CITY OF LONGMONT
SECTION 300 - STORM DRAINAGE
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300.00 STORM DRAINAGE POLICY AND PROVISIONS

300.01 GENERAL PROVISONS

300.01.01 TITLE

These storm drainage regulations, together with all future amendments, shall be known as the City of Longmont Storm Drainage Criteria, and are incorporated into these City Standards as Section 300 Storm Drainage, and may be referenced as the Storm Drainage Criteria (or "Criteria"). The Storm Drainage Criteria Manual was last amended July 1984, and adopted by reference as ordinances of the City. The previous manual is hereby repealed and replaced by these City Standards.

300.01.02 JURSIDICTION

The jurisdiction of the Storm Drainage Criteria shall be the same as stated in Section 100 of the City Standards.

300.01.03 AUTHORITY

These Storm Drainage Criteria have been adopted pursuant to the authority conferred within: Article 4.9 (Enactment of Codes by Reference) of the Municipal Charter and Title 15.07.50 (Subdivision Design and Improvements) of the Longmont Municipal Code and shall have the same force and effect as all other ordinances of the City.

300.01.04 PURPOSE

The purpose of the Storm Drainage Criteria is to provide the minimum design and technical criteria to be adhered to in the analysis, design and construction of public and private storm drainage and flood control facilities for properties located within the jurisdiction of the City of Longmont, Colorado. All development or any construction submitted for approval under the provisions of the Development Code (Section 15 of the Municipal Code) shall include adequate storm drainage system analysis and appropriate drainage system and flood control design conforming to the criteria set forth herein.

300.01.05 INTERPRETATION

The City Engineer will be responsible for the interpretation of the provision of this criteria using the following guidelines:

1. In their interpretation and application, the provisions of this criteria shall be held to be the minimum requirements for promotion of the health, safety, morals, convenience, order, prosperity, and general welfare of the community.
2. This criteria is not intended to interfere with, abrogate, or annul any other regulation, statue, or other provision of law.
3. Where any provision of this criteria imposes restrictions different from those imposed by any other provisions of this criteria or any other regulation, or provision of law, that provision which is restrictive or imposes higher standards shall govern.
4. This criteria is not intended to abrogate any easement, covenant, or any other private agreement or restriction, provided that where the provision of this criteria are more restrictive or impose higher standards or requirement than such easement, covenant or other private agreement or restriction, the provisions of these regulations shall govern.

5. . Flood prone property will be reviewed under Title 20, Floodplain Regulation, in the Municipal code and Section 301 of these Design Standards.

300.01.06 ENFORCEMENT RESPONSIBILITY

The enforcement of these Storm Drainage Criteria are the same as stated in Section 100 of the City Standards.

300.01.07 AMENDMENTS AND REVISIONS

Amendments and revisions to the Storm Drainage Criteria shall be the same as for the entire City Standards

300.01.08 STORM DRAINAGE CRITERIA

The City of Longmont regulations for storm drainage analysis, design and construction are generally based upon the Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual (USDCM) Volume 1 and 2 as amended by this manual for local policies, procedures and regulations. While the City of Longmont is not within the boundary of the UDFCD, the concepts, design approaches and technical calculation methodologies apply to the City. Within the USDCM Volume 1 and 2, recommendations for areas within the UDFCD boundary shall apply to the City of Longmont unless specifically addressed in these City Standards.

300.02 PRINCIPALS AND POLICIES

300.02.01 GENERAL PRINCIPALS

Drainage accomodationsfor urban areas is necessary to preserve and promote the general health, welfare, and economic well-being of the region. Drainage is a regional phenomenon that affects all governmental jurisdictions and all parcels of property. Because drainage affects all properties regardless of political boundaries or jurisdictions, it is necessary to formulate a program that balances both public and private involvement. Overall, the governmental entities most directly involved must provide coordination and master planning, but drainage planning must also be integrated on a regional level. The underlying principles in this chapter provide direction for planning drainage facilities. These principles are made operational through a set of policy statements. The application of the policy is, in turn, facilitated by technical drainage criteria, which are the focus of this section of the City Standards. When considered in a comprehensive manner, at a regional level and with public and private involvement, drainage facilities can enhance the general health and welfare of the region and assure optimum economic and social relationships while avoiding uneconomic flood losses and disruption.

The City of Longmont embraces principles of drainage planning that have been guided by UDFCD and previous criteria manuals. Following these principals allows for drainage planning and decisions that are made in a consistent manner, considering both public safety and environmental protection. These principles include:

1. Drainage is a regional phenomenon that does not respect the boundaries between government jurisdictions or between properties. For this reason, it is necessary to formulate stormwater programs that include both public and private involvement. Overall, the City will provide coordination and master planning on a regional basis, but drainage planning must be integrated on a basin wide level to achieve optimum results. The manner in which proposed drainage systems fit into existing regional systems must be quantified and discussed by basin wide master plans.

2. A storm drainage system is a subsystem of the total urban water resource system. Stormwater system planning and design for any site must be compatible with comprehensive regional plans and should be coordinated with planning for land use, open space and transportation. Erosion and sediment control, flood control, site grading criteria, and water quality all closely interrelate with urban stormwater management. Any individual master plan or specific site plan should address all of these considerations.

3. Every urban area has an initial (i.e., minor) and a major drainage system, whether or not they are actually planned and designed. The initial drainage system, sometimes referred to as the "minor system," is designed to provide public convenience and to accommodate moderate, frequently occurring flows. The major system carries more water and operates when the rate or volume of runoff exceeds the capacity of the minor system. Both systems should be carefully considered.

4. Runoff routing is primarily a space allocation problem. The volume of water present at a given point in time in an urban region cannot be compressed or diminished. Channels and storm drains serve both conveyance and storage functions. If adequate provision is not made for drainage space demands, stormwater runoff will conflict with other land uses, result in damages, and impair or disrupt the functioning of other urban systems.

5. Planning and design of stormwater drainage systems shall not be based on the premise that problems can be transferred from one location to another. Urbanization tends to increase downstream peak flow by increasing runoff volumes and velocities. Stormwater runoff can be stored and slowly released via detention facilities to manage peak flows, thereby reducing the drainage capacity required immediately downstream.

6. An urban storm drainage strategy should be a multi-objective and multi-means effort. The many competing demands placed upon space and resources within an urban region argue for a drainage management strategy that meets a number of objectives, including flood management, water quality enhancement, groundwater recharge, recreation, wildlife habitat, wetland creation, protection of landmarks/amenities, control of erosion and sediment deposition, and creation of open spaces.

7. Design of the storm drainage system should consider the features and functions of the existing drainage system. Every site contains natural features that may contribute to the management of stormwater without significant modifications. Existing features such as natural streams, depressions, wetlands, floodplains, permeable soils, and vegetation provide for infiltration, help control the velocity of runoff, extend the time of concentration, filter sediments and other pollutants, and recycle nutrients. Each development plan should carefully map and identify the existing natural system. Techniques that preserve or protect and enhance the natural features are encouraged. Good designs improve the effectiveness of natural systems rather than negate, replace or ignore them.

8. In conjunction with new development and redevelopment, coordinated efforts are required to minimize increases in, and reduce where possible, stormwater runoff volumes, flow rates, and pollutant loads to the maximum extent practicable. Key practices include:

    a. The perviousness of the site and natural drainage paths shall be preserved to the extent feasible. Areas conducive to infiltration of runoff should be preserved and integrated into the overall runoff management strategy for the site.

    b. The rate of runoff should be slowed. Preference will be given to stormwater management systems that maximize vegetative and pervious land cover. These systems will promote infiltration, filtering and slowing of the runoff. It should be noted that, due to the principle of mass conservation, it is virtually impossible to prevent increases in post-development runoff volumes for all storm events when an area urbanizes. Increased flow volumes may not cause flooding problems if a watershed has a positive outfall to a stream or river; however, increases in runoff volumes may cause problems for small, enclosed watersheds (i.e. draining to a lake)

or into streams of limited capacity. Increases in runoff volumes, if not appropriately managed, can also adversely affect stream stability.

c. Pollution control is best accomplished by implementing a series of measures, which can include source controls, minimizing directly connected impervious area, and construction of on-site and regional facilities to control both runoff and pollution. Implementing measures that reduce the volume of runoff produced by frequently occurring events through infiltration and disconnection of impervious areas is one of the most effective means for reducing the pollutant load delivered to receiving waters.

9. The stormwater management system shall be designed beginning with the outlet or point of outflow from the project, giving full consideration to downstream effects and the effects of offsite flows entering the system. The downstream conveyance system shall be evaluated to ensure that it has sufficient capacity to accept design discharges without adverse upstream or downstream impacts such as flooding, stream bank erosion, and sediment deposition. In addition, the design of a drainage system shall take into account the runoff from upstream sites, recognizing their future development runoff potential (e.g., imperviousness).

10. The stormwater management system requires regular maintenance. Failure to provide proper maintenance reduces both the hydraulic capacity and pollutant removal efficiency of the system. The key to effective maintenance is clear assignment of responsibilities to an established entity and a regular schedule of inspections to determine maintenance needs and to ensure that required maintenance is conducted. All projects shall be designed with adequate access to perform inspections and maintenance considering the maintenance capabilities of the responsible party when selecting specific design criteria for a given site or project.

11. Floodplains should be preserved whenever feasible and practicable. Nature has claimed a prescriptive easement for floods, via its floodplains, that cannot be denied without public and private cost. Floodplain encroachment must not be allowed unless competent engineering and planning have proven that flow capacity is maintained, risks of flooding are defined, and risks to life and property are strictly minimized.

12. Reserve sufficient right-of-way for lateral movement of incised floodplains. Whenever an urban floodplain is contained within a narrow non-engineered channel, its lateral movement over time can cause extensive damage to public and private structures and facilities. For this reason, whenever such a condition exists, it is recommended that, at a minimum, the channel be provided with grade control structures and a right-of-way corridor be preserved of a width corresponding to normal depth calculations for the future stable channel geometry, plus maintenance access requirements.

300.02.02 BASIC HYDROLOGIC DATA

1. The City of Longmont has undertaken several master planning initiatives which are the basic storm runoff and flood data to facilitate intelligent and orderly planning for storm drainage facilities. The City maintains and updates the masterplans on a periodic basis and are available upon request..

2. The City of Longmont maintains data to delineate flood hazard areas along all waterways in urbanized areas and in areas that may be urbanized in the future. This data is based on the information from the Federal Emergency Management Agency (FEMA), the U.S. Geological Survey (USGS), private consulting engineers, and the Colorado Water Conservation Board (CWCB). This information is regularly reviewed and updated to reflect changes due to urbanization, changed channel conditions, climate change, and the occurrence of extraordinary hydrologic events.

3. Before commencing design of any drainage project, comprehensive facts and data shall be

collected and examined for the particular watershed and area under consideration, and the basis for the design should then be agreed upon by the city and surrounding jurisdictions that are affected.

300.02.03 PLANNING POLICIES

1. Storm drainage is a part of the total urban environmental system. Therefore, storm drainage planning and design must be compatible with comprehensive regional plans including but not limited to Envision Longmont. A master plan for storm drainage should be developed and maintained in an up-to-date fashion at all times for each urbanizing drainage watershed.
2. The planning for drainage facilities will be coordinated with planning for open space and transportation. By coordinating these efforts, new opportunities may be identified that can help solve drainage problems. Natural streams should be used to convey storm runoff wherever feasible.
3. Planning and design of stormwater drainage systems will not be based on the premise that problems can be transferred from one location to another.
4. Storage of runoff in detention and retention reservoirs can reduce the drainage conveyance capacity requirement immediately downstream. Acquisition of open space adjacent to streams provides areas where storm runoff can spread out and be stored for slower delivery downstream.
5. Runoff from small, frequently occurring storms will be managed to reduce runoff peak flows, volumes (where feasible) and pollutant loading to streams. Management of these frequently occurring events helps to protect beneficial uses of streams and promotes channel stability.

300.03 PLANNING AND DESIGN

300.03.01 TOTAL URBAN SYSTEM

Storm drainage is a part of the total urban environmental system. Therefore, storm drainage planning and design should be compatible with comprehensive regional plans. Master plans for storm drainage have been developed and are maintained by the City for the Longmont region. Ongoing updates to the masterplans continue to provide greater detail for the major basins in the region.

Good urban drainage planning is a complex process. Fundamentals include:

1. Major Drainage Planning: Local and regional planning should consider the major drainage system necessary to manage the 100-year runoff; that is the runoff having a one percent probability of occurrence in any given year. Implementation of major drainage plans will reduce loss of life and major damage to the community and its infrastructure.
2. Outfall System Planning: Outfall system planning efforts identify detention, water quality and conveyance practices within a watershed that ultimately discharges to a receiving stream. Outfall system plans typically address storm drainage improvements, stream crossing improvements, stream enlargement, stabilization, and floodplain preservation.
3. Minor Drainage System Planning: All local and regional planning should consider the minor drainage system to transport the runoff from 2-year to 5-year storms; these storms have a 50% to 20% respective probability of occurrence in any given year. The planner of an minor system must strive to minimize future drainage problems from these more frequently occurring storms.
4. Water Quality and Environmental Design: All planning efforts should address stormwater quality treatment requirements, opportunities for the development to mimic natural hydrology and preserve natural features, enhance habitat, and evaluate impacts of new facilities. When

convened early in the planning and design process, a multi-disciplinary design team can help to ensure that the benefits to total urban systems are considered in the drainage planning effort.

5. Long-term Maintenance and Operation: Future operation and maintenance by private and public entities needs to be considered during the planning stages to ensure that the facility functions as designed over the long-term.

300.03.02 MASTER PLANNING

Existing City-wide master plans will be updated as needed to reflect conditions that change over time. Initial steps include the planning of major drainage systems from the point of outfall, proceeding in an upstream direction. Major drainage systems, which are defined as servicing an area of at least 130 acres, are typically well defined and often dictate the design of the initial drainage system, including storm drains, detention facilities, and stormwater quality BMPs. Master planning must be based upon potential future upstream development, taking into consideration both upstream and downstream existing and future regional publicly owned and operated (or controlled) detention and retention storage facilities. Assurances for construction and perpetual operation and maintenance of detention and retention facilities must be provided for the effects of the facilities to be considered in master planning. In the absence of such detention and retention facilities, the basis of design for both the minor and major systems is fully developed upstream conditions without storage. Master planning should be completed in adequate detail to provide a clear drainage framework for future development in a particular watershed. Generalized concepts based on rough hydrological analyses should not be used as master plans; a more rigorous analysis is necessary.

300.03.03 DEVELOPMENT AND SITE PLANNING

All land development proposals shall receive full site planning and engineering analyses. In this regard, professional consideration must be given to the criteria outlined in this manual. Development of an area without the provision of adequate drainage multiplies the cost to the public because the drainage problem must be corrected later, usually at public expense. Where flood hazards are involved, City review shall include consideration of proposed land use so that it is compatible with the flood hazard risks involved with the property, and appropriate easements or land dedication should be provided to preclude encroachment upon waterways or flood storage areas.

A development plan should consider broad goals such as:

a. Drainage and flood control problem alleviation,

b. Economic reasonableness,

c. Broader regional development context,

d. Environmental preservation and enhancement, consider water quality and stream stability,

e. Social and recreational objectives.

These goals have the potential to influence the type of drainage subsystem selected. Planning for drainage facilities should be related to the goals of the urban region, should be looked upon as a subsystem of the total urban system, and should not proceed independent of these considerations (Wright 1967).

300.03.04 MANAGING RUNOFF FROM FREQUENTLY OCCURRING STORMS

Protecting and enhancing the water quality of streams is an important objective of drainage planning. Erosion control, maintaining stream stability, and reducing pollutant loading from stormwater runoff must be considered. Volume 3 of the USDCM provides criteria for stormwater runoff BMPs that help

to reduce runoff volumes for frequently occurring storm events and provide treatment of the water quality capture volume (WQCV), which is based on the 80th percentile runoff-producing event. The first step in managing runoff from frequently occurring storms is implementing runoff reductions practices, also known as minimizing directly connected impervious area (MDCIA), which reduces the amount and connectivity of impervious surfaces in a development. This can be accomplished through a variety of techniques such as functional grading, wide and shallow surface flow sections, disconnection of hydrologic flow paths, and the use of bioretention and permeable pavements. The extent to which MDCIA and runoff reduction can be implemented on a development site is dependent on the site conditions (e.g., soil type, groundwater depth, depth to bedrock) and development type (e.g., new development, redevelopment, ultra urban, infill,). Opportunities for runoff reduction should be evaluated in each development. Once this step has been completed, then BMPs designed to treat the remaining WQCV can be implemented. An alternative to treating the WQCV is use of an integrated detention and water quality detention facility based on capture and treatment of the Excess Urban Runoff Volume (EURV). Design criteria for these facilities, described as full spectrum detention facilities, are provided in USDCM Volume 2.

300.03.05 SEPARATION OF STORMWATER AND SANITARY FLOWS

Sanitary sewage systems that overflow or bypass untreated sewage into surface streams are not permitted in Colorado. Drainage planning should prevent inflow to sanitary sewers resulting from street flow and channel flooding. In cases where sanitary sewers are flooded by urban storm runoff, engineers and planners should work together to correct these problems. Additionally, illegal connections of sanitary sewers to the storm drain system or conditions where storm drains intercept flows from leaking sanitary sewers must be corrected to protect public health.

300.03.06 MULTIPLE-OBJECTIVE CONSIDERATIONS

Planning for drainage facilities should be coordinated with planning for open space, recreation and transportation. By coordinating these efforts, new opportunities can be identified which can assist in the solution of drainage problems (Heaney, Pitt and Field 1999).

1. Lower Drainage Costs. Planning drainage works in conjunction with other urban needs results in more orderly development and lower costs for drainage and other facilities.
2. Open Space. Open space provides significant urban social and environmental benefits. Use of stabilized, natural streams is often less costly than constructing artificial channels. Combining the open space needs of a community with the major drainage system is a desirable combination of uses that reduces land costs and damages due to flooding and promotes riparian zone protection and establishment over time.
3. Transportation. Design and construction of new streets and highways should be fully integrated with drainage needs of the urban area for better streets and highways and better drainages and to avoid creation of flooding hazards. The location of borrow pits needed for road construction should be integrated with broad planning objectives, including storm runoff detention.
4. Natural Channels. Natural streams should be used in lieu of storm drains for stormwater runoff wherever practical. Preservation and protection of natural streams are encouraged; however, significant consideration must be given to their stability as the tributary area urbanizes.
5. Channelization. Natural streams within an urbanizing area are often deepened, straightened, lined, and sometimes put underground. A community loses a natural asset when this happens. Channelizing a natural waterway usually speeds up the flow, causing greater downstream flood peaks and higher drainage costs, and does nothing to enhance the environment. Natural streams within an urbanizing area require stabilization, not channelization.
6. Channel Storage. Streams having “slowflow” characteristics, vegetated bottoms and sides, and wide water surfaces provide significant floodplain storage capacity. This storage is beneficial

because it reduces downstream runoff peaks and provides an opportunity for groundwater recharge. Wetland channels, wide natural streams, and adjacent floodplains provide urban open space.

7. Major Runoff Capacity. Streams and their residual floodplains should be capable of carrying the 100-year storm runoff, which can be expected to have a one percent chance of occurring in any given year.

Facility Maintenance and Access. Urban streams require both scheduled and unscheduled maintenance activities such as removal of sediment, debris and trash; mowing, and repair of hydraulic structures. Assured long term maintenance is essential, and it must be addressed during planning and design. Waterways, detention facilities, and other drainage facilities shall have permanent access for routine and major maintenance activities in conformance with the requirements as outlined in Section 200 of these City Standards.

300.03.07 AVOIDING TRANSFER OF STORMWATER PROBLEMS

Planning and design of stormwater drainage systems shall not be based on the premise that problems can be transferred from one location to another. Both intra-watershed and inter-watershed transfers shall be avoided and appropriate assumptions should be made during master planning. Key principles include:

1. Intra-Watershed Transfer: Channel modifications that create unnecessary problems downstream should be avoided, both for the benefit of the public and to avoid damage to private parties. Problems to avoid include land and channel erosion and downstream sediment deposition, increase of runoff peaks, and debris transport, among others.
2. Inter-Watershed Transfer: Diversion of storm runoff from one watershed to another introduces significant legal and social problems and should be avoided unless specific and prudent reasons justify and dictate such a transfer and no measurable damages occur to the natural receiving water or urban systems or to the public.

300.03.08 DETENTION AND RETENTION STORAGE

Stormwater runoff can be stored in detention basins. Such storage, when properly designed, constructed, and maintained with adequate assurances for the long-term, can reduce the peak flow drainage capacity required, thereby reducing the land area and expenditures required downstream. Retention ponds, both on and off-line, require a legal right to store water in Colorado and are only permitted in special cases and require an exception to these City Standards. Consultation with the State Engineer’s Office is needed in such cases to meet all water rights, well permitting and jurisdictional dam regulations.

Analysis of storage options shall include the consideration of the following:

1. Upstream Storage

Provide temporary storage of storm runoff close to the points of rainfall occurrence to the extent practical. Opportunities for storage include on-site detention basins, parking lots in limited applications, ball fields, property line swales, and parks. Wherever reasonably acceptable from a social standpoint, parks should be used for short-term detention of storm runoff. Such use may help justify park and greenbelt acquisition and expenditures. This "Blue-Green" concept was introduced in the 1960’s (Jones 1967) and remains an effective strategy in drainage planning.

Parking lots create more runoff volume and higher runoff rates than natural conditions. Where

practical, parking lots should be designed to provide temporary storage of runoff during infrequent events (e.g., 5- year or greater).

2. Downstream Storage

Detention and retention of storm runoff is desirable in slow-flow channels, in storage facilities located in the stream, in off-line facilities, and by using planned channel overflow ponding in park and greenbelt areas. Lengthening the time of concentration of storm runoff to a downstream point is an important goal of storm drainage and flood management strategies.

3. Reliance on Privately Controlled Facilities and Water Storage Reservoirs

Privately controlled facilities cannot be used for flood mitigation purposes in master planning because their perpetuity cannot be reasonably guaranteed. Additionally, publicly owned water storage reservoirs and irrigation ditches (city, state, water district, irrigation company, etc.) should be assumed to be full for flood planning purposes and only the detention storage above the spillway crest or ditch irrigation capacity after considering decreed flows are considered in the determination of downstream flood peak flows. Exceptions may occur where legal agreements are in place ensuring flood storage in perpetuity and/or amount of storm water allowed by agreement in irrigation ditches.

4. Reliance on Embankments

The detention of floodwaters behind embankments created by railroads, highways or roadways resulting from hydraulically undersized culverts or bridges should not be utilized for flood peak mitigation when determining the downstream flood peaks for channel capacity purposes unless such detention has been established in perpetuity through a legally binding agreement.

300.03.09 DRAINAGE REPORTS

All proposed modifications to storm drainage basins including but not limited to changes in impervious area, changes to conveyance infrastructure or storage require the submittal of a Drainage Report to the City Engineer for review and approval prior to commencement of any construction activity. Reports shall be submitted according to the Development Code process as outlined in Title 15 of the Municipal Code.

All drainage reports shall include the information required in the checklist for Drainage Reports in the Appendix. Reports shall include analysis of the existing conditions and an explanation of the relationship to the City's stormwater master plans. Analysis and identification of off-site basins that affect the property of interest shall be described in the report and shown in the exhibits. Historic basins and the correlating historic flows for minor and major storm events shall be analyzed and described within the report.

Drainage reports shall provide narrative of proposed improvements and development of sub-basins and demonstrate how the development will not adversely impact downstream property.

All calculations and analysis shall conform to the minimum design criteria as indicated in Section 302.01.

301.00 FLOOD RISK MANAGEMENT

301.01 WORK WITHIN THE FLOODPLAIN

301.01.01 COMPLIANCE

All work within the floodplain as designated by the Federal Emergency Management Administration or by consultants, City designated floodplains, master plans or other means within the City of Longmont shall conform to theFloodplain Regulations in Title 20 of the Longmont Municipal Code.

301.01.02 FLOODPLAIN DEVELOPMENT PERMITS

All work within any designated floodplain requires an approved Floodplain Development Permit (FPDP) from Public Works and Natural Resources prior to start of any work.

All Floodplain Development Permits require a Floodplain Impact Analysis (FIA) and applicable approval by FEMA. Reference the appendix for FIA and FEMA submittal checklists.

301.01.03 FLOODPLAIN DEVELOPMENT CRITERIA

1. Floodway
    a. No new buildings or fill is allowed in any designated floodway within the City
    b. New floodways shall be analyzed using ½ ft surcharge criteria

2. Development

    a. A FEMA comment document for CLOMRs and CLOMR-Fs (if there is no designated floodway) will be required for any development proposed in any FEMA mapped floodplain before any work can begin the 100-year floodplain.
        i. A “No Rise” certification may replace a CLOMR or CLOMR-F under some circumstances as determined by the Floodplain Administrator.
        ii. A City of Longmont approved Floodplain Impact Analysis (outline in the appendix) will be required to support a CLOMR and a CLOMR-F submittal to FEMA
        iii. No impact (0.00 ft) to any existing insurable structure(s) from proposed development will be allowed
        iv. A final comment letter from FEMA on the proposed condition (CLOMR or CLOMR-F) will be required before grading and infrastructure construction can commence
    b. Any new construction or development site proposed in any designated 100-year floodplain fringe shall be permanently removed from the 100-year floodplain before a building permit can be issued.
        i. A FEMA approved (effective date) LOMR or LOMR-F will be required before any vertical (building) construction can begin on property in a FEMA mapped 100-year floodplain.
        ii. Once site grading and infrastructure placement is complete and a Fill Certificate is received and approved by the City of Longmont Floodplain Administrator (if required), an as-built survey can be commenced to submit to FEMA for final removal of the property from the floodplain

3. Design Flood Elevation
    a. New Construction
        i. If property is removed from any 100-year floodplain by filling, then the final grading shall be, at a minimum, 1 ft above the 100-year water surface elevation (WSE)
        ii. If the proposed project is a critical facility (see Title 20 for definition), then the final grading shall be, at a minimum, 2 ft above the 100-year WSE.
        iii. For projects that require fill in the floodplain, a Fill Certificate will be required from the Engineer of Record (EOR). The Fill Certificate will certify the elevation(s), compaction, slope and slope protection for all fill placed in the floodplain. It shall be signed and seal by the EOR.
        iv. No basements are allowed on property removed from the 100-year floodplain by filling (LOMR-F).
    b. Existing Building(s) in the 100-year floodplain
        i. First Floor Elevation (FFE) must be 1 ft above the 100-year WSE if the proposed improvement is greater than 50% of the value of the building
            - Applies to original structure and additions (lateral and vertical)
            - Only applies to addition if it is not attached to the original structure
            - Applies to foundation repairs
            - Applies to new structures on original foundations
        ii. Floodproofing Certification will be required for any existing commercial/industrial building that has proposed improvements greater than 50% of the value of the building.
            - Only non-manual floodproofing methodologies are allowed in the City
        iii. An Elevation Certificate will be required for substantial improvements to existing buildings

302.00 STORM DRAINAGE IMPROVEMENTS

302.01 MINIMUM DESIGN CRITERIA

302.01.01 INTENDED USE OF DESIGN CRITERIA

Storm drainage planning and design shall adhere to the criteria developed and presented in or adopted by this manual. The design criteria presented herein represent current best engineering practice, and their use in the City of Longmont is required. The criteria are intended to establish guidelines, standards and methods for sound planning and design. Future revisions and updates to the criteria will be necessary to reflect advances in the field of urban drainage engineering,and urban water resources and floodplain management. The City will utilize the criteria in planning new facilities and in their reviews of proposed works by developers, private parties, and other governmental entities, including other agencies of the state and federal governments.

302.01.02 MINOR AND MAJOR DRAINAGE CRITERIA

Every urban area has two separate and distinct drainage systems, whether or not they are actually planned and designed. One is the initial system, and the other is the major system. Both systems must be planned and properly engineered to provide for orderly urban growth, reduce costs to future

generations, and avoid loss of life and major property damage.

1. Design Storm Return Periods For Minor and Major Drainage Systems

Storm drainage planning and design shall recognize the need for two separate and distinct storm drainage systems: the minor drainage system and the major drainage system. Design storms for the minor and major drainage systems within the City of Longmont are specified in Table 1-1.

Table 1-1. Design storms and purposes of minor and major drainage systems

Drainage System	Design Storm	Purposes
Minor Drainage System	2 year storm for Single Family Residential 5 year storm for Multi-Family and Commercial	Reduce the frequency of street flooding and maintenance costs, provide protection against regularly recurring damage from storm runoff, help create an orderly urban system, and provide convenience to urban residents.
Major Drainage System	100-year storm (1% probability of occurrence for any given year)	Avoid major property damage and loss of life for the storm runoff expected to occur from an urbanized watershed.

There are many developed areas within the City that predate and may not fully conform to the drainage standards in Table 1-1. The City recognizes that upgrading already developed areas to conform to all of the current policies, criteria, and standards will be difficult, if not impractical to obtain, short of complete redevelopment or renewal. However, stormwater and flood risk management techniques can be applied to these areas.

Strict application of these criteria in the overall planning of new development is practical and economical; however, when planning drainage improvements and designating floodplains for developed areas, the use of the policies, criteria, and standards should be adjusted to provide for economical and environmentally sound solutions consistent with other goals of the area. Where the 100- year storm is not chosen for design purposes, the residual impact of the 100-year storm should be investigated and made known.

2. Critical Facilities

Drainage design shall consider that certain critical facilities need a higher level of flood protection. Facilities including, but not limited to, hospitals, police, fire stations and emergency communication centers shall be designed in a manner so that their functioning will not be compromised, even during a 100-year flood.

All new, additions to and substantially improved critical facilities shall be located outside the FEMA mapped 100-year floodplain (Special Flood Hazard Area)

Or

Elevated or floodproofed including the structure(s), electrical, heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork), to a minimum of two feet (2 ft) above the 100-year flood elevation.

302.01.03 RAINFALL CALCULATIONS

Rainfall shall be calculated in accordance with the methodologies presented in Chapter 5 Rainfall of the Urban Drainage and Flood Control District, Urban Storm Drainage Criterial Manual Volume 1 except as modified herein.

NOAA Atlas 14 rainfall data shall be used to determine depth duration frequency values related to use with the Rational Method and the Colorado Urban Hydrograph Procedure (CUHP). The data can be found graphically at:
https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

For most analysis within the City, basins will have an area less than 2 square miles therefore, no Depth Reduction Factor (DRF) will be necessary. If a larger area will be analyzed, the City Engineer or designee shall provide direction for the use of DRF related to CUHP calculations.

302.01.04 RUNOFF COMPUTATIONS

The determination of the magnitude of runoff for any storm interval shall be made using the techniques described in Chapter 6 Runoff of the Urban Drainage and Flood Control District, Urban Storm Drainage Criterial Manual Volume 1 except as modified herein.

The peak discharges determined by any method are approximations. Rarely will the drainage system operate at the design discharge. In actual practice, flow will always be more or less, as the hydrograph rises and falls during a storm event. Thus, the Design Engineer should not overemphasize the detailed accuracy and precision of computed discharges but should emphasize the design of practical and hydraulically balanced drainage infrastructure based on sound logic and engineering, as well as dependable hydrology. The use of more than three significant figures for estimating peak discharges conveys a false sense of precision and should be avoided.

Because of the public's reliance on published peak flow estimates, these values should not be changed unless it is clear either an error was made or a recalibration of the regional hydrologic model impacts the area of study and, in either case, when continued use of the published flows is not in the public's interest.

The Rational Method may be used for calculating peak flows from small basins, generally under 4 acres. Larger basins, greater than 4 acres shall use the CUHP methodology for determining storm flows and may be used in areas less than 4 acres. The Storm Water Management Model (SWMM) may be used for combining and routing hydrographs produced through the CUHP methodology. The SWMM hydrology capabilities should not be used to create hydrographs unless specifically directed by the City Engineer.

302.01.05 STREET CONVEYANCE

The design of streets to convey stormwater including inlets and storm drainage pipe systems shall be analyzed using the techniques described in Chapter 7 Street, Inlets and Storm Drains of the Urban Drainage and Flood Control District, Urban Storm Drainage Criterial Manual Volume 1, except as modified herein.

Street Conveyance Design: Streets are a significant component of the urban drainage system, and use of streets for storm runoff should be made within reasonable limits, recognizing that the primary

purpose of streets is for traffic. Reasonable limits of the use of streets for conveyance of storm runoff should be governed by the design criteria summarized in Table 1-2 for initial storm runoff, Table 1-3 for major storm runoff and Table 1-4 for allowable maximum cross-street flow for minor and major design storm runoff as defined in section 4.2.1. These criteria are consistent with the intent that major storm runoff will be removed from public streets at frequent and regular intervals and routed into streams, as well as the recognition that runoff tends to follow streets and roadways; therefore, streets and roadways may be aligned to provide a specific runoff conveyance function.

The definition of street classification shall be the same as identified in Section 200 of these City Standards. The following tables supersede Tables 7-1, 7-2, 7-3, and 7-4 in USDCM Chapter 7.

Table 1-2. minorAllowable Use of Street Capacity for Minor Storm Runoff

Street Classification	Maximum Encroachment
Local	No curb overtopping. Flow may spread to crown of street
Collector / Minor Arterial	No curb overtopping. Flow spread must leave at least one lane free of water.
Arterial	No curb overtopping. Flow spread must leave at least one lane free of water in each direction but should not flood more than two lanes in each direction.
Expressway (Freeway)	No encroachment is allowed on any traffic lanes.

Table 1-3. Major Storm maximum street ponding depth

Street Classification	Maximum Ponding Depth
Local and Collector	Residential dwellings shall be 12 inches or more above the 100-year flood at the ground line or lowest water entry of a building. The depth of water over the gutter flow line should not exceed 12 inches for local and collector streets.
Arterial and Expressway (Freeway)	Residential dwellings shall be 12 inches or more above the 100-year flood at the ground line or lowest water entry of a building. The depth of water should not exceed the street crown to allow operation of emergency vehicles. The depth of water over the gutter flow line should not exceed 12 inches.

Table 1-4. Maximum allowable cross street flow

Street Classification	Minor (Minor) Design Runoff	Major Design Runoff
Local	6 inches of depth in cross pan	12 inches above gutter flow line
Collector	Where cross pans allowed, depth of flow should not exceed 6 inches	12 inches above gutter flow line
Arterial	None	No cross flow. 12 inches maximum depth at upstream gutter or roadway edge.
Expressway (Freeway)	None	No cross flow. 12 inches maximum depth at upstream gutter or roadway edge.

Minor and major drainage planning should go hand-in-hand. When maximum allowable street encroachment will be exceeded, a storm drain system based on the minor storm shall be planned. Development of a drainage system sized for the major storm that can also drain the minor runoff from

the streets is encouraged; this enables the storm drain system to commence further downstream.

Other design criteria for use of streets include:

1. An arterial street crossing will require a storm drain system unless approved by the City Engineer.
2. Bubblers (inverted siphons which convey flows beneath roadways) are not allowed because of plugging with sediment and difficulty in maintaining them. Additionally, these serve as a breeding ground for bacteria and mosquitos.
3. Collector streets should have cross pans only at infrequent locations as specified in Chapter 200 of these City Standards and in accordance with good traffic engineering practices.
4. The local street criteria for overtopping also apply to any private access road that serves commercial areas or more than one residence, for emergency access and safety reasons.
5. Drainage design objectives for streets should include reducing street repair and maintenance costs, minimizing nuisance to the public, and minimizing frequent disruption of traffic flow.

For hydraulic evaluation of proposed curb and gutter, the minimum longitudinal slope of streets shall be no greater than identified in Section 200 of these City Standards. Minimum street cross slopes are defined in Section 200 of these City Standards and supersede any values provided by UDFCD. When evaluating existing conditions, actual survey information shall be used to determine the existing curb and gutter or cross pan slopes and configuration.

302.01.06 INLET DESIGN

Inlets within the street curb and gutter section shall be designed as a CDOT Type R Inlet. Combination Type 13 inlets may be allowed and require an Exception to the City Standards in specific circumstances where the Engineer of Record (EOR) can demonstrate a Type R will not work and the Combination Type 13 inlet will not be greater than four feet in depth from the flow line to the invert of the box. Other CDOT inlet types may be utilized outside of the street section. Trench drains are not allowed within the public right-of-way.

302.01.07 STORM DRAIN SYSTEM DESIGN

Storm Drainage Systems shall be designed with access points at all bends or transitions within the system and no further than 400 feet apart. Access points shall include but not be limited to manholes and inlets.

For public storm sewer systems pipe diameters less than 15 inches are not allowed. Minimum pipe diameter within a roadway section shall be a minimum of 18 inches in diameter.

302.01.08 OPEN CHANNELS FOR MAJOR AND MINOR DRAINAGE CONVEYANCE

Open Channel design and calculations shall be in accordance with the methodologies presented in Chapter 8 Open Channels of the Urban Drainage and Flood Control District, Urban Storm Drainage Criterial Manual Volume 1 except as modified herein.

Open natural or naturalized channels for transporting major storm runoff are more desirable than underground conduits, and use of such is encouraged. Open conveyance planning and design objectives are often best met by using naturalized streams, which characteristically have slower velocities and large width-to-depth ratios. Additional benefits can be obtained by incorporating parks and greenbelts with the naturalized stream layout. Use of naturalized streams (and other storm runoff features) should be considered in the early planning stages of a new development.

When evaluating existing natural water courses (perennial, intermittent and ephemeral), straightening, fill placement, and other alterations should be minimized and carefully evaluated. Such actions tend to reduce flood storage and increase the velocity to the detriment of those downstream of and adjacent to the channel work. Reduce flood peaks and control erosion so that the natural channel regime is preserved as much as practical. Some type of structural stream stabilization is almost always necessary to stabilize the stream against increased flows associated with urbanization. For example, grade control structures and structural protection at the stream toe and on the outer banks at bends are normally required. Riparian buffer zones can be used to accommodate future meandering and bank sloughing, at least in part. See riparian buffer zone criteria in Chapter X of the LDC.

Any work within the natural streams through the City shall consider the restoration of such in accordance with USDCM Chapter 8, Open Channels, Sections 1 through 5 and the City Floodplain Management regulations. Work in urbanized areas do not always allow for full natural stream construction but the same techniques need to be evaluated and implemented to the extent possible.

During design, construction, and maintenance of open channel systems resiliency of the system shall be considered to promote minimization of impacts from flood events and provide an ability of the system to rebound from damage from storm events. As such, incorporation of the philosophy of design for the frequent events (bankfull design) but plan for room for a major event (100-year flood) will produce open channels that are properly designed, functional, habitat accomondating and esthetically pleasing for the urban environment.

302.01.09 SWALE DESIGN

Swales function as conveyance of storm water for flows generally less than 100 cfs in the 100 year storm event. Conveyance channels carrying greater than 100 cfs will be analyzed and designed according to natural stream City Standards.

Natural swales will be designed to have a minimum longitudinal slope of 50:1 (2%) and side slopes no steeper than 4:1 (25%). Swales will be designed as a trapezoidal cross section with a minimum bottom width of 12 inches. It is recommended swales be designed with a minimum bottom width of two feet and side slopes of less than 5:1 (20%) where feasible.

Exceptions to the minimum standards for swales may be considered by the City Engineer in conformance with Section 103.01 of these Design Standard based upon design constraints and the proposed design mitigates the issues of standing water, capacity and erosion control. Concrete trickle channels in swales are discouraged and should only be proposed if no other options are available.

Swale design as part of a water quality best management practice may vary from these minimum criteria but shall be addressed in the design report.

In areas of common lot line swales in residential applications, swales may be designed as a “V” shaped channel with no bottom width if the longitudinal slope is greater than 50:1 and the velocity in the major storm event is not greater than 5 ft/s, the depth is no greater than 12 inches and there is still a minimum of XX feet on either side between buildings.

For design of swales outside of the parameters in Table 8-4 of Chapter 8 Section 6.1.1 of USDCM Volume 1, the stability of a channel shall be evaluated using the calculated shear stress as prescribed in FHWA HEC 15 Design of Roadside Channels with Flexible Linings, Third Edition. (https://www.fhwa.dot.gov/engineering/hydraulics/pubs/05114/05114.pdf) Any exception requests for swale design shall demonstrate the maximum permissible tractive force is not exceeded for the

proposed swale lining as prescribed in HEC 15.

Maintenance

302.01.10 STORM SEWER AND SWALE OUTFALLS

The depth of flow in the receiving stream must be taken into consideration for backwater computations for both the minor and major storm runoff. An analysis of the joint probability of occurrence may be warranted. FEMA recommends modeling a 10-year water surface in the receiving stream for a 100-year tributary discharge. HEC-22 also provides guidance based on the ratio of main stream watershed area to that of the tributary stream.

Cross Pans

302.01.11 RAW WATER STORAGE AND JURISDICTIONAL DAMS

The City of Longmont has maintained the agricultural land surrounding the community through IGA's, conservation easements and open space purchases. Agriculture in the high plains relies upon a complex network of irrigation ditches and reservoirs to manage water distribution in this semiarid climate. Many of the reservoirs associated with the irrigation system are under the jurisdiction of the State Engineer's Office. The State requires these reservoirs to maintain an outlet for volume control, a spillway to control overflow, the location of the outfall "channel", and the reservoir owners must maintain an emergency response plan. This plan identifies the inundation area should a dam breech occur.

Any drainage analysis must identify if the basin is within the outfall channel path under maximum conditions or in the inundation area of an upstream reservoir. The analysis shall demonstrate how water from the outlet channel or a breach will safely pass through the developed area without impacting structures or creating an undue hazard.

302.01.12 USE OF IRRIGATION DITCHES

Use of irrigation ditches for collection and transport of either minor or major storm runoff is prohibited unless specifically provided in a master plan and/or approved by the City and the ditch owner and follows adequate hydraulic engineering analysis that demonstrates such use is without unreasonable hazard and does not adversely impact upstream and downstream properties.

Irrigation ditches are typically characterized by flat slopes and limited carrying capacity. Experience and hydraulic calculations demonstrate that these physical limitations generally preclude use of ditches as an outfall point for the minor storm drainage system. Exceptions to the rule can occur when the capacity of the irrigation ditch is adequate to carry the normal ditch flow plus the minor storm runoff with adequate freeboard to avoid creating a hazard to those below the ditch. In such cases, written approval must be obtained from the ditch owner stating that the owner understands the physical and legal (i.e.liability) consequences of accepting such runoff.

Irrigation ditches are not suitable as an outfall for major storm runoff. Without major reworking of irrigation ditches to provide major carrying capacity without undue hazard to those downstream or below the ditch, the ditches are almost always inadequate for such a use and should not be used as an outfall. Moreover, because ditches are normally privately owned, one cannot assume the perpetual existence or function of a ditch.

Other irrigation ditch-related considerations include:

1. Land planners downhill from a ditch should ignore the effects of the ditch in hydrologic calculations, but should plan for continued ditch seepage.
2. Irrigation ditches are sometimes abandoned in urban areas after the agricultural land is no longer farmed. Provisions must be made for a ditch's perpetuation, defined as continued operation, capacity, and serviceability, prior to use as an outfall for urban drainage.

Any irrigation ditch or ditch lateral traversing a property shall grant an easement to the ditch owner or the City prior to further development of the property. Such easement may be vacated in the future by the ditch owner, the property owner or the City if the irrigation function is abandoned by the ditch owner.

302.01.13 HYDRAULIC STRUCTURES

Hydraulic Structure design and calculations shall be in accordance with the methodologies presented in Chapter 9 Hydraulic Structures of the Urban Drainage and Flood Control District, Urban Storm Drainage Criterial Manual Volume 2, except as modified herein.

1. In-Stream Grade Control Structures

Grade control structures or drop structures are an important element of stream protection and stabilization when urbanization increases flow rates, frequency and volume of runoff. Design and construction of these types of structures within the recognized waterways of the City of Longmont require careful design and review. The principles and methodologies provided in Chapter 9, Section 2, of the USDCM Volume 2 shall generally apply and be used to guide design and review of such structures but individual site constraints may require additional evaluation and modifications which will require approval by the City Engineer.

2. Pipe Outfalls and Rundowns

All pipe outfalls shall have either a flared end section or headwall and wing wall treatments with an adequate rundown design to prevent erosion and failure of the outfall structure. Toe walls will be required at outfalls 24 inches in diameter or greater. Smaller outfalls may require a toe wall based on the hydraulic characteristics of the storm sewer system. Joint restraint for flared end sections may be required as determined by the City Engineer.

Outfalls requiring headwall and wing walls will generally meet CDOT design specifications for structural wall and footing design. Alternatives may be considered given site restraints. Any alternative will require review and approval by the City Engineer. The alternative shall be a structural engineering design sealed and signed by a Colorado registered Professional Engineer.

Outfalls to a stream or other body of water shall be designed a minimum of one foot above the normal water surface elevation. Any design perpendicular to the flow of a channel or stream shall demonstrate the effect of flow on the existing channel and prescribe adequate protective measures to not adversely affect the existing channel.

3. Energy Dissipation and Erosion Protection

Local scour shall be controlled by the construction of riprap aprons, low tail water basins or grouted

boulders. Concrete impact basins shall only be considered when conditions do not allow or velocities are greater than can be addressed by a riprap or boulder energy dissipation solution.

302.01.14 STREAM ACCESS AND RECREATIONAL CHANNELS

Stream access and recreational channel design and calculations shall be in accordance with Section 600 of these City Standards. Access to maintain a channel shall be in conformance with Section 200 of these City Standards.

302.01.15 CULVERTS AND BRIDGES

Culvert and Bridge hydraulic design and calculations shall be in accordance with the methodologies presented in Chapter 11 Culverts and Bridges of the Urban Drainage andFlood Control District, Urban Storm Drainage Criterial Manual Volume 2, except as modified herein. Additional culvert and bridge requirements are found in Section 200 of these City Standards.

1. Design Reports

All culvert and bridge designs shall include a hydrology and hydraulic analysis as part of the final drainage report as prescribed in Section 200 of these City Standards. The report is required to meet the minimum standards outlined in Section 200 and the report requirements in Appendix D. Culvert and bridge design shall take into account the major and minor storm events as well as maintenance access and procedures.

2. Low Flow Channels

Culverts and bridges with flat bottoms shall account for low water flows and maintain a low flow channel allowing for adequate flow velocity in minor storms to scour sediment from a culvert or bridge. Multiple barrel sections shall have at least one barrel lower than the others to contain the low flow channel which often requires a smaller “bankfull” channel within the section to reduce the generation of cattails immediately upstream and downstream of the crossing

3. Submerged Culvert Inlet

For design of new installations, major storm headwater depths over culverts shall not exceed 18 inches of depth.

4. Minimum Culvert Sizes

Minimum culvert size shall be 18 inches within the public right-of-way or public easement.

5. Safety Grates / Trash Racks

All culverts up to and including sixty (60) inches in diameter shall be designed with a trash rack on the inlet side of the culvert. Outlets will require trash racks for pipe diameter eighteen inches or larger or as determined by the City Engineer. Design of inlet and outlet configurations as well as the hydraulic design shall be determined based on the length of the culvert compared to the size, as well as the maintenance requirements.

6. Long Culverts

Culverts where the length exceeds 10 times the height shall be considered long or where outlet conditions control the flow characteristics for design.

All long culverts shall be designed with a trash rack hinged to the top of the culvert at the headwall or as designated by the City Engineer. The grate shall allow for lifting by equipment in the case of emergency and for general maintenance.

Long culvert design shall evaluate the need for air venting or installation of an ARV based on the hydraulic characteristics of the culvert and to utilize the full capacity of the conduit.

Long culverts shall include grates or safety grating on the outlet to prevent nuisance entry from the downstream side.

7. Bridge Classification and Design

Bridges are generally considered to span greater than 20 feet and obtain their structural integrity through a deck structure supported by abutments and/or piers. The design of a bridge structure is complex and requires the analysis of many different variables and conditions. All bridges shall be design in accordance with Section 200 of the City Standards and meet all requirements of the state and federal agencies. See Section 2. Low Flow Channels for low flow channel design requirements.

8. Bridge Minimum Conveyance and Freeboard

Bridges for streets designated as arterial or freeways shall be designed to pass the major storm with a minimum of 2 feet of freeboard unless otherwise determined by the City Engineer. Bridges on local or collector street classifications shall be designed to pass the 10-year storm with a minimum of 2 feet of freeboard.

Resiliency

Resilient option or changes to bridge design criteria may be considered pending a benefit to cost analysis and approval by the City Engineer.

302.01.16 STORAGE

1.0 General Requirements

Storm water storage design and calculations shall be in accordance with the methodologies presented in Chapter 12 Storage of the Flood Control District, Urban Storm Drainage Criterial Manual Volume 2 except as modified herein.

In accordance with Flood Control District guidance and state law, all development which increases site imperviousness beyond the historic conditions through development or redevelopment shall provide detention through storage to attenuate increased storm flows to release at historic conditions. All new detention facilities and any reconstruction of former facilities shall be designed to meet the requirements of full spectrum detention. Areas of redevelopment of less than one acre may not need to provide additional detention if the area is served by a regional or sub-regional detention pond or demonstrate minimal impacts to the surrounding area and downstream properties by providing LID design in accordance with USDCM Vol 3 or other means in accordance with these criteria.

Storage volume and release rate criteria are based on three design events: WQCV, EURV and the 100 Year Event. Water quality capture volume (WQCV) is defined in Volume 3 of the UDFCD Manual.

Excess Urban Runoff Volume (EURV) is the difference between the developed and pre-developed runoff volume, a relatively constant value for a given developed imperviousness over a wide range of storm events. The 100-year event is the calculated difference between the developed runoff and the historic runoff for the site during the one (1) per cent rainfall event.

Facilities that combine the first two events or all three events generally do not require a separate design for WQCV; the WQCV and water quality release rate are included in the Excess Urban Runoff Volume design as outlined in UDSCM Vol 2.

Controlling the Excess Urban Runoff Volume (EURV) and releasing it at a negligibly small rate allows larger storms to be released at discharges and hydrograph shapes similar to predevelopment conditions. This approach matches predevelopment discharges over a wide range of events, especially in the frequent storms where urban runoff impacts are most evident. The approach has been termed “full-spectrum detention”, and is intended to reduce the flooding and stream degradation impacts associated with increases in peak, duration, and frequency of runoff from urban surfaces.

The EURV and 100-year detention volumes, based on current policy, are similar in magnitude to the 10-year and 100-year volumes associated with Longmont’s former criteria (as long as WQCV is added to the UDFCD 100-year required volume). The main difference is that the EURV is drained at a much slower rate than the 10-year detention volume as previously required.

1.01 Full Spectrum Detention and Former Criteria
If existing master plans t recommend 10-year/100-year detention facilities, the City generally intends for these to be built as full-spectrum facilities; however, the City Engineer shall make the final determination. There may be opportunities to convert existing 10-year/100-year detention facilities into full-spectrum facilities by reducing the capacity of the 10-year control orifice to a EURV release rate, and ensuring that the debris grate for the EURV orifices and the 100-year outlet and emergency spillway for the facility are adequate.

1.02 Definition of Redevelopment, Expansion and/or Improvement. Redevelopment of a site occurs when a change in the property use and/or function is desired, which result in physical changes to the site. The redevelopment of a site shall require that onsite detention be provided for the entire site, including those areas that previously had not provided detention because the site was developed prior to current City criteria and standards.
Expansion of a site occurs when additional area on the site is proposed to be developed. The expansion of a site requires current City standards for detentionbe met for the entire site, where feasible. There are two conditions that may arise for site expansion, depending upon whether or not detention has been provided for the existing site prior to expansion.

- Detention has been provided for the existing developed area. The new expansion shall require that additional detention be provided to accommodate the expanded development.
- Detention has not been provided for the existing developed area. Detention will be required for the full expansion and to the extent possible, for the existing site area that has previously been un-detained. A reasonable attempt shall be made to provide detention storage for the previously developed, un-detained portion of the site but a final determination shall be made by the City Engineer.

1.03 Exemptions. Exemptions from the detention requirement may be granted for additions to existing buildings and paved areas, provided that the total impervious area of all additions (cumulative over the history of the site expansions from the originally approved site) cover less than 2,500 square feet of impervious area and that no adverse impacts to downstream properties would be created by the additional undetained runoff.

1.04 Adjacentcy to a Major Drainageway. It is understood that under some conditions, the undetained release from a developed site adjacent to a major drainageway or floodplain can "beat the peak" of the major storm event, reducing the maximum peak flow. It is also understood that onsite detention provides benefits other than reducing major storm event discharge rates, by reducing the more frequent lower flows. The lower flows are the channel producing flows which can contribute to channel degradation and erosion. It is also the City's policy to limit the impact of developed flows onto downstream properties.

Should a development propose to limit or not provide detention with the intent to "beat the peak", the application shall include an exception request in accordance with Section 100 requirements. The exception justification shall include an analysis of the effect of higher flow rates on the downstream storm sewer system including channel erosion and sedimentation as well as on the impact to downstream properties. Water Quality requirements must be met by all projects. See Section 302.01.18.

1.05 Temporary Detention. Temporary detention shall be provided where permanent detention in unavailable, such as when a regional detention pond is intended, but has not been constructed or similar circumstances. Temporary detention shall be provided to ensure that the historical release rates are maintained on site. Temporary detention must meet all the standards set forth for permanent detention ponds. Easements are required for temporary detention

1.06 Regional Detention. Regional detention refers to online facilities located on a major drainage way, with an upstream watershed area generally ranging from about 130-acres to one-square mile. Regional detention facilities are typically designed as a part of the watershed master planning process, in which stormwater management needs for the watershed as a whole are developed in a staged, regional plan.

Because of their size, regional interaction with other watershed facilities and significance in floodplain management, regional facilities are not allowed to be privately owned. All regional facilities shall be owned and maintained by the City, or in certain circumstances, a special district. If a special district will own and maintain a regional facility they shall demonstrate their authority, expertise, and resources to provide the necessary inspections and maintenance.

Compared to onsite facilities, regional detention facilities are typically more reliable, require less land area, and are more cost effective to construct and maintain. Regional facilities, being larger, can generally provide more favorable riparian habitat and offer greater opportunities for achieving multi-use objectives, such as combining with park and open space resources and connecting to trail systems.

Regional detention facilities meeting the requirements below may be recognized and included in hydrologic modeling of downstream major drainageways. Sub-regional and onsite detention facilities may not be recognized in the determination of flow rates for downstream major drainage ways.

Generally, the following conditions shall be met for regional facilities:

1. Regional detention facilities shall be designed to accommodate the fully developed flows from the upstream watershed.

2. Regional detention facilities are required to be owned and maintained by the City. The property for the Regional Detention Facility shall be deeded to the City.

4. Drainage easements shall be provided to the City, for adequate access for operation and maintenance as well as easements on the downstream property to allow for the pond release in perpetuity.

5. An Operations and Maintenance Manual is required to be prepared for the regional facility.

7. The creation of a jurisdictional dam shall be avoided.

8. The facility must be permitted under applicable Federal, State and environmental permits and clearances.

11. The drainage system that conveys flows to the regional facility shall be designed to accommodate fully-developed flows to the regional facility.

1.07 Sub-regional Detention. Sub-regional detention refers to facilities serving more than one lot that are not a part of the regional master-planned detention system, and are typically located on a minor drainageway.

Sub-regional detention facilities may be constructed by the City when it is found to be in the interest of the municipality or by a special district to serve several landowners in the upstream watershed or by a single landowner. It may be possible for a single landowner to construct a sub-regional facility that serves other properties, provided that the responsibilities for construction, operation and maintenance of the sub-regional facility are clearly defined and agreed to by all property owners. A maintenance agreement specific to the facility shall be required. Sub-regional detention offers many of the same benefits as regional facilities in comparison to onsite detention. As such, new development shall implement regional or sub-regional detention. If a development is not able to provide sub-regional detention due to site constraints, an exception meeting the requirements as outlined in Section 100 may be considered by the City.

The City shall approve any sub-regional detention facilities that meet….. Generally, the conditions listed for regional facilities shall be adhered to for sub-regional facilities, with the exception that sub-regional facilities need not be owned and maintained by the City. Requirements for clearly defining ownership and maintenance responsibilities, preparing an O&M Manual, providing adequate easements, and the other conditions listed for regional facilities are required for sub-regional detention facilities. The City may require that sites upstream of sub-regional water quality facilities reduce directly connected impervious area, depending on the impacts to receiving streams from undetained site runoff. This will be determined by the City on a site-specific basis.

1.08 Onsite Detention. Onsite detention refers to facilities serving one lot or a group of contiguous lots managed by a single entity, generally commercial or industrial sites draining areas less than 20 acres. The City prefers that regional or sub regional facilities be available to serve proposed development. In lieu of this availability, onsite detention may be allowed.

Onsite detention facilities may not be recognized in the determination of flow rates for downstream major drainageways. Onsite detention facilities shall be designed for runoff from the site and any upstream offsite areas that are routed into the pond. Generally, offsite flows shall not be routed through an onsite detention pond, but routed around the pond.

Integrating Detention in Landscape Areas. Locating detention basins in landscape areas generally works well, especially if ample space is reserved for the facility. Incorporating detention into landscaped areas generally creates detention facilities which are easy to access and inspect, are relatively easy to maintain, and can enhance the overall aesthetics of a site.

Parking Lot Detention. Parking lot detention is not allowed for primary pond storage volume and outlet configuration. In some commercial areas, a limited area of parking may be used to offset some of the storage volume that needs to be provided. Parking lot detention requirements are outlined later in this document. Parking lot detention is not appropriate for most instances, and will be reviewed on a case-by-case basis. Parking lot detention is not allowed in residential land uses, including multifamily.

Underground Detention. Underground detention is generally not allowed but may be considered on a case-by-case basis as approved through the exception process.

Rooftop Detention. Rooftop detention is prohibited.

2.0 Detention Basin Design Criteria

2.01 Sizing Methodology. Full spectrum detention pond sizing shall be designed utilizing one of the three different procedures described in the Chapter 12 Storage of the UDFCD Manual. The simplified equation method may be used for basin areas up to 10 acres in size. The UD-Detention workbook method may be used for sites up to 130 acres and the CUHP/SWMM methodology may be utilized

for developments ranging from 10 acres to one square mile. The drain time for the Excess Urban Runoff Volume shall be 72 hours, as specified in the UDFCD Manual, or, if approved, up to the 2-year rainfall event allowable release rate.

The Water Quality Capture Volume and the incremental portions of the Excess Urban Runoff Volume, and the 100-year volume of a full-spectrum detention basin are normally combined into one facility with one outlet structure where the EURV is included in the 100-year flood volume. However, other release methodologies as described in Chapter 12 of the FCD Manual may be considered.

2.02 Onsite Detention and Offsite Flows. Two approaches are generally acceptable for addressing offsite flows that must be conveyed through a site, and the potential impacts to onsite detention.

1. Design for No Pass-through. In this approach, offsite runoff is not allowed to be "passed through" the detention pond. Flows not intended to be detained in the pond shall be routed around the detention pond, and reconnected below the pond at the outfall, if necessary.

2. Design for Offsite Flows. An alternative method is to design the detention basin for the entire upstream watershed area, including the future development flows from offsite areas without giving any credit to offsite detention facilities. This method may be practical if the offsite tributary area is relatively small.

2.03 Multiple Small Detention Basins. Extended detention basins providing Water Quality Capture Volume, Excess Urban Runoff Volume, and 100-year detention typically function best if configured in one or a few large basins as opposed to multiple small basins with very small orifices. Therefore, a minimum number of detentionfacilities is generally preferable. The same is not necessarily true for porous landscape and porous pavement detention, which may be configured in multiple small installations.

2.04 Detention Basins in Series. Locating two or more detention basins in series on an individual development site inherently leads to inefficiencies in the required storage volume of the downstream facilities and is generally discouraged, especially for the Water Quality Capture Volume and the Excess Urban Runoff Volume portion of a full-spectrum detention facility.

If site runoff is detained by two or more detention facilities in sequence before leaving the site, hydrograph approaches, as described in Section 3.4 of the Storage Chapter, in Volume 2 of the UDFCD Manual, shall be used to determine the effect of sequential detention and to determine the detention capacity that is needed to reduce runoff peaks to the specified predevelopment flow rates at the end of the system.

2.05 Interconnected Ponds. When sequential ponds are located in close proximity, separated by a short culvert or pipe at a roadway crossing, or when sequential ponds have similar invert elevations, the ponds may have to be modeled as "interconnected ponds". This situation could also occur if other downstream conditions cause variable backwater effects that influence the discharge of the detention pond outlet pipe. In these scenarios, the water surface elevation in the downstream pond can reduce the discharge rate from the upper pond and in some cases reverse flow can occur from the downstream pond into the upstream pond. The routing analysis is much more complex because the ponds are hydraulically connected and the water surface elevations continuously vary and change the discharge characteristics. It is the responsibility of the design engineer to ensure that the appropriate analyses are performed and submitted when ponds are "interconnected".

2.06 Outlets into Streets. Detention ponds that have an outlet pipe terminating in the gutter of a street, such as through a chase section, present potential ponding and icing problems in the gutter, and create hazards to the traveling public during periods in which the pond is emptying rapidly. Therefore, detention ponds shall be designed to outlet into a storm sewer, drainage way, or other designated drainage system that is reasonably available. It must be shown that the storm sewer, drainage way, or other designated drainage system to which the pond outlets, has the capacity to convey the discharge flows.

A pond outlet may discharge into the gutter in cases where the minor storm peak flow for the tributary area is less than 5.0-cubic feet per second and a storm sewer or other drainage system is not reasonably available. It must be demonstrated that the street has adequate capacity to convey the excess runoff within the allowable limits. A transition from the outlet pipe to a curb chase will normally be required, and the chase section shall be designed to reduce the velocity and spread of flow as much as possible. The location of the outlet shall be designed to minimize potential problems or conflicts with other improvements, and shall be angled toward the downstream slope of the gutter to direct flows downstream instead of perpendicularly into the street.

2.07 Excavated and Embankment Slopes. All excavated or embankment slopes from the pond bottom to the 100-year water surface elevation shall be no steeper than 4 (horizontal) to 1(vertical). Excavated slopes above the 100-year water surface elevation and the slope on the downstream side of embankments shall also be 4 to 1 or flatter. Embankments shall be provided with a top width of at least 10 feet. An emergency overflow spillway shall be provided.

It is the responsibility of the design engineer to ensure that the design of any earthen embankment is based on specific recommendations of a geotechnical engineer and that the design requirements are clearly identified within the construction plans. In addition, the construction of large embankments or dams may fall under the jurisdiction of the Office of the State Engineer.

All earthen slopes shall be covered with topsoil and revegetated in accordance with requirements of Section 600. Adequate provisions for the establishment and maintenance of the vegetation, such as temporary or permanent irrigation should be provided.

2.08 Freeboard Requirements. The minimum required freeboard for detention facilities is 1.0-foot above the computed water surface elevation when the emergency spillway is conveying the maximum design flow.

2.09 Low Flow Channels. All grassed-bottom detention ponds shall include a low flow channel sized to convey a minimum of 1% of the 100-year peak inflow. The low flow channel shall be constructed of concrete, concrete with boulder edges, soil-riprap, or other materials accepted by the City Engineer. The trickle channel shall have a minimum depth of 0.5-ft. and a minimum width of 2-ft. for private ponds, and 4-ft for regional ponds. The minimum slope shall be 0.7-percent and the design longitudinal slope should ensure that non-erosive velocities are maintained adjacent to the low flow channel when the design capacity is exceeded.

As approved by the City Engineer, an unlined low flow channel may be used. The unlined low flow channel shall be at least 1.5-feet deep below adjacent grassed benches and shall be vegetated with herbaceous wetland vegetation or riparian grasses, appropriate for the anticipated moisture conditions. The minimum longitudinal slope shall be 0.5-percent and the minimum width of the grassed bench adjacent to the low flow channel shall be 12-feet on one or both sides where equipment can access. The maximum side slope below the bench shall be 4 to 1 and the maximum bottom width of the channel shall be 12-feet if equipment can access one side of the channel and 24-feet if equipment can access both sides. The need for an underdrain shall be evaluated for individual projects based upon the type of soil and infiltration rate.

2.10 Pond Bottom Slope. For grassed detention facilities, the pond bottom shall be sloped at least 4.0-percent for the first 25-feet adjacent to a lined low flow channel and at least 1.5- to 2-percent thereafter to drain toward the low flow channel or outlet, measured perpendicular to the low flow channel. The benches above unlined low flow channels, if approved, shall slope at least 1.5- to 2-percent toward the low flow channel.

2.11 Inlet Facilities. Runoff shall enter a detention facility via a stabilized drainage way, a 100-year drop structure, or a storm sewer with energy dissipater.

2.12 Detention Pond Outlet Configuration. Detention basin outlets shall be functional for controlling

the design release rates, provided with safety and debris grates to reduce the potential for debris plugging, easy to maintain, and designed with favorable aesthetics.

The minimum net open area of the grate protecting the Excess Urban Runoff Volume orifices and the flood control orifice shall comply with Figure 7 of UDFCD's Volume 3, Typical Structural Best Management Practice Details. The safety grate criteria discussed in the Culverts section of Volume 1 of the UDFCD Manual, shall also apply.

If the control orifices are 2.5-inches or greater in diameter or 2-inches square, standard fabricated bar grating (with nominal openings of 1- by 4-inches) may be used as a debris grate instead of well-screen. The larger grate may reduce the potential for clogging with debris. The vertical spacing between orifices may be increased to 8-inches or 12-inches and the orifice areas increased by a factor of two (for 8-inch spacing) or three (for 12- inch spacing) to enable larger orifices and larger trash rack openings.

Bar grating may be used on parallel sloping wingwalls, either as the primary debris grate (if orifices are at least 2.5 inches in diameter) or as a course screen and safety grate in lieu of handrail. Sloping bar grating shall have a lockable hinged section at least 2-feet square to allow access to the orifice plate or wellscreen. Manhole steps shall be provided on the side of the wingwall directly under the hinged opening. The bearing bars for steel bar grating shall be designed to withstand hydrostatic loading up to the spillway crest (assuming the grate is clogged and bears the full hydrostatic head), but generally not designed for larger loads (like vehicular loads) so that the hinged panels are not excessively heavy. Panels of bar grating shall be no more than 3-feet wide and all parts of the grating and support frames shall be hot-dipped galvanized. Bar grating shall be fastened down to the outlet structure.

The flood-flow orifice shall be sized to provide the allowable 100-year release rate when the 100-year detention volume is completely full. The weir crest at the top of the EURV volume shall pass the allowable 100-year release rate at a head that is at least 0.5-feet below the completely-full 100-year full-spectrum volume, maintaining control at the 100-year orifice in the design event.

2.13 Emergency Spillway and Embankment Protection. Whenever a detention basin uses an embankment to contain water, the embankment shall be protected from catastrophic failure due to overtopping. Overtopping can occur when the pond outlets become obstructed or when a storm larger than a 100-year event occurs. Erosion protection for the embankment may be provided in the form of a buried riprap layer on the entire downstream face of the embankment or a separate emergency spillway constructed of buried riprap or concrete. In either case, the emergency protection shall be constructed to convey the 100-year developed flow from the upstream watershed without accounting for any flow reduction within the detention basin. The invert of the emergency spillway shall be set at the 100-year water surface elevation. A concrete wall shall be constructed at the emergency spillway crest extending at least to the bottom of the riprap and bedding layers located immediately downstream. The crest wall shall be extended at the sides up to one foot above the emergency spillway design water surface. Riprap embankment protection shall be sized based on methodologies developed specifically for overtopping embankments. The thickness and bedding requirements shall be based on the criteria identified in the UDFCD Manual. The emergency spillway is also needed to control the release point and direction of the overflow. The emergency spillway and the path of the emergency overflow downstream of the spillway and embankment shall be clearly depicted on the drainage plan. Structures shall not be permitted in the path of the emergency spillway or overflow. The emergency overflow water surface shall be shown on the detention facility construction drawings.

2.14 Retaining Walls. The use of retaining walls within detention basins is generally discouraged due to the potential increase in long-term maintenance costs and concerns regarding the safety of the general public and maintenance personnel. If retaining walls are proposed they shall meet the following requirements:

1. Bottom of the footings shall be located above the excess urban runoff volume (EURV).
2. Wall heights shall not exceed 24-inches from finished grade to the top of wall, and
3. Walls shall not be used on more than 50-percent of the pond circumference.

4. If retaining walls are terraced, a separation of at least 5-feet shall be provided between walls. Additional width may be required to address the wall design, anchoring system and maintenance requirements. The engineering analysis shall include a discussion and the necessary calculations to determine the appropriate “bench” width. The maximum ground slope between adjacent walls shall be four (4) percent.
5. Detention pond retaining walls may require a Building Permit (unless waived by the City Engineer) and shall be provided with handrails or guardrails designed to meet safety criteria as well as International Building Code (IBC) and ANSI 117 requirements.
6. Retaining walls may not be used where live loading or additional surcharge from maintenance equipment of vehicle traffic could occur. An exception may be granted if the wall is designed to accommodate the live loading condition.
7. Foundation walls of buildings shall not be used as detention basin retaining walls.
8. The horizontal distance between the top of any retaining wall in a detention area and any adjacent sidewalk, roadway curb or structured feature is to be a minimum of three times the height of the wall.
9. The horizontal distance to any maintenance access drive not used as a sidewalk or roadway shall be at least four feet.
10. Any future outfalls to the pond shall be designed and constructed with the detention basin. This reduces the likelihood of disturbing the retaining walls when constructing the “future” outfall.
11. Perimeter fencing to limit access, safety railing, or guardrail may be required depending upon the location of the wall relative to roadways, parking areas and pedestrian use areas.
12. A Professional Engineer licensed in the State of Colorado shall perform a structural analysis and design the retaining wall for the various loading conditions the wall may encounter, including the hydrostatic pressure differential between the front and the back of the wall and live loading conditions, if applicable. A drain system shall be designed behind the wall to ensure that hydrostatic pressures are equalized as the water level changes in the pond. The wall design and calculations shall be stamped by the professional engineer and submitted to the City. The design details and requirements for the retaining wall(s) shall be included in the construction drawings.
13. Retaining walls shall not be used within the limits of any impermeable lining of water quality basins or detention ponds.
14. Exceptions may be considered in accordance with Section 100.

2.15 Easement Requirements. Easements for all detention facilities shall be provided in accordance with Section 100. Drainage easements shall be provided to ensure the proper design, construction and maintenance of the detention basins and outlet facilities. Drainage easements shall be granted to the City for inspection and maintenance purposes, and shall be shown on the Drainage Plan, Final Plat and Final Development Plan. The minimum area required for detention basin easements shall contain storage and water quality capture volume including freeboard, associated facilities, and adequate maintenance access around the perimeter based on the access road width criteria provided in Section 100. Access shall be provided in an easement extending from public right-of-way to the basin.

3.0 Design Standards for Parking Lot Detention

3.01 Depth Limitation. The maximum allowable design depth above pavement surfaces for the Excess Urban Runoff Volume is three (3) inches and for the major storm event is nine (9) inches. However, to account for future overlays or parking lot resurfacing, the design volumes shall be attained with an assumed two (2) inch overlay (translating to an allowable depth of one (1) inch for the Excess Urban Runoff Volume and seven (7) inches for the major storm event). The Water Quality Capture Volume shall be located entirely out of (below) the pavement area, possibly in one or more landscaped parking islands or adjacent landscaping. An emergency spillway sized for the 100-year

inflow peak shall be provided with a crest set at the 100-year water surface elevation and a maximum flow depth over the emergency spillway of six (6) inches. A minimum of one (1) foot of freeboard is required above the 100-year emergency water surface to the first floor elevation of any adjacent structures (equivalent to 18-inches over the 100-year water surface).

3.02 Outlet Configuration. The outlet configuration shall be designed in accordance with criteria shown in USDCM Volume 3, for the type of Water Quality Capture Volume facility selected for the site. Outlets for the Excess Urban Runoff Volume and 100-year events shall limit peak flows to the maximum design release rates.

4.0 Detention Pond Landscaping Guidelines

Integration of detention and site landscaping requirements is encouraged. Consideration to the type and quantity of landscaping materials should be given, to ensure that the capacity of the pond is maintained, and that future maintenance activities can be performed with minimal disruption of vegetated areas. The following is a list of recommendations for pond grading and landscaping:

a. Wherever possible, involve a landscape architect in the design of detention facilities to provide input regarding layout, grading, and the vegetation plan.

b. Create a basin with a pleasing, natural shape that is characterized by variation in the top, toe, and slopes of banks. Avoid boxy, geometric patterns that are easy to draw using CAD. Better results are usually achieved by creating a grading plan by hand and then smoothly digitizing the proposed contours in to the design drawings. A “golf course look” is more attractive than straight lines and straight slopes.

c. Grass selection and plant materials are key in softening the appearance of a detention area and blend it in with the surrounding landscaping and natural features. Species are to be suitable for the particular hydrologic conditions in the basin; with wetland or riparian species selected for the bottom areas subject to frequent and prolonged inundation. Bluegrass rarely works well in the lowest, water quality portion of a basin.

d. Multipurpose detention facilities are encouraged to include activities such as passive open space areas, pedestrian paths, children’s play areas, and active recreation areas. It is recommended that active recreation facilities be located above the EURV water surface to avoid frequent inundation.

e. To reduce the potential for clogging of debris grates, no straw mulch shall be used within the Excess Urban Runoff Volume of a detention basin. Instead, erosion control blanket shall be installed for a width of at least 6-feet on either side of concrete low flow channels or up to a depth of 1-foot in soil riprap or benched low flow channels.

f. Trees shall not be planted within the Excess Urban Runoff Volume. Trees such as Cottonwood, Willow, and Aspen shall not be planted within the 100-year water surface of a detention basin to avoid loss of capacity and nuisance spreading of root systems within the facility.

5.0 Designing for Maintenance

Detention facilities shall be designed to facilitate ongoing maintenance operations. The following provisions for maintenance shall be required.

5.01 Access for Sediment Removal. A stable access and working bench shall be provided so that equipment can remove accumulated sediment and debris from the detention basin and perform other necessary maintenance activities on all components of the facility. Unless otherwise approved by the City, the horizontal distance from the working bench to the furthest point of removal for the forebay, bottom of the detention basin, or outlet structure shall be no more than 24-feet. The working bench and access drive shall slope no more than 10- percent, and be at least 12-feet wide for a centerline radius greater than 80-feet and at least 14-feet wide for a centerline radius between 50- and 80-feet. The minimum centerline radius shall be 50-feet. Unless otherwise approved, the working bench and access drive shall be constructed of the following materials:

1. Below any permanent water surface: CDOT Class P concrete, at least 6-inches thick with

minimum reinforcement consisting of No. 4 reinforcing bars at 12- inches each way, centered in slab. Surface of concrete shall be provided with a grooved finish to improve traction, with grooves oriented to drain water away to one or both sides. Concrete shall be placed over at least 6-inches of 1.5-inch crushed rock compacted in a 6-inch thick lift over at least a 6-inch layer of compacted subgrade.

2. Below the Excess Urban Runoff Volume water surface: Concrete as specified above, or Class 5 or 6 aggregate base course per CDOT 703.03, or any graded crushed rock smaller than 2-inches may be used. The granular material shall be compacted in a 12-inch thick lift over at least a 6-inch layer of compacted subgrade.

3. Above the Excess Urban Runoff Volume and below the 100-year water surface: Concrete as specified above, or Class 5 or 6 aggregate base course per CDOT 703.03, or any graded crushed rock smaller than 2-inches may be used. The granular material shall be compacted in an 8-inch thick lift over at least a 6-inch layer of compacted subgrade.

The use of reinforced turfgrass meeting applicable UDFCD criteria, if proposed in this zone for an access drive, will be considered by the City on a site specific basis. If used, a system of marking the edges is required so that its location is evident to maintenance crews. Also, shrubs, trees, sprinkler heads and valve boxes shall not be located in the reinforced turfgrass area. As stated above, any retaining walls shall be laid out in a manner that avoids access restrictions. Any handrails or fences, likewise, shall permit vehicular access. The entrance to an access drive from a roadway or parking lot shall be located so that traffic safety is not compromised.

302.01.17 REVEGETATION

Revegetation design and implementation shall be in accordance with Section 600 of these City Standards.

302.01.18 WATER QUALITY TREATMENT

Water Quality Design shall conform to the City of Longmont Municipal Code 14.26 Storm Water Quality. Stormwater quality control measures are designed based on either the Water Quality Capture Volume (WQCV) or the Excess Urban Runoff Volume (EURV):

1. WQCV: The WQCV, as described in detail in Volume 3 of the USDCM, corresponds to approximately the 80th percentile runoff event and is used in BMPs designed for water quality purposes only. It is appropriate to size BMPs for the entire area tributary to the BMP. The release rate for the WQCV varies based on the type of BMP.
2. EURV: The EURV represents the difference between the developed and pre-developed runoff volume for the range of storms that produce runoff (generally greater than the 2-year event from pervious land surfaces). The EURV is relatively constant for a given imperviousness over a wide range of storm events. The EURV is a greater volume than the WQCV and is detained over the minimum time necessary to allow for the recommended drain time of the WQCV, and is used to better replicate peak discharge in receiving waters for runoff events exceeding the WQCV. The EURV is associated with Full Spectrum Detention, a simplified sizing method for both water quality and flood control detention. EURV calculation procedures are provided in Chapter 12 Storage, of the USDCM, Volume 2.

302.01.19 MAINTENANCE OF STORAGE AND WATER QUALITY FACILITIES

Long-term maintenance provisions must be arranged for storage and water quality facilities. Sub regional and on-site detention ponds shall be privately owned and maintained unless agreed to otherwise in the Public Improvement Agreement or other agreement with the City. Detention ponds

are defined to include the outlet structure and outlet release pipeline until it reaches a City storm sewer system. Routine maintenance of detention facilities includes the removal of debris, excessive vegetation from the embankment, and sediment. Long term maintenance includes the repair and/or replacement of outlet structures, trickle channel, outlet pipes, channel slopes, and other related facilities. When appropriate maintenance is not provided, the City may provide the necessary maintenance and assess the associated cost to the property owner.

Maintenance requirements for water quality facilities (BMPs) vary, depending on the BMP type, as described in Chapter 6, Volume 3 of the USDCM. Without maintenance, detention, and water quality facilities will become unsightly social liabilities and eventually become ineffective for their intended functions. In general, the underlying property owner is responsible for maintenance of any storage facility unless another agreement has been made and provided to the City. All water quality facilities shall be permitted under Section 14.26 of the Municipal Code and the permit will designate the maintenance obligations.

302.01.20 STORM SEWER MAINS

1. Pipe inside diameter shall be eighteen (18) inches and larger for public storm sewers. Pipe inside diameter shall be fifteen (15) inches and larger for private storm sewers that are connecting to public storm sewer system.
2. All piping and material shall be of the type and materials specified herein. The use of materials other than those specified herein require approval from the City Engineer.
3. All materials shall be new and unused.
4. All pipe sizes and references to pipe diameter on the drawings or in the specifications are intended to be the nominal inside diameter, and shall be interpreted as such.
5. The City Engineer reserves the right to resize any storm sewer main that is inadequate for the proposed use, based on condition and capacity of existing storm drainage system.

DEPTH

All pipes will have a minimum of two (2) feet of cover from the top of the subgrade under the asphalt and base course to the top of the bell of the pipe. Reference detail 300-01 Reinforce Concrete Pipe Trench

ALIGNMENT

The location of storm sewer mains shall typically be under the asphalt, ten (10) feet south or east of the street centerline. Storm sewer mains shall be located a minimum of ten (10) feet horizontally from the edge of all existing or proposed water mains or sanitary sewer mains and shall be located a minimum of five (5) feet horizontally from lip of gutter. No storm sewer mains shall be installed within fifteen (15) feet of any existing or proposed structures, unless approved by the City Engineer. Follow the requirements for Utility Line Separations and Crossings located in Section 103 of these City Standards for storm sewer clearance from other utilties.

All weather vehicular access shall be provided to manholes and storm inlet boxes installed in areas outside of the public right-of-way. This shall consist of a minimum ten (10) foot wide, all weather path or roadway constructed to the specifications as outlined in Section 200.

FUTURE EXTENSIONS

The extensions of storm sewer pipe shall be of the same material as the existing pipe. The physical connection to the existing storm sewer system shall be plugged at the first downstream manhole until the storm system has been completed to the satisfaction of the City Engineer.

302.01.21 MANHOLES

1. The contractor shall place manholes at all changes in grade, alignment, pipe materials, and pipe sizes. The crown of the pipes shall be at the same elevation, or the drop across the manhole between the incoming and outgoing inverts shall be a minimum of two tenths (0.2) feet. In the instance where flows enter and exit straight through the manhole without any bends or branches a one tenth (0.1) foot drop may be permissible. All drops less than two tenths (0.2) feet will require the City Engineer's approval. When a tee invert is constructed, the invert coming into the straight through channel must be a minimum of two tenths (0.2) of a foot higher than the out invert.
2. Manholes shall be located at street intersections whenever possible.
3. Manholes shall be at least forty eight (48) inches diameter for pipes between fifteen (15) inches and thirty six (36) inches in diameter. Manholes shall be at least sixty (60) inches in diameter for pipes between forty two (42) inches to forty eight (48) inches in diameter. Manholes shall be at least seventy two (72) inches in diameter for pipes between fifty four (54) inches and sixty (60) inches in diameter. Manholes shall have a box base or precast tee for pipes larger than sixty (60) inches in diameter. This only applies when one pipe is exiting and entering the manhole. Manholes with multiple pipes entering or pipes entering at angles into a manhole shall be evaluated on a case by case basis and may require further information on the plans for concrete spacing between pipes. Reference detail 300-02 Standard Manhole
4. Drop manholes are allowed for drainage improvements. No outside drops are allowed on manholes and the City Engineer may restrict the difference in height between the incoming pipe invert and the outgoing pipe invert. Inside drop manholes must be a minimum five (5) ft. in diameter. Reference Wastewater Collection detail 400-05 Inside Drop Manhole.
5. Manholes must be spaced no farther apart than four hundred (400) feet for pipes with inside diameters of fifteen (15) inches to thirty six (36) inches, and five hundred (500) feet apart for pipes with inside diameters of forty two (42) inches and larger.
6. Manholes shall not be located in areas where ponding is anticipated or where extended detention basins are present or anticipated.
7. If the manhole invert is deeper than fifteen (15) feet below finished grade or rim elevation, a structural design of the manhole base is required to be submitted to the City Engineer for review.
8. Maintenance access: All weather vehicular access shall be provided to manholes installed in areas outside of the public right-of-way. This shall consist of a minimum ten (10) foot wide gravel, asphalt, or concrete path or roadway constructed to the specifications outlined in Section 200.

Manholes shall be located a minimum distance of four (4) feet from the edge of the curb and gutter or maintenance access path. If the manhole is located at a greater distance on an access path, provide a bulb-out or concrete pad area in order to allow maintenance vehicles to turn-around.

9. If the possibility of surface runoff cannot be avoided or the hydraulic grade line of the major storm event is within one (1) foot of the manhole rim, a solid manhole cover, having an integral O-ring type gasket that can be bolted closed, must be used. Reference detail 300-04 Standard Manhole Cover.
10. All manholes located outside the dedicated street right-of-way or withina 100-year floodplain shall be designed and constructed with a watertight, bolted type cover and the manhole ring shall be

bolted to the manhole cone.

11. Manholes shall be located within asphalt or concrete paving. Manholes shall not be located within concrete pans, sidewalks, or gutters.
12. Flat top manholes are not an approved alternative. An exception is for any instances where a flat top manhole is approved by the City Engineer. Reference detail 300-03 Flat Top Manhole Exception.

302.01.22 SUBMITTALS

1. An electronic copy of the signed and sealed preliminary drainage report is required to be submitted with the preliminary plat. The applicant is responsible to submit copies of the report to any irrigation ditch company or other agency that may be affected by the proposed project. The preliminary drainage report will include conceptual mitigation of floodplain impacts, hydrology for on-site and tributary off-site areas, proposed flow routes including estimated locations of inlets and storm sewer alignment, and calculations for the proposed detention and/or water quality pond (or other facility) requirements and configurations. The preliminary drainage report must be approved prior to approval of the preliminary plat. See the Appendix for the Drainage Report checklist.
2. One (1) paper copy of the signed and sealed final drainage report is required to be submitted with the final plat submittal. The applicant is responsible to submit copies of the report to any irrigation ditch company or agency that may be affected by the proposed project. The final drainage report will include the updated information from the preliminary drainage report, approved floodplain impact analysis (if applicable) and hydraulic calculations for all drainage improvements and details. The final drainage report must be approved prior to approval of final plat and construction drawings. See Appendix X for the Drainage Report checklist.

302.02 MATERIALS

302.02.01 GENERAL REQUIREMENTS

1. The Contractor shall provide a copy of the manufacturer's installation recommendations for each type of pipe to each foreman and inspector prior to construction. These installation recommendations shall be followed during construction unless otherwise allowed by the City Engineer. City Standard requirements take priority over the manufacturers installation recommendations.
2. The City Engineer reserves the right to require testing of pipe and materials after delivery and to reject all pipe or materials represented by the sample which fail to comply with the specified requirements.
3. For a specific list of materials accepted by the City Public Works and Natural Resources Department see the Appendix.

302.02.02 REINFORCED CONCRETE PIPE MATERIAL (RCP)

ALLOWABLE USE

Reinforced concrete pipe shall be used on storm sewer projects under pavement surfaces within City right-of-way.

DESCRIPTION

1. Circular reinforced concrete pipe shall meet the requirements of ASTM C76 and the requirements located in the Wastewater Collection Section 400 of these City Standards.
2. The use of elliptical reinforcing pipe will only be allowed if approved by the City Engineer. If approved, elliptical reinforced concrete pipe shall meet the requirements of ASTM C507 and the requirements contained herein.
3. All RCP pipes shall be constructed with Type II modified cement. The absorption of the concrete pipe shall not exceed 5.5%.
4. Each pipe joint shall conform to ASTM C361, Section 8, with the gaskets confined in a groove cast in the pipe spigot. Pipe with collars in lieu of integral cast bells will not be accepted. The pipe joints shall be designed to withstand, without cracking, the gasket compression plus a differential load across the joint equal to 4,000 pounds per foot of inside diameter.
5. Each piece of reinforced concrete storm sewer pipe shall be plainly and permanently marked showing the pipe class, date of manufacture, and the manufacturer's name or mark. These markings shall be made on the outside of the pipe before curing or shall be painted on the pipe using waterproof paint.
6. The City Engineer may require the submittal of reports covering joint leakage, joint shear, cement mill reports, and three edge bearings on each size and class of pipe for review before any pipe is installed in the field. The tests for joint leakage, joint shear, and three- edge bearing are for proof of design only. Reports covering tests made on other pipe of the same size, class, and design as specified herein, and manufactured from materials of equivalent type and quality are generally acceptable.
7. The City Engineer may require the submittal of drawings, specifications, and other data showing complete details of the design, fabrication, and construction of the reinforced concrete pipe for review. These submittals shall include data on all materials proposed to be used in the pipe, the size and location of each cage of the reinforcement, joint details including reinforcement, gasket details, and test results on materials, joints, and pipe.

LENGTHS

Pipe laying lengths shall be a minimum of seven foot six inches (7'-6"). The class of pipe shall be as indicated on the approved plans. The class of pipe shall be determined to withstand loading requirements with Class III being the minimum class utilized. Bedding for concrete pipe will be a minimum of six (6) inches below the pipe to the springline or the midpoint of the pipe.

JOINT TYPE

Gaskets shall be rubber O-ring type per ASTM C361 and ASTM C443. Gaskets will be used in a bell and spigot joint. A Type 4-G Gasket is an acceptable substitute for an O-ring joint.

302.02.03 POLYVINYL CHLORIDE (PVC) PIPE MATERIAL

ALLOWABLE USE

Polyvinyl Chloride (PVC) Pipe can be used on storm sewer projects which are not under the pavement within City right-of-way.

DESCRIPTION

Polyvinyl chloride pipe shall be in accordance with the PVC Material requirements located in the Wastewater Collection Section 400 of these City Standards. All sizes of PVC pipes shall be SDR 35 or better, and shall have the ASTM specification, nominal diameter, and name or trade mark of the manufacturer imprinted on the outside of the pipe.

302.02.04 CORRUGATED HIGH DENSITY POLYETHYLENE PIPE

ALLOWABLE USE

Corrugated high density polyethylene Pipe (HDPE) maybe used on storm sewer projects which are not under the pavement within City right-of-way with approval by the City Engineer

DESCRIPTION

1. Corrugated high density polyethylene pipe (HDPE) shall be manufactured in accordance with AASHTO M294, or MP7. Clean reworked material may be used.
2. Type S pipe shall be used for storm sewer projects. Type S pipe has a full circular cross section, with an outer corrugated pipe wall and a smooth inner liner.
3. The minimum parallel plate stiffness values when tested in accordance with ASTM D2412 shall be as follows:

Table X – Minimum Parallel Plate Stiffness

Diameter (nominal)	Pipe Stiffness (minimum) (pii)
15”	42
18”	40
24”	34
30”	28
36”	22
42”	20
48”	18
60”	14

4. Pipe and resin producers shall be certified according to the Plastic Pipe Institute/Corrugated Polyethylene Pipe Association Third Party Certification Program. All corrugated polyethylene pipe, fifteen (15) inches in diameter and larger, shall contain the appropriate program mark, either an official label or permanent affixation prior to shipment.
5. All pipe shall be clearly marked at intervals no more than ten (10) feet with manufacturers name or trademark, nominal size, AASHTO specification designation, plant designation code, and date of manufacture or code
6. Minimum Size ?

JOINT TYPE

Watertight joints shall meet a laboratory test pressure of 10.8 psi per ASTM D3212 and shall have a bell and spigot or bell-bell design with an elastomeric gasket meeting the requirements of ASTM F477.

302.02.05 STORM SEWER INLETS AND STRUCTURES

ALLOWABLE USE

Reinforced concrete box culverts may be used on storm sewer projects under the pavement within City right-of-way.

DESCRIPTION

1. Reinforced concrete box culverts shall conform to the requirements of ASTM C789 or C850 depending on the cover over the concrete box culvert.
2. All concrete and steel reinforcing work shall be in accordance with the Colorado Department of Transportation Sections 601 and 602, except as modified by Section 200 of these City Standards. Additives for concrete, other than those specified in the mix design, shall not be used without prior approval of the City Engineer. When approved for use, chemical admixtures or additives shall comply with applicable ASTM or AASHTO standards. Calcium chloride or admixtures containing chloride shall not be allowed in reinforced concrete.
3. All concrete, unless otherwise specified on the plans, shall use Type II cement and have a minimum compressive strength of 4,000 psi in twenty-eight (28) days. The concrete design mix will be subject to the City's approval. An air entraining agent must be used in all concrete. Metal reinforcement shall be deformed steel bars sized according to their application by the EOR, subject to the approval of the City. All steel reinforcement shall conform to ASTM A615, Grade 60.
4. Inlet grates in streets, alleys, and areas with pedestrians shall be of a design that is safe for bicycles and pedestrians.
5. Structures, detention outlets, and inlets shall be reinforced as per the approved plans. All structures shall have steel rebar reinforcement to prevent shrinkage.
6. An exception to these City Standards is required for a a Type 13 inlet.
7. Access covers and steps shall be provided for all inlets. Access covers shall have the words "Storm Sewer, Confined Space, Entry Permit Required" cast on the cover. Access covers will be sized for twenty four (24) inch diameter openings, one (1) inch thick, designed for traffic loading. Access covers will be located above the pipelines so the City's jetting equipment can access the pipelines.

302.02.06 END SECTION AND OUTFALL MATERIAL

1. All concrete, unless otherwise specified on the plans, shall use Type II cement and have a minimum compressive strength of 4,000 psi in twenty-eight (28) days. The concrete design mix will be subject to the City's approval. An air entraining agent must be used in all concrete. Metal reinforcement shall be deformed steel bars sized according to their application by the EOR, subject to the approval of the City. All steel reinforcement shall conform to ASTM A615, Grade 60.
2. All storm sewers end sections and outfalls shall have a cast-in-place reinforced concrete headwall or a pre-manufactured flared end section as approved by the City Engineer. Pre- manufactured end sections shall be manufactured of the same materials as the pipe to which they are connected and shall meet the minimum material specifications applying to the pipe. Reference details 300-07A Standard Flared End Section and 300-07B Elliptical Flared End Section.
3. All storm sewer openings that are eighteen (18) inches or larger or subject to unauthorized entrance or trash accumulation will have a designed trash rack with a galvanized coating.

Reference details 300-07C Flared End Section Trash Rack (Circular Pipe), 300-07D Trash Rack Mounting Detail (Circular Flared End Section) 300-07E Flared End Section Trash Rack (Elliptical Pipe) and 300-07E Trash Rack Mounting Detail (Elliptical Flared End Section) for specific installation information.

302.02.07 MANHOLES

DESCRIPTION

1. All manholes shall be constructed using precast concrete sections fabricated from Type II cement and otherwise conforming to ASTM C478.
2. Manhole steps shall be polypropylene meeting the following requirements: Grade 60 steel-reinforced, corrosion-resistant polypropylene plastic that conform to ASTM C478. In addition, they shall be fabricated with positive-friction lock system for being hand driven by hammer into preformed holes.

Manholes shall be all concrete, unless otherwise specified on the plans, and shall use Type II cement and have a minimum compressive strength of 4,000 psi in twenty-eight (28) days. The concrete design mix will be subject to the City's approval. An air entraining agent must be used in all concrete. Metal reinforcement shall be deformed steel bars sized according to their application by the EOR, subject to the approval of the City Engineer. All steel reinforcement shall conform to ASTM A615, Grade 60.

3. All precast manhole cones shall be of the eccentric type. Reference detail 300-02 Standard Manhole.

MISCELLANEOUS MATERIALS

Mortar; non-shrink, non-metallic grout; and preformed plastic gaskets shall be in accordance with the Wastewater Collection Approved Materials List located in the Appendix.

CASTINGS

1. All castings for manhole, covers and frames and for other purposes must be of rough gray iron, and have a workman like finish free from blow-holes. Manhole frames and covers shall be as indicated on the Wastewater Collection Approved Materials List located in the Appendix.
2. Manhole covers shall have the words "Storm Sewer, Confined Space, Entry Permit Required" cast on the cover. Manhole covers will be sized for twenty four (24) inch diameter openings, one (1) inch thick, designed for traffic loading. Manhole covers will be located above the pipelines as shown in detail 300-05 Manhole Cover Location to allow for the City's jetting equipment to access pipelines.

302.03 INSTALLATION

302.03.01 GENERAL REQUIREMENTS

This section of the City Standards covers the furnishing and installation of all drainage improvements, storm sewers, storm inlets, manholes, headwalls, other appurtenances and all related work necessary to complete the drainage improvements. Trenching and backfill shall be done in accordance with Section 109 Utility Trenching in these City Standards and shown in detail 300-01 Reinforced Concrete Pipe Trench. The work covered by this section will not be accepted until the backfill connected with the work has been completed and approved. Any section of storm sewer line that is found defective in tests, material, alignment, grade, or joints shall be corrected.

302.03.02 PIPE INSTALLATION

Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in line. The end of the pipe will be plugged or capped with approved materials at the end of the work shift or if work stops temporarily. Pipe shall be installed working downstream to upstream with the bell end facing upstream. All pipe installed must be to the required line and grade as shown on the approved plans and checked to insure there is no variation from that line and grade. No pipe shall be laid when, in the opinion of the City Engineer, trench conditions are unsuitable, such as unstable bedding, pipe subgrade, or trench walls or the presence of contaminated soil or liquids. Shoring shall be used if trench conditions warrant based on OSHA standards.

1. Pipe shall be laid to a true line and at uniform rates of grade as shown on the approved plans. Fine grading of the trench shall proceed ahead of pipe laying.
2. The contractor shall make all pipe connections to the manholes. When connecting to existing storm drains, the contractor shall take every precaution necessary to prevent dirt or debris from entering the existing storm sewer system.
3. Bedding material shall meet the requirements outlined in the Utility Trenching chapter located in Section 109 of these City Standards.

LOWERING OF PIPE AND ACCESSORIES INTO TRENCH

All pipe, fittings, and accessories shall be carefully lowered into the trench with suitable equipment in a manner that will prevent damage to the pipe. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. Pipe and accessories shall be inspected for defects prior to being lowered into the trench. All foreign matter or dirt shall be removed from the interior of the pipe and the accessories before lowering into the trench. The pipe shall be kept clean by means approved by the City Engineer during and after installation.

CUTTING OF PIPE

The cutting of pipe for inserting into fittings, shall be done in a neat and workmanlike manner without damage to the pipe or lining and so as to leave a smooth end with beveled edges recut to match the original pipe. Flame cutting of existing ductile iron pipe shall not be allowed. Existing asbestos cement pipe (ACP) shall not be cut. An entire section of ACP shall be removed and replaced with a non-asbestos type pipe.

JOINING OF PIPE

Push on and mechanical joints shall be installed in accordance with the manufacturer's recommendations.

JOINT DEFLECTION

Storm Sewer pipes shall not have any deflections. All pipes shall be laid and maintained to the required lines and grades as shown on the approved plans. No deviation shall be made from the required line or grade except with the written consent of the City Engineer. Manholes and other necessary appurtenances shall be installed at the required locations. All pipes shall be laid to the depth shown on the Plans or as directed by the City Engineer in writing.

302.03.03 STORM SEWER INLETS AND STRUCTURES

1. All casting used shall sit flush with the surrounding concrete.

2. The bottom of all storm inlet structures shall be formed to drain to the outlet pipe as per the inlet details.
3. All storm inlet structures shall be flushed with water after completion of construction. The inlets are not acceptable if water remains in the invert of the structure.
4. The minimum size of the outlet pipe from the storm inlet structure shall be eighteen (18) inches in diameter. The outlet pipe shall be laid to provide a minimum velocity in the pipe of three (3) feet per second for the minor storm event.
5. Access covers will be located above the pipelines so the City's jetting equipment can access the pipelines as shown in detail 300-06 Type R Inlet Access Location.
6. Storm inlets and headwalls shall be either cast-in-place or precast. and require structural drawings designed by a Professional Engineer.
7. New holes for pipeline connections to existing storm inlets must be cored, not broken open with sledge hammers.

302.03.04 MANHOLES

Manholes shall be constructed of concrete in accordance with the detail 300-02 Standard Manhole. The materials, operations, excavation, and backfilling shall conform to the applicable sections of these City Standards.

MANHOLE BASES

1. Contractor may provide cast in place manhole inverts or precast manhole inverts at Contractor's option. In case of any change in alignment or elevation of manholes, Contractor is responsible for making all changes with the approval of the City Engineer.
2. All cast-in-place concrete bases for manholes shall be constructed such that they are level, conforming to the dimensions as shown on the standard details and approved plans.. Invert channels shall be smooth and semi-circular in shape conforming to the inside of the adjacent sewer section. . Storm sewer manhole inverts shall be coordinated with the City Inspector prior to installation. Invert channel to be formed or shaped with trowel to suit field conditions.
3. All precast concrete bases for manholes shall be constructed with the base and first barrel section poured monolithic, in conformance with ASTM C478, using Type II cement. The pipe penetration gaskets shall be as specified in the Wastewater Collection Approved Materials List located in Appendix I. No modification of precast sections will be permitted on the job site. All such fabrication must be accomplished at the point of manufacture. The manufacturer shall cut openings of sufficient size to receive entering pipes providing three quarter (3/4) inch annular space around the pipe or as required by the manufacturer of penetration gaskets. Inverts within the precast base shall have the same requirements as the inverts for the cast-in-place manhole bases.
4. Pipe size changes shall be accomplished by matching pipe crowns and forming the channel to accommodate the pipe size differential. The floor of the manhole outside of the channels shall be smooth and shall slope toward the channels at not less than one (1) inch per foot.

PIPE CONNECTIONS

1. Manholes shall be thoroughly bonded to the barrel of the pipe. Provide a rubber gasket on pipe barrel for reinforced concrete pipe. All connections with pipes shall be made without projections or voids. Inlet and outlet pipes shall be flush with interior manhole diameter. Reference detail 300-02 Standard Manhole.

When a storm sewer pipe is anticipated to be extended in the future, the Contractor shall install a manhole at the end of the line and install pipe stub out(s) a minimum of one joint length or up to five (5) feet beyond the ROW as directed by the City Engineer. The stub out shall be sealed with a plug at the outer end.

2. New holes for pipeline connections to existing manholes must be cored, not broken open with sledge hammers.

3. MANHOLE STEPS

1. Manhole steps shall not be installed in the grade rings. Steps shall be positioned, as shown in detail 300-02 Standard Manhole.
2. In areas where the manhole will be exposed to groundwater, damp-proofing shall be provided consisting of an approved waterproofing applied to the thicknesses and recommendations of the manufacturer. The waterproofing shall only be applied to clean surfaces free of oils, greases, and foreign matters and shall not be placed on surfaces when the ambient air temperature is less than 50 degrees Fahrenheit, unless approved by the manufacturer. See the Wastewater Collection Approved Materials List located in the Appendix.
3. Manhole covers shall be lined up with the pipeline inlet and outlet to allow the maintenance jetting equipment access to the pipelines. Coordinate with City inspector on cover placement over large diameter pipes with reference to access and manhole step locations. Placement allows for the jet nozzle of the maintenance equipment to be inserted down the manhole cover, make one ninety (90) degree bend and enter the upstream pipe. The jet nozzle is fed into the pipe to the upstream manhole and the water jet is turned on as the nozzle is pulled back through the pipeline. The dirt and water are vacuumed out of the downstream manhole into a storage tank. Reference detail 300-05 Storm Drainage Manhole Cover Location

MANHOLE RISERS

Manhole frames shall be raised using precast reinforced concrete rings or cast in place concrete; No other material will be allowed. The first step will be no lower than eighteen (18 inches from the final street grade. Drop-in type risers are not allowed for new construction. Drop-in type risers may be used on overlay projects, but only one riser may be used and it shall not exceed four (4) inches in height. All risers must have a minimum of three (3) set screws per riser. No steps are allowed on the riser section. Reference detail 300-02 Standard Manhole .

302.04 TESTING

302.04.01 GENERAL REQUIREMENTS

This section concerns the testing of storm sewer trunk lines, laterals, manholes, and appurtenances. Clean all manholes, pipes, and structures by removing sheeting, bracing, forms, soil sediment, concrete waste, and other debris. Do not discharge soil sediment or debris to drainage channels or existing storm sewer. Dispose of debris properly in a waste containment site that is acceptable to the City.

302.04.02 INFILTRATION TESTING

1. After the compaction of fill material has been completed, tested, and approved, the Contractor will check for infiltration and exfiltration in the main. This check will begin at the furthest upstream end of the system and proceed downstream in the storm sewer main from section to section. A

section shall be defined as any portion of installed storm sewer line between two adjacent manholes.

2. Visible infiltration is not allowed.

302.04.03 AIR TESTING

1. The air test shall be made when the sewer is clean. The line shall be plugged at each manhole with pneumatic plugs. Low pressure air shall be introduced into the plugged line until the internal pressure reaches four (4.0) psig greater than the average back pressure of any groundwater pressure that may submerge the pipe. At least two (2) minutes shall be allowed for the air temperature to stabilize before readings are taken and the time is started.
2. The portion being tested shall pass if it does not lose air at a rate to cause the pressure to drop from three point six (3.6) to three (3.0) psig (greater than the average back pressure of any ground water that may submerge the pipe) in less than the time listed below. If failure of the test occurs in any section, that section must be repaired and retested until satisfactory results are achieved.

Table X – Air Testing

Pipe Diameter (inches)	Minimum Allowable Minutes to hold 3.6 – 3.0 psig Pressure
4	2.0
6	3.0
8	4.0
10	5.0
12	6.0
15	7.5

3. All service plugs shall be secured in place to prevent displacement during testing operations.

302.04.04 MANHOLE LEAKAGE TEST

Manholes shall be tested by vacuum testing. Vacuum test shall be performed after assembly and backfilling, but prior to paving. Care shall be taken to effect a seal between the vacuum base and the manhole rim. Pipe plugs shall be secured to prevent movement while the vacuum is drawn. A vacuum of ten (10) inches of mercury shall be drawn. The time for the vacuum to drop to nine (9) inches of mercury shall be recorded. If preformed plastic gaskets are pulled out during the vacuum test, the manhole shall be disassembled and the gaskets shall be replaced. Acceptance shall be defined as when the time to drop to nine (9) inches meets or exceeds the following:

Table X – Manhole Leakage Testing

Diameter	Time to Drop One Inch (1”) Hg
4 ft.	60 seconds
5 ft.	75 seconds

1. Manholes will not be accepted if there is any visible infiltration when empty.
2. All manholes installed will be tested. Any manhole whose test is unsatisfactory shall be repaired and retested until satisfactory results are obtained.
3. Failure of any test is considered failure of the manhole involved. If the manhole fails the test after

repair options have been exhausted, the manhole shall be replaced

302.04.05 VISUAL INSPECTION

1. All new storm sewer lines shall be subject to inspection by lamping or other visual means. All new PVC pipe shall be subject to mandrel testing in accordance with the PVC Material requirements located in the Materials chapter of Section 3020 of these City Standards.
2. All newly constructed storm sewer lines shall be completely jetted to remove dirt and debris prior to Construction Acceptance. The contractor will be responsible for removing all of the dirt and debris from the lines during the jetting operation and will not allow any debris into any active City storm sewer line. Jetting shall be done after first lift of asphalt is completed. Please note that if City inspectors indicate a problem exists with the line or if unusual problems occur during construction, the City Engineer, at their sole discretion, may require the lines to be videotaped by City personnel or by private contractor, at the developer's expense, prior to Construction Acceptance.
3. Contractor/Developer may, at his expense, hire an independent firm to videotape the storm sewer line. A designated City employee will be assigned to observe the camera work and video tapes of the line will be supplied to the City for further review.
4. Storm manholes and storm sewer lines must be clean prior to scheduling video inspection. If rescheduling is necessary due to the fault of the Contractor, all costs for time lost on the originally scheduled camera inspection may be billed to the Contractor.
5. The storm sewer lines may be inspected by camera instead of air tested if approved by the City Engineer.

302.04.06 FINAL ACCEPTANCE REQUIREMENTS.

1. A water test for manholes may also be required by the City Engineer. This test will be subject to less than a 1"/hour rise or fall to pass.
2. Any visible infiltration which the City Engineer considers to be detrimental to the system shall be repaired in a manner approved by the City Engineer before the work will be accepted. No manhole will be accepted that has visible infiltration.
3. Upon completion of the construction, the City Engineer will carefully inspect all drainage improvements and appurtenances. Any unsatisfactory work shall be removed and replaced in a proper manner. The invert of the storm sewer pipes and manholes shall be left smooth, clean and free from obstructions throughout the entire length. Manhole rings and covers must be raised to finished grade before acceptance of the storm sewer line.
4. Prior to the issuance of Final Acceptance, all of the installed storm sewer lines shall be videotaped by City personnel. All defects found in the lines at the time of the camera operations shall be repaired prior to the City granting Final Acceptance.This work must be scheduled with the City by the Developer prior to final lift asphalt paving.

303.00 UNDERDRAINS

303.01 MINIMUM DESIGN AND CONSTRUCTION CRITERIA

1.

303.01.02 GENERAL

1. The purpose of an underdrain system is to provide a safe method of conveying groundwater via gravity to an acceptable discharge point in a storm sewer system or drainage channel. These

criteria serve to specify and outline the minimum guidelines for the design, construction, inspection and maintenance of an underdrain system.

2. Underdrain systems typically include a foundation perimeter underdrain, an underdrain service line from each lot, an underdrain service line clean-out, an underdrain main and underdrain access points.
3. Underdrain systems will be designed and constructed in accordance with the requirements of these City Standards and in accordance with the Underdrains Section in the Development Standards Chapter 15.05 of the Longmont Municipal Code. Additional criteria may be outlined during plan review as determined by the City Engineer.
4. All area underdrains and underdrain collection systems shall have a positive gravity outlet piped to an existing underdrain collection system, to a storm sewer, or to a drainage channel. The use of any conveyance system other than a gravity system, such as a lift station, must be approved by the Exception process outlined in Section 100 of these City Standards.
5. Underdrain collection systems are considered a dewatering system and require a General Purpose Water Well Permit from the Colorado Department of Water Resources.
6. A Professional Engineer must design, and stamp area underdrain systems, underdrain collection system plans, City Standard exceptions and the underdrain report. The system shall be designed with consideration of any seasonal high groundwater levels anticipated at the project site.
7. Underdrain systems are privately owned and maintained by the property owner or Home Owner's Association.
8. Only groundwater may be discharged into an underdrain system. No person(s) shall connect other sources of surface runoff to an underdrain main, underdrain service line or foundation perimeter underdrain. No person shall contribute or cause to be contributed, directly or indirectly, any pollutant or wastewater to an underdrain collection system.
9. Groundwater cannot be discharged to the sanitary sewer system.
10. Connection of an underdrain collection system to an existing underdrain collection system will be allowed only with written approval from the Owner of the receiving underdrain system.
11. Underdrain collection system shall be installed within public right-of-way.
12. Underdrain systems shall be constructed of materials identified in the Wastewater Collection Approved Materials List located in the Appendix.

303.01.03 UNDERDRAIN COLLECTION SYSTEM

1. Underdrain collection system shall consist of an underdrain main that must be a minimum of six (6) inch diameter rigid walled non-perforated pipe.
2. Underdrain mains shall be white or purple gasketed SDR-35 pipe. Other types of underdrain pipe may be used upon submittal of the pipe specification and approval by the City Engineer.
3. Six (6) inch diameter underdrain mains shall be placed adjacent to and in the same trench as sanitary sewer mains and shall have a minimum clearance horizontally of one (1) foot from the outside diameter of the underdrain main to the outside diameter of the sanitary sewer main and vertically one and one half (1.5) feet from the outside diameter of the underdrain main to the outside diameter of the sanitary sewer main . Reference detail 300-08 Sanitary Sewer and Underdrain Trench
4. Underdrain collection systems that require eight (8) inch and larger diameter underdrain mains shall be placed in a separate trench from all other underground utilities and shall meet the minimum separation requirements for other utilities. Reference the Utility Line Separation and

Crossing chapter in Section 103 of these City Standards.

5. The configuration of a single six (6) inch underdrain main shall be installed at a minimum of six (6) inches below the sanitary sewer manhole base and will require the installation of an underdrain clean-out upstream of the sanitary sewer manhole. Reference details 300-09 Underdrain Clean-out Installation and 300-10 Underdrain Clean-out.
6. Underdrain manholes are required for underdrain collection systems where three (3) or more underdrain mains intersect. The intersecting underdrain mains shall be deflected in advance of the underdrain manhole to provide a minimum three (3) feet of clearance from the outside diameter of the sanitary sewer manhole.. The underdrain manhole shall be located downstream of the sanitary sewer manhole. Reference detail 300-11 Underdrain Manhole Placement.
7. Underdrain collection systems that require eight (8) inch diameter and larger underdrain mains shall have standard manholes as access points. Manholes shall be constructed in accordance with the requirements in detail 300-02 Standard Manhole and these City Standards.
8. The outlet of the underdrain collection system shall be a gravity outfall designed to account for the possibility of backflow and blockage of the system. Erosion control is required at the outlet discharge of the system.
9. All underdrain mains shall be installed to the lines, grades, and depths specified in the approved plans. No deviation shall be made from the required line or grade except with the written consent of the City Engineer.
10. Maintenance access must be provided to all access points and discharge locations.
11. A Professional Engineer shall perform regular inspections during construction of underdrain collection system to ensure that the system is built in accordance with the approved plans.

303.01.04 SERVICE LINES

1. Underdrain service lines are installed with the underdrain collection system and shall be a minimum four (4)-inch diameter solid pipe. Underdrain service lines are required to include a clean-out for maintenance access. Reference detail 300-13 Foundation Perimeter Underdrain and Service Line Connection
2. All underdrain service lines must be connected by gravity to the underdrain main, storm sewer, drainage channel or other approved conveyance system. Reference detail 300-14 Underdrain Service.
3. Sump pumps may be installed as backup to the gravity collection system
4. The installation of a sump pump with no connection by gravity to an underdrain collection system requires an Exception per the requirements in Section 100 of these City Standards and must be approved by the City Engineer. Reference details 300-14A Underdrain Service Exception A and 300-14B Underdrain Service Exception B for exceptions approved by the City.
5. Underdrain service lines are typically installed in the same trench with the sanitary sewer line. Underdrain service lines shall be placed adjacent to and in the same trench as sanitary sewer service and shall have a minimum clearance horizontally of one (1) foot from the outside diameter of the underdrain service to the outside diameter of the sanitary sewer service and vertically oneand one half (1.5) feet from the outside diameter of the underdrain service to the outside of the sanitary sewer service. Reference detail 300-08 Sanitary Sewer and Underdrain Trench.
6. A Professional Engineer shall inspect and certify, in writing to the Public Works and Natural Resources Department, that the service lines were installed for each lot with the underdrain collection system. A City inspector will inspect the installation of the underdrain service line and the connection of the foundation perimeter underdrain to the service line according to the

approved plans. Reference details 300-13 Foundation Perimeter Underdrain and 300-14 Underdrain Service.

7. Underdrain service lines are owned and maintained by the property owner up to the underdrain main.

303.01.05 FOUNDATION PERIMETER UNDERDRAIN.

1. A foundation perimeter underdrain shall be installed as required by the geotechnical engineering report. All foundation perimeter underdrains, whether inside or outside the foundation walls shall be connected by gravity to the underdrain main via an underdrain service line. Reference detail 300-13 Foundation Perimeter Underdrain.
2. All perimeter underdrains must be a minimum four (4)-inch diameter perforated pipe.
3. A Professional Engineer shall inspect and certify, in writing, to the Chief Building Official that the foundation perimeter underdrain was built and properly connected to the underdrain service line according to approved plans.
4. a
5. Foundation perimeter underdrain systems are owned and maintained by the property owner.

303.01.06 DEWATERING INTERCEPTOR DRAIN

1. A dewatering interceptor drain is utilized during construction only and is not considered a permanent improvement and as such is not intended or designed to permanently drain groundwater.
2. The purpose of a dewatering interceptor drain is to drain perched groundwater during construction.
3. A groundwater interceptor drain is a private system installed and maintained by the Contractor.

303.01.07 AREA UNDERDRAIN

1. The purpose of an area underdrain is to mitigate site groundwater through a perforated perimeter underdrain.
2. Perforated pipe cannot be located in the ROW and requires a dedicated outlot or easement. If the area underdrain crosses the ROW, solid pipe shall be connected to the perforated pipe and extended through the width of the ROW.
3. An area underdrain is a private system owned and maintained by the property owner and/or Home Owners Association.

303.01.08 ACCESS POINTS

Access is required for maintenance of the underdrain collection systems and must be installed at all changes in grade, size and alignment. Access to underdrain collection systems cannot connect to or surface in sanitary sewer manholes.

1. CLEAN-OUT
    a. Clean-outs are required to be installed on straight run underdrain mains where there are two pipes or less.

b. Clean-outs for six (6)-inch diameter underdrain mains must be a minimum diameter of 6-inches

c. Clean-outs for six (6)-inch diameter underdrain mains must be spaced a maximum distance of two hundred (200) feet between clean-outs and shall be placed on the upstream side of any sanitary sewer manhole installed in a shared trench.

d. Clean-outs shall be PVC pipe in accordance with the PVC Material requirements located in the Wastewater Collection Section 400 of these City Standards

e. Clean-outs located in the ROW are required to install a traffic rated clean-out box over the six (6) inch clean-out cap and include a concrete collar designed by a Professional Engineer to meet traffic loadings.

f. Reference details 300-09 Underdrain Clean-Out Installation and 300-10 Underdrain Clean-Out

2. UNDERDRAIN MANHOLES

a. Underdrain manholes are required for underdrain collection systems where three (3) or more underdrain mains intersect and shall be precast reinforced concrete structures. Provide precast submittal to City Engineer for review.

b. For intersecting mains six (6) inches and smaller in diameter, a two (2) feet inside diameter underdrain manhole is required. Reference details 300-11 Underdrain Manhole Installation and 300-12 Underdrain Manhole.

c. For intersecting mains eight (8) inches and larger in diameter, a four (4) feet inside diameter standard manhole is required. Reference detail 300-02 Standard Manhole.

d. Underdrain manholes shall be placed a minimum of three (3) feet from the outside diameter of any sanitary sewer manholes.

e. Underdrain manholes must be spaced no farther than four hundred (400) feet apart, unless approved by the City Engineer.

303.02 REPORT CRITERIA

303.02.01 GENERAL REQUIREMENTS

If based on recommendations made in the geotechnical engineering report for a site, an underdrain collection system is required then the Developer shall submit an underdrain report for review and approval.

303.02.02 UNDERDRAIN REPORT REQUIREMENTS

1. The purpose of the underdrain report is to identify and define solutions to groundwater problems on the site.
2. The report must identify groundwater conditions that exist on the site prior to development and expected groundwater conditions after development.
3. The report must include supporting documentation such as drawings, figures, calculations and tables
4. The report must include a cover letter presenting the design for review.

5. The report must be prepared and sealed by a Professional Engineer licensed in the State of Colorado.
6. Groundwater test bores must be done between April and October.

303.02.03 REPORT CONTENTS

1. **General Location and Description** - township, range, section, ¼ section, local streets within and adjacent to the subdivision/project site, names of surrounding developments, area in acres, ground cover, irrigation facilities, etc.
2. **Intent of the Report** - present the need for the underdrain system based on the referenced geotechnical engineering report. Define ownership and describe maintenance responsibilities for the underdrain system.
3. **Existing Condition** - discussion of the existing site cover, type of soils, reference and discussion of the recommendations for groundwater mitigation per the geotechnical engineering report and a discussion of the impact on the groundwater based on the proposed underdrain design.
4. **Underdrain Design** - include a discussion of the following:
    a. The proposed groundwater mitigation based on the geotechnical engineering report recommendations.
    b. The design concept for the proposed underdrain collection system.
    c. The criteria selected to calculate and design the underdrain collection system.
    d. The installation, size and materials for the proposed underdrain collection system
    e. Underdrain exceptions if required (lift stations, and sump pumps, with no underdrain collection system, etc.)
    f. Underdrain main calculations, plans and details including engineered designs for exceptions
    g. Approval from existing underdrain collection system owner for connection of proposed system to the existing system is required.
5. **Underdrain Maintenance** - discussion of ownership and maintenance responsibilities of all structures, underdrain main, sump pumps or lift stations, if any, and the underdrain service lines from the main to the buildings. The Owner/Homeowners Association (HOA) will be responsible for maintenance and repairs for the underdrain collection system and outfall at discharge locations including erosion protection. Reference Underdrain Construction notes in Appendix C
6. **Conclusion** - include a discussion of the following:
    a. Summary of the effectiveness of the proposed underdrain design to control groundwater.
    b. Effect of the underdrain collection system discharge.
    c. Compliance with standards and municipal code.
    d. Compliance with the approved master plan.
7. **References** - reference all criteria and technical information used.
8. **Appendices**
    a. Underdrain pipe sizing calculations and flow calculations at the specific design points including any existing flows contributing to the system.
    b. Erosion Control sizing calculations at discharge location.
    c. Calculations and details for any proposed underdrain system facilities such as lift station, etc.

d. Underdrain map.

9. **Underdrain Details**

   a. Reference underdrain details 300-08 through 300-14

303.03 CONSTRUCTION ACCEPTANCE

303.03.01 GENERAL

1. The City will not issue Construction Acceptance for the underdrain collection system until receipt of the Professional Engineer's Underdrain Certification, dye testing and/or video inspection reports and record / as-built plans.
2. For Final Acceptance, the Developer/Owner is required to obtain an Infrastructure Permit from the City for underdrain collection systems installed in the public ROW.

303.03.02 RECORD (AS-BUILT) DRAWINGS.

1. Record drawings /as-builts for the underdrain collection system shall be attested to by a Professional Engineer registered in Colorado and submitted to the City prior to the issuance of construction acceptance associated with the underdrain collection system.
2. "As-built" drawings shall include the vertical and horizontal alignment of the underdrain collection system, underdrain service lines to each lot, the location of maintenance access points (cleanouts or manholes) including invert elevations, appropriate profiles and underdrain details.