer

State of Colorado No. _____

(Affix Seal)

The above statement shall not appear on the report if there are any construction deficiencies. A Certificate of Occupancy will not be issued by the City until all deficiencies have been corrected and the report certified.

If you have any questions, please do not hesitate to call. Thank you.