

**TOWN OF LYONS
SECTION 2
STORM DRAINAGE SYSTEM**

2.1 DESIGN CRITERIA

2.1.1 SUBMISSIONS:

1. **Storm Drainage Public Improvement Plans** : The public improvement plans shall describe the proposed storm drainage system in adequate detail so as to serve as construction drawings as well as satisfying the requirements of this section.
2. **Preliminary Storm Drainage Report:** A storm drainage report is required by the subdivision regulation with the Preliminary Plan Submittal. The purpose of the preliminary storm drainage report is to present a conceptual plan for the proposed storm drainage system prior to actual sizing of facilities. The preliminary drainage report shall include, but not be limited to the following:
 - a) A map of the watershed in which the development is located with sufficient detail to identify the flow-paths of storm drainage to and from the development to a major drainage way.
 - b) Identify nearby irrigation ditches and reservoirs to be affected by storm drainage from the development.
 - c) Coefficients and calculations for determining historical and developed flows for the minor (2-year) and the major (100 year) storm.
 - d) The storm drainage public improvement plans which shall include:
 1. The drainage area boundary and drainage sub-area boundaries in which the subdivision is located.
 2. Existing and proposed contours at two foot intervals where the average cross slope is less than ten percent and at five foot intervals where the cross slope exceeds ten percent.
 3. Finish grade for all lots and streets indicating flow directions.
 4. Existing drainage facilities and structures including irrigation ditches, roadside ditches, drainageways and culverts.
 5. Proposed drainage facilities and structures including piping and open drainageways, inlets, manholes, culverts and other appurtenances.
 6. The proposed outfall points for runoff from the subdivision.
 7. Routing and accumulative flows at various critical points for the minor and the major storm runoff.
3. **Final Storm Drainage Report:** The final storm drainage report shall be submitted with the final plat as a further development of the preliminary storm drainage report and shall include the following:
 - a) Street capacity calculations at critical street sections for the minor and major storm runoff.

- b) Hydraulic grade lines for all storm sewers for the minor and major storms.
- c) Backwater profiles for open channel for the minor and major storm runoff with input data and procedures used for the calculations.
- d) Results of culvert design calculations with all input data and procedures used.
- e) Inflow and outflow design hydrographs for detention facilities.
- f) Stage volume curves, outlet rating curves, spillway rating curves, and the method used to determine the rating curves.
- g) An erosion- control plan where soil and slope conditions dictate. This plan should indicate methods to be used during and after construction to control erosion and sediment in the development.
- h) A statement, which describes the safety hazards that may be associated with the various drainage structures and the provisions that have been included in the design to minimize safety hazards.

2.1.2 METHOD: runoff from minor and major storms must be computed before the drainage system can be destined. Two computational techniques are recommended for determining runoff using rain intensities from Table 2-1.

1. Rational Method: This method is recommended for storm sewer, culvert design, and overland flow from areas generally less than 200 acres. The Rational Method is applicable to both minor and major storm runoff.
2. Colorado Urban Hydrograph Procedure (CUHP): This method is recommended for areas from 50 to 40000 acres with relatively flat slopes that will undergo significant urbanization.

2.3 CRITERIA: The following design criteria shall be utilized in the design of the subdivision storm drainage system:

1. **Streets and Gutters:** Allowable street and cross street flow for the 2 year and 100 year storm is given in Table 2-2. Culverts should be **sued used** when it is necessary to transport runoff across streets without curb and gutter. Minimum grade for all gutters shall be 0.4 percent.
2. **Storm Sewers:** The storm sewer systems and subsequent storm inlets shall commence at all locations where the allowable street capacity is exceeded or wherever ponding of water is likely to occur due to the 2- year storm.
 - a. Pipe size: The average flow velocity in any conduit shall not be less than 2.0 feet/second. All storm sewers shall be of sufficient structural strength to withstand and AASHTO H-20-44 loading. The minimum allowable pipe sized for storm sewers shall be 15 inches for all sewers or a minimum cross-sectional area of 1.23 square feet. If non- circular sections are used

the minimum dimension shall be 12 inches to provide space for cleaning equipment.

b. Manholes: Manholes shall be placed wherever there is a change in size, direction, elevation or slope, where there is a junction of two or more systems or laterals, or when the maximum allowable distance is reached, as follows:

Vertical pipe dimension	Max. allowable distance between Manholes and/or cleanouts
15 - 36 inches	400 feet
37 - 60 inches	500 feet
61 inches and larger	750 feet

c. Inlets, outlets, and curb openings: Storm sewer inlets shall be designed so that the encroachment of gutter flow on the street or intersection does not exceed requirements of Table 2-2.

The only inlet type allowed on streets with curb and gutter will be the Colorado Department of Highways Type R inlet. For drainageways other than streets *(for example, parking lots, medians, sump basins), the Colorado Department of Highways Type D area inlet shall be used. See Figure 2.3 for details.

All curb openings shall be installed with the opening at least 2 inches below the gutter slope.

The outlet pipe of the storm inlet shall be sized on the basis of the theoretical capacity of the inlet, with a minimum diameter or equivalent diameter of 15 inches.

Because of possible debris plugging, pavement overlaying, parked vehicles, and other factors which decrease inlet capacity, the reduction factors to be used shall be:

Drainage of condition Of street	Inlet type	Percentage of theoretical capacity
Sump	Comb. curb opening	80
Continuous grade	(R) and area inlet (D) Curb opening (R)	80

Continuous grade refers to a street that has continuous slope past the inlet. Sump conditions exist whenever water is restricted to the inlet area because the inlet is located at a low point.

3. **Culverts:** Culverts may be of any shape and construction as required by existing topographic features. The size, shape, location, and type of construction of culverts shall be subject to the approval of the Town Administrator.

a. Culvert design: The required size of the culvert shall be based upon adequate hydraulic design analysis. However, to minimize maintenance

requirements, the minimum allowable culvert size of r culverts under County roads shall be 18" for circular culverts or a minimum cross sectional area of 1.77 square feet. For culverts in road wide ditches, the minimum size shall be 15" for circular culverts or a 1.23 square foot minimum cross sectional area.

Culverts shall be analyzed to determine whether discharge is controlled by inlet or outlet conditions for both the minor storm discharge and the major storm discharge.

Culvert installations shall be designed with an emergency overflow for the major storm on all streets other than major arterials. Culverts under all streets shall have sufficient capacity to pass the runoff from the major storm and maintain the allowable cross street flow as presented in Table 2-2.

The recommended maximum headwater- to- diameter ratios are:

<u>Storm frequency</u>	<u>Headwater to diameter (HW/D)</u>
10 year	Equal to or less than 1.0
100 year	Equal to or less than 1.5

The values may be exceeded provided excessive ponding above culvert entrances will not cause property or roadway damage, culvert clogging, saturation of fills, detrimental upstream deposits of debris, or inundation of existing or future utilities and structures.

b. Culvert inlets and outlets: Culvert inlets shall be designed to minimize entrance and friction losses. Inlets shall be provided with either flared end sections or headwalls with wingwalls. Projecting ends will not be acceptable. For large structures, provisions shall be made to resist possible structural failure due to hydrostatic uplift forces. Culvert outlets shall be designed to avoid sedimentation, undermining of the culvert, or erosion of the downstream channel. Outlets shall be provided with either flared end sections or headwalls with wingwalls. Additional outlet control in the form of riprap, channel shaping, etc., may be required where excessively high discharge velocities occur.

4. **Open Channels:** Natural and man made, lined or unlined open channels are acceptable. Preferably, open channels should be unlined with grass cover, have slow flow characteristics, be wide and shallow, and be natural in their appearance and functioning. However, lined channels will be required where constrictions or excess velocities dictate. All channels must be designed to handle minor and major flows.

This design must give full consideration to esthetics, safety, sediment deposition, and scour, as well as hydraulics.

a. Unlined Channels: For the 100 year storm design flow the following design criteria apply.

1. Side Slopes: Minimum is 5:1. maximum is 4:1 to allow for mowing equipment.

2. Depth: The maximum depth should be limited to 3.5 feet, through 4.0 feet is acceptable where good maintenance can be expected and where durations of peak flows are short lived.
3. Bottom width: The bottom width should be at least 6 to 8 times the depth of flow; 20 to 30 times the depth is common.
4. Velocity: maximum velocities shall be those normally specified for hydraulic design to provide for an economical cross section and prevent scour problems.
5. Channel Slope: Grass- lined channels, to function well, normally have slopes of from 0.2 to 0.6 percent. Where the natural topography is steeper than desirable, drops should be utilized.
6. Curvature: Minimum center- line curve radius shall be twice the design flow top width or 100 feet, whichever is greater.
7. Design discharge freeboard: Minimum shall be in general, 1 to 2 feet.
8. Trickle Channels: Trickle channels or underdrain pipes are required on all grassed channels in urban areas. Trickle channels are preferred because of maintenance. Waterways that are normally dry prior to urbanization will often have continuous base flow after urbanization because of lawn irrigation. A trickle channel is subject to erosion, and must therefore be amply protected with appropriate erosion control devices. Trickle channels should be designed to carry 0.5 to 1 percent of the major storm flow.

b. Lined Channels: Lined channels must be designed to withstand the various forces and actions that tend to overtop the bank, deteriorate the lining, and erode unlined areas. Design shall be in accordance with standard hydraulic design procedures for lined open channels.

5. **Detention:** Storm water detention facilities shall be required where release of storm water will adversely affect areas downstream of development. In general, detention will be required when development will significantly change the historic drainage conditions.

- a. Hydraulic Design: The CUHP is the preferred method for detention design and determination of detention volume. For small basins the method presented in the Denver Regional Council of Governments" Urban Storm Drainage Criteria Manual (1969) may be used. Since the Rational Method does not produce a hydrograph of design purposes, its use is not recommended except for very small basins. Release rates from the detention structures shall not exceed the historical peak runoff rate for the 100- year storm.
- b. Maintenance: The design of a detention structure should include 1) plans for controlling debris and sediment, 2) plans for controlling trickle flows to prevent muddy wet areas, and 3) provisions for adequate slope protection.
- c. Emergency Spillway: The emergency spillway should be designed to avoid overtopping by storms in excess of the major storm, and to avoid overtopping the structure due to clogging of the outlet during the major

storm. A minimum of 2 feet of freeboard will be required between the spillway and the top of the embankment. These emergency provisions should include an easement for the overflow path to a major drainageway.

d. **Outlet Facilities:** Outlet facilities should be adequate to provide for evacuation of the detention structure within 30 to 36 hours following the major storm. This will allow for multiple day events, which are common to this region.

2.2 SPECIFICATIONS

2.2.1 SCOPE: The work covered by these specifications concerns the furnishing of all labor, equipment and materials and performing all operation for the construction of storm drainage system including streets and gutters, storm sewers, culverts, open channels and detention structures in accordance with these specifications and the Standard Design Drawings in paragraph 2.5.

2.2.2 GENERAL REQUIREMENTS : Work shall be done in accordance with engineered construction plans prepared under the direction of a professional engineer and approved by the Town Administrator. Plans shall conform to the Town's minimum design standards. Where work is to be done on an irrigation ditch, the approval of the ditch owner is required prior to approval by the Town Administrator. Separation of water mains, storm sewer lines, and sanitary sewer lines, general excavation, trenching, backfill and compaction requirements are specified in the General Specifications, Section 7.

2.2.3 MATERIALS :

1. **Pipe Specifications:**
 - a: **Concrete Pipe:** Concrete pipe and fittings shall conform to specifications for "Reinforced Concrete D-Load Culvert Storm Drain and Sewer Pipe" ASATM Designation C-655-70T and/or ASTM Designation C-76-70 whichever is designated on the plans or in the Special Provisions and as modified herein: Crushing strength requirements for non-reinforced concrete pipe and fillings shall exceed the minimum strength as set forth in ASTM Designation C-14-70 Table 2, by 200 pounds when tested for "Three Edge Bearing", in accordance with ASTM Designation C-497-70a. Pipe joist may be either tongue and grooved or bell and spigot. Tongue and grooved shall be cotton fabric diapered and sealed with 1:2 Portland cement sand grout. Bell and spigot joints shall be conformed to the U.S. Bureau of Reclamation Type R-4 using flexible water-tight rubber gaskets conforming to ASTM Designation C-443-70. Type II cement containing not more than 5% tricalcium aluminate in accordance with ASTM Designation C-150 shall be used in the manufacture of all pipe. Pipe seconds, if approved by the Town representative on an individual basis, may be used outside the rights of way of collector or arterial streets and outside the flow lines of residential streets.

b. Corrugated Metal Pipe: Corrugated metal pipe, fittings and bands shall be fabricated in accordance with AASHO M-36 specification and furnished according to the size and gauge designated on the plans or in the Special Provisions. Coupling bands shall be the same metal thickness as the conduit. Special fittings and elbows shall be the same metal thickness as the conduit to which they are joined and conform of the applicable requirement of AASHO M-36. Sections on which the spelter coating has been damaged shall be either re-galvanized, as provided under AASHO M-36, or painted with one full brush coat of a zinc rich paint (Military Specification MIL-P21035) on properly cleaned surfaces. Round flexible conduits 54" in diameter and larger shall be preformed to an elliptical shape by elongating the vertical axis 5%. Elongation shall be maintained in the field, by struts, until backfilling is completed.

2. **Manholes:** Manholes shall be constructed in accordance with the specification of 5.2.3, paragraph 2.
3. **Storm Drain Inlets:** Inlets shall be Colorado Department of Highways Type "R" or Type "D" as called for in the approved plans. See Figures 2-2 and 2-3.
4. **Plugs:** A water-tight compression plug, as recommended by the manufacturer, shall be installed to seal all dead ends and wyes. At all dead ends and wyes, a 9 gauge steel wire shall be attached to the plug and extended vertically to within 12" of finish grade, where the wire shall be attached to a 2" x4" x 24" section of timber.

2.3 **CONSTRUCTION**

2.3.1 GENERAL REQUIREMENTS: Section 7, GENERAL SPECIFICATIONS shall be followed except as modified in paragraph 2.3.2.

2.3.2 SPECIFIC REQUIREMENTS: The following specific requirements shall be followed in the construction of the storm drainage system:

1. **Pipe Installation:** Lines shall be constructed continuously upgrade from an existing manhole or outlet. Special care shall be taken to lay pipe to exact line and grade. Pipe bedding material shall be placed in the trench bottom, to the thickness specified to provide a uniform and continuous bearing support for the pipe at every point between bell-holes. Preparatory to making pipe joints, all surfaces of the joint shall be clean and dry. Lubricants shall be used as recommended by the pipe manufacturer. The pipe shall be set in position and checked for line and grade using care to keep the joint absolutely free of dirt. When final grade is approved by the Town Inspector, the joint shall be carefully pushed home using appropriate methods of leverage. Care shall be taken so that the bell end of the pipe will not be deflected to the extent that the

gasket is pinched or rolled. Adjustment in line or grade may then be made by working the bedding material around the pipe. Tongue and groove joist shall be sealed by means of a mortar grout held in place with cotton fabric diapers. If O-ring gaskets are used, immediately after completing the joint, the seating of the gasket shall be checked around the entire circumference of the pipe, by visual and finger inspection. The pipe shall be secured in place by installation of the bedding material tamped under and along the pipe barrel up to spring-line.

All sewers shall be kept thoroughly clean and free from gravel, dirt and debris. Whenever work ceases for any reason, the unfinished end of the pipe shall be securely closed with a temporary tight fitting plug.

The Town Inspector shall be notified at least twenty-four hours in advance of when pipe is to be laid in any trench. No pipes shall be covered until they have been inspected by the Town Inspector.

2. **Manholes and Cleanouts:** Construction of manholes and cleanouts shall be in accordance with 5.2.4, paragraph 4, and the referenced Standard Drawings, Figures 5-3 and 5-4.
3. **Connections to Existing Manholes:** Connections to existing manholes shall be accomplished in accordance with 5.2.4. paragraph 5.
4. **Open Channels and Special Structures:** All work shall conform to details shown on the approved plans and accompanying specifications. Construction shall be accurately done to line and grade by using construction stakes placed by field parties under the supervision of an engineer or land surveyor registered in the State of Colorado. The contractor is responsible for placing and maintaining adequate barricades, signs, and warning devices to protect workers and the public.
5. **Restoration and Clean Up:** The Contractor shall restore or replace all removed or damaged paving, curbing, sidewalks, gutters, sod, shrubbery, fences, irrigation ditches, pipe, or other structures or surfaces to a condition equal to that before the work began and to the satisfaction of the Town Inspector. The construction site shall be left clean and orderly at the end of each work day.

2.4 TESTING

Final acceptance of the sewer line shall be based on an inspection covering all items in this specification. The inspection shall be done in an appropriate manner by the Contractor. Testing of all lines shall be performed by the Contractor in the presence of the Town Inspector. All lines shall be lamped and a sewer ball of appropriate diameter may be required to be forced through the line by water at the discretion of the Town Inspector. The Contractor shall remedy, at his own expense, any poor alignment or any other defects in workmanship or materials as found by the Town Inspector. Final acceptance will be based on re-inspection of the sewer after the appropriate repairs and corrections are completed.

2.5 **STANDARD DESIGN DRAWINGS**

- Figure 2-1 Intensity Duration Curves for Lyons, Colorado
- Figure 2-2 Colorado Department of Highway "R" Inlet
- Figure 2-3 Colorado Department of Highway Type "D" Inlet