1. INTRODUCTION

1.1 Purpose

Providing adequate drainage in urban areas is a necessary component in maintaining the overall health, welfare, and economic well-being of a community. Haphazard growth in an urban setting can result in erratic development of the urban stormwater drainage system. Problems caused by erratic development can include flooding, soil erosion, and pollution, which may manifest themselves in loss of life, property damage, increased stress on municipal budgets, and loss of the natural beauty of a community. Urban drainage and flood control management is a complex issue primarily because it is related to the mobility of the public, water supply, sanitation, aquifer recharge, irrigation, and urban layout. The urban stormwater drainage and flood control system in and of itself is important, but it must also mesh with community growth plans and regional drainage plans.

It is the goal of the City to provide a consistent program of storm drainage and flood control, to protect human life and health, and to minimize property damage resulting from erosion, sedimentation, and flooding.

It is also a goal of the City to plan for urban drainage and flood control to help achieve an orderly, efficient, pleasant, and diverse urban area, which, in turn, will complement other efforts conducive to public health, safety, and welfare.

The purpose of this Drainage Criteria Manual is to provide technical drainage design criteria and guidance to aid in achieving these goals. This manual applies within the corporate limits of the City and its extraterritorial jurisdiction.

1.2 Contents

This manual includes nine technical chapters that provide guidance on the major aspects of urban stormwater management and drainage facility design. The manual is intended to be an effective and practical resource that provides users with accepted engineering approaches and policies.

It is assumed that the user has basic knowledge of hydraulics, hydrology, and stormwater management concepts. For additional design and engineering guidance not specified in this manual, refer to the current issue of the following publications:

City of Lincoln, Nebraska:

- Drainage Criteria Manual

City of Omaha, Nebraska:

- Omaha Regional Stormwater Design Criteria Manual

Federal Highway Administration (FHWA):

- Hydraulic Design Series 5: Hydraulic Design of Highway Culverts (HDS 5)
- Hydraulic Engineering Circular No. 9: Debris Control Structures Evaluation and Countermeasures (HEC 9)
- Hydraulic Engineering Circular No. 13: Hydraulic Design of Improved Inlets for Culverts (HEC 13)
- Hydraulic Engineering Circular No. 14: Hydraulic Design of Energy Dissipators for Culverts and Channels (HEC 14)

- Hydraulic Engineering Circular No. 15: Design of Roadside Channels with Flexible Linings (HEC 15)
- Hydraulic Engineering Circular No. 22: Urban Drainage Design Manual (HEC 22)

Natural Resources Conservation Service (NRCS):

- National Engineering Handbook, Part 630 Hydrology

Nebraska Department of Transportation (NDOT):

- Drainage Design and Erosion Control Manual

Mile High Flood District (formerly Urban Drainage and Flood Control District):

- Urban Storm Drainage Criteria Manual

1.3 Objectives

Drainage, flood control, and water quality protection in the City is an integral part of a comprehensive community plan. Drainage represents only one component of a larger urban system. The objectives of the drainage and flood control policies and guidelines outlined in this manual are to:

1. Employ a consistent Stormwater Management Plan for the City, to minimize adverse effects to the environment and to handle storm runoff safely and efficiently.
2. Employ Stormwater Design Criteria that ensures that design of the drainage system is consistent with good engineering practices and minimizes stormwater interference with vehicular traffic.
3. Reduce the exposure of people and property to flood hazards.
4. Systematically minimize the level of flood, sediment, and erosion damage to public and private property.
5. Comply with floodplain regulations as required by the Federal Emergency Management Agency (FEMA) and administered by the Nebraska Department of Natural Resources (NeDNR).
6. Encourage upstream drainage area and flood plain uses which are consistent with approved land use plans for those areas, and coordinate with plans for the total community.
7. Ensure that corrective works are consistent with the overall goals of the city and region and provide an efficient use of public funds.
8. Manage stream and drainage channel corridors to promote environmental diversity and to protect buildings and facilities from damage by channel erosion.
9. Stabilize channels in order to minimize the disruption of existing infrastructure such as bridges and utility lines.
10. Maintain existing natural drainage patterns.

1.4 Criteria Summary

1.4.1 Drainage Design and Technical Criteria

The design criteria presented in this manual are based on accepted engineering practice for drainage and stormwater management. Extensive input from the State of Nebraska Department of Transportation's Drainage Design and Erosion Control Manual, the City of Lincoln Drainage Criteria Manual, and the City of Omaha Regional Stormwater Design Criteria Manual was used in the development of this manual.

The criteria within this manual are intended to establish guidelines, standards, and methods for effective planning and design. Drainage policies, procedures, and guidelines outlined in the manual are subject to amendment by the City as conditions warrant. They are not intended to establish legal standards. Special situations may call for variations from these requirements, subject to approval from the City. The City may set aside these criteria in the interest of the health, safety, order, and general welfare of the

community. The proper documentation of drainage decisions is vital for project records and archival purposes.

1.4.2 Minor and Major Drainage Systems

An urban area has two separate and distinct drainage systems, whether or not they are actually planned for and designed. One is the minor system and the other is the major system. The minor system is typically designed to provide public convenience and to accommodate relatively moderate frequent flows. The major system carries more water and operates when the rate or volume of runoff exceeds the capacity of the minor system. To provide for orderly urban growth, reduce costs to taxpayers, and minimize loss of life and property damage, both systems must be planned and properly engineered.

1.4.2.1 Minor Drainage System

The minor drainage system is typically thought of as storm drains and related structures, such as inlets, curbs, and gutters. The minor system is normally designed for floods with return frequencies of 5 years to 10 years, depending on the surrounding land use.

The minor drainage system design will be based on the 5-year (20% annual exceedance probability) design storm for residential areas and the 10-year (10% annual exceedance probability) design storm for downtown and industrial/commercial areas. **During design of the storm sewer system, the hydraulic grade line for all enclosed systems shall be determined to ensure that inlets act as inlets, not outlets.**

The downstream existing conveyance system should be evaluated to ensure that it has sufficient capacity to accept design discharges without adverse backwater impacts on the proposed conveyance system, or downstream impacts such as flooding, streambank erosion, and sediment deposition. Starting tailwater conditions for the major and minor design storm flow should be determined.

1.4.2.2 Major Drainage System

The major drainage system is designed to convey runoff from and to regulate encroachments for large, infrequently occurring events. When development planning and design do not properly account for the major storm flow path, floodwaters will seek the path of least resistance, often through individual properties, thus causing damage. An assured route of passage for major storm floodwaters should always be provided such that public and private improvements are not damaged.

The 100-year return frequency storm (1% annual exceedance probability) shall be the major drainage system design storm for all new developments. Runoff from the 100-year storm event shall pass through a development without flooding buildings, homes, or residential lots. Overland flow routes can be provided using streets, swales, and open space.

Open channels for transportation of major storm runoff are desirable in urban areas and use of such channels is encouraged. Open channel planning and design objectives are best met by using natural, or natural-type channels, which characteristically have slow velocities, and a large width to depth ratio. Optimum benefits from open channels can best be obtained by incorporating parks and greenbelts with the channel layout.

To the extent practicable, open channels shall follow the natural channels and shall not be filled or straightened significantly. Effort must be made to reduce flood peaks and control erosion so that the natural channel features are maintained. Channel improvement or stabilization projects are encouraged to minimize use of visible concrete, riprap, or other hard stabilization materials to maintain the riparian characteristics.

1.4.3 Storm Runoff Computation

The calculation of the storm runoff peaks and volumes is important to the proper planning and design of drainage facilities. Peak runoff values shall be calculated by using either the rational method, NRCS unit hydrograph method, or rational or NRCS methodological software as appropriate.

1.4.4 Detention

Design storms equal to the 2-, 10- and 100-year frequency events shall be used in the design of detention and retention facilities. The NRCS Curve Number method shall be used to develop inflow and outflow hydrographs for the design of storage facilities. The Rational Method or Modified Rational Method shall not be used for design of storage facilities. If a detention or retention facility is used for both water quantity and water quality, it shall also take into account the water quality storm event.

In new or redevelopment areas, post-project peak flow rates shall not exceed existing peak flow rates for the 2-year, 10-year, and 100-year discharges at the project property line and in accordance with other chapters of this Drainage Criteria Manual.

Detention facilities shall be designed with adequate access and sediment storage right-of-way (including sediment forebays) to facilitate maintenance. Unless private maintenance of on-site detention facilities is acceptably performed, necessary maintenance by City forces may be provided. The cost of this service may be allocated to responsible parties.

The owner shall provide record drawings of the storage facility to the City.

1.4.5 Flood Corridor Management

The City participates in the National Flood Insurance Program (NFIP). By ordinance, the City will comply with floodplain regulations as required through the Federal Emergency Management Agency (FEMA) and administered by the Nebraska Department of Natural Resources (NeDNR). Mapped floodplains are present in and around the City.

Projects with construction occurring in a mapped floodplain will require certification that:

- Where construction occurs in Zone A Floodplains, it does not increase, cumulatively, the floodplain base flood elevation more than one foot (1'), and
- Where construction occurs in Floodways, there is no increase in the base flood elevation.

The base flood is defined as the flood having a one percent chance of being equaled or exceeded in magnitude in any given year (100-year event). The base flood elevation is the calculated water surface elevation produced by the base flood.

1.4.5.1 Preservation of Flood Corridor

New development shall preserve a minimum corridor in all channels that drain greater than 40 acres or have a defined bed and bank. The width of minimum flood corridors shall be equal to the greater of:

- The extent of the 100-year floodplain, or
- The channel bottom width, plus 60 feet, plus six times the channel depth

The corridor shall be centered on the channel or aligned such that the corridor follows the natural flow of flood waters. Individual areas of encroachment into the corridor may be permitted for parks, pedestrian/bike trails, recreational uses, and public purposes, provided the encroachments are minimal and the uses are generally consistent with the purpose of the corridor.

1.4.6 NPDES Construction Site Activities

A NPDES "notice of intent" and a Stormwater Pollution Prevention Plan (SWPPP) shall be required before land disturbance or vegetation removal activities occur on any site greater than or equal to one (1.0) acre in size. Approval of the permit will be provided when both the City and State approve the permit application. Structural and non-structural best management practices (BMPs) are required to address erosion and sediment control concerns. The SWPPP shall be prepared by a designated erosion control designer with erosion and sediment control training, experience, and knowledge.

Contractors and developers shall contact the City at least one business day prior to performing land disturbance or vegetation removal on any site greater than or equal to 1.0 acre. Construction sites will be inspected periodically for compliance with submitted SWPPPs.

1.4.7 Post Construction Stormwater Quality

Structural and nonstructural BMPs that address long-term stormwater quality enhancement are required for new or redevelopment projects that disturb more than one acre. Effective, reasonable, and cost-effective BMPs should be selected for implementation on a site-specific basis and in a manner that is consistent with existing basin plans. Water quality guidelines are outlined in Chapter 9 of this manual. The following is a list of structural BMP types that may be considered:

- Create temporary ponding areas on parking lots and in landscaped or turfed open areas of building sites.
- Reduce the amount of impervious area directly connected to the storm drain system.
- Intentionally create longer vegetated drainage paths for minor storm events.
- Develop multipurpose extended detention facilities.
- Use retention facilities (wet ponds) where feasible.

The following is a list of non-structural BMP types that may be considered:

- Use appropriate vegetation to reduce the need for fertilizer and pesticides.
- Preserve environmentally sensitive areas to protect them from development or other disruption.
- Set aside more open space.
- Preserve or re-establish riparian vegetation.
- Implement staged grading of developments to minimize the amount of land disturbed at one time.

1.4.8 Drainage Easements

All easements for storm drain pipe should be a minimum of 20 feet wide. In situations where the engineer can clearly demonstrate that an easement less than 20 feet is adequate, the City may consider such a request. Easements for surface water flow shall be used where a drainageway must be maintained to carry stormwater flow in excess of the storm drain pipe capacity. The easement cross-section shall accommodate the depth and width of flow from the 100-year storm. The width must also be designed to allow for access of maintenance equipment during the major storm.

Drainage easements should also be provided at all areas of ponding or backwater near inlets, culverts, and levees. Easements at these locations should be sized to cover the entire ponding or backwater area for the 100-year storm.

1.5 Submittals

The City requires submittals of drainage reports, hydrologic and hydraulic calculations, and drainage plans when a project changes the land use or drainage patterns of an area. Additional, specific submittal requirements for post-construction stormwater BMPs for development disturbing one acre or more are detailed in Chapter 9 of this manual. Submittal of drainage documentation and data must be coordinated with the City.

1.6 Software

Drainage design software accepted by the City may be used. The City should be consulted to determine if software is acceptable prior to its use. Any software used for design in the City must be capable of utilizing and meeting the design criteria found in this manual. Software available from the Federal Highway Administration such as HY-8 or Hydraulic Toolbox, the U.S. Army Corps of Engineers such as HEC-RAS or HEC-HMS, or state agencies such as the Nebraska Department of Transportation's Rational Method RMA Calculator are generally acceptable in their most recent versions, for example.

1.7 References

- City of Lincoln Public Works and Utilities Department, 2004. *Drainage Criteria Manual.*
- City of Omaha Environmental Quality Control Division, 2014. *Omaha Regional Stormwater Design Manual.*
- Federal Highway Administration, 2009. *Hydraulic Engineering Circular No. 22, Third Edition, Urban Drainage Design Manual.*
- Nebraska Department of Transportation, 2006. *Drainage and Erosion Control Manual.*
- Mile High Flood District (formerly Urban Drainage and Flood Control District), 2016. *Urban Storm Drainage Criteria Manual.*