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<td>Volumes</td>
<td>( V_5 = (36 , C_t) , A )</td>
<td></td>
<td>( V_{100} = (66 , C_t) , A )</td>
<td>6.2</td>
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<tr>
<td>Release Rates</td>
<td>( Q_5 = 0.2 , A )</td>
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<td>( Q_{100} = 1.0A )</td>
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<tr>
<td>Froude Number</td>
<td>( N_f = \frac{v}{\sqrt{(g \cdot dh)}} )</td>
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<td></td>
<td>1.7 and 5.2</td>
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<td>Hydraulic Depth</td>
<td>( a / w )</td>
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<td>5.2</td>
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<td>Manning's Equation</td>
<td>( Q = \frac{1.49 \cdot a \cdot R_h^{2/3} \cdot S^{1/2}}{n} )</td>
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<td>Overland Flow Time</td>
<td>( t_o = \frac{L}{60 \cdot v} )</td>
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<td>Overland Flow Time</td>
<td>( t_o = \frac{0.395 \cdot (1.1 - C_s) \cdot L^{1/2}}{S} )</td>
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<td>Rational Equation</td>
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<td>4.4</td>
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<td>( T_c = t_o + t_i )</td>
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<td>Watershed Inches of Runoff</td>
<td>( WIR = 0.9 \cdot C_i^3 + 1.19 \cdot C_i^2 + 0.78 \cdot C_i )</td>
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<td>Orifice Flow</td>
<td>( Q = C_d \cdot a \cdot (2g^*h)^{1/2} )</td>
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<td>Pond Volume</td>
<td>( V_0 = \frac{(A_0 + A_1 + (A_0 \cdot A_1))^{1/2}}{3} \cdot (d_1 - d_0) )</td>
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<td></td>
<td>( V_1 = \frac{(A_1 + A_2) \cdot (d_2 - d_1)}{2} )</td>
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<td>Suppressed Weir</td>
<td>( Q = 3.33 \cdot B \cdot h )</td>
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<td>Triangular Weir</td>
<td>( Q = 2.5 \cdot \tan(\theta/2) \cdot h )</td>
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<tr>
<td>Symbol</td>
<td>Description</td>
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<td>Θ</td>
<td>Angle of the Triangular Weir Opening in degrees</td>
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<tr>
<td>a</td>
<td>Area of Flow in square feet</td>
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<td>Tributary Area in acres</td>
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<td>Area of Pond at bottom of pond in square feet</td>
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<td>Area of Pond at depth number 1 in square feet</td>
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<tr>
<td>A₂</td>
<td>Area of Pond at depth number 2 in square feet</td>
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<td>B</td>
<td>Width of Weir Opening in feet</td>
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<td>C</td>
<td>Runoff Coefficient (expressed as a decimal point)</td>
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<td>Coefficient of Discharge – 0.60 approximates most orifices used for detention pond applications.</td>
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<td>Composite percentage of impervious area (expressed as a decimal point)</td>
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<td>Depth or Elevation at the Bottom of the Pond in feet</td>
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<td>d₁ or d₂ or d₃</td>
<td>Depth or Elevation at Stage or Elevation 1, 2, 3, etc. in feet</td>
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<td>Head (Height of Water from the bottom of weir opening, or center of orifice or pipe)</td>
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<td>Travel Distance in feet</td>
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<td>Flow in cfs</td>
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<td>t₀</td>
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<td>Channel or Conduit Flow Time in minutes</td>
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<td>Volume in cubic feet</td>
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<td>Top Width of Flow in feet</td>
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<td>y</td>
<td>Depth of Flow in the deepest part of the channel in feet</td>
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<td>Reciprocal of the Cross Slope as a decimal point (i.e. 0.02 = 2 percent)</td>
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<tr>
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<tr>
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</tr>
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<td>square mile</td>
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### Where:

- cf: cubic feet
- cfs: cubic feet per second
- cm: centimeters
- ft/sec: feet per second
- gpm: gallons per minute
- lb.: pound
- MG/D: million gallons per day
- mph: miles per hour
- sq.: square
SECTION 1.0
INTRODUCTION

1.1 TITLE
This Manual together with all future amendments shall be known as the City of Englewood Storm Drainage Criteria Manual, hereinafter called the Manual.

1.2 PURPOSE
The purpose of the Manual is to provide minimum standards to safeguard the health, property and public welfare through the proper control and handling of storm drainage flows and discharge.

This Manual is intended to establish similarity and consistency for the design, presentation, and review of storm drainage improvements within the City of Englewood, Colorado. The design guidelines contained in this Manual are intended for use as engineering guides in the solution of drainage problems. Following the principles and practices, stated within, should facilitate the design, submittal, and review process. The standards and specifications contained within are intended to provide a consistent, adequate, and coordinated approach for dealing with drainage issues in order to serve and protect the people who benefit from these facilities.

The criteria contained in this document provide adopted standards for the more frequent construction and development issues. It is impossible to provide standards for every issue, so good engineering judgment will be required when issues arise that are not addressed in this Manual.

The questions to be considered by the designer and the reviewer when encountering these situations shall be:
• Will the safety of the affected property owners adjacent to and downstream from the proposed facilities be enhanced or maintained?
• Will the intended purposes for the proposed improvements be met?
• Will the operating and maintenance costs be kept at reasonable levels?
• Will the installation costs be kept at reasonable levels?
• Will the proposed construction be compatible with surrounding existing and proposed improvements?

1.3 AMENDMENTS
The policies and criteria presented herein are basic guidelines which may be amended in the future as new technology is developed, or as new regulations are adopted, and/or as experience gained in the use of this document indicate a need for revision. Amendments will be applicable to all drainage studies submitted after the effective date of amendment. However, final drainage reports which are submitted for approval within sixty days after the effective date of amendment and which have prior approval of a preliminary drainage report are exempt from the amendments.

1.4 AUTHORITY
1) General
A municipality's inherent police powers enable it to enact ordinances that serve the public's health safety, and general welfare. These regulations together with future amendments have been adopted as the Englewood Storm Drainage Criteria Manual pursuant to the City of Englewood Municipal Code, Title 12 – Chapter 5, titled “The Englewood Storm Water Utility and Enterprise Fund".
2) **Failure to Comply**
   It shall be deemed a nuisance to fail to comply with any provision of the Englewood Drainage Criteria Manual. Any person, corporation, partnership, or other entity violating any provision of the Manual shall be subject to Title 15 of the Englewood Municipal Code.

3) **Stop Work Orders**
   Whenever any work is being performed contrary to any provision of the Manual, the Public Works Director or designee may order the work stopped by notice in writing served on any person engaged in doing or causing such work. Any person shall forthwith stop such work until authorized by the Director of Public Works or designee in writing to proceed with the work. It is unlawful to do or perform any work in violation of such stop order.

4) **UDFCD**
   It is recognized that certain projects financed wholly or in part with county, state, Urban Drainage and Flood Control District (UDFCD), or federal funds may be subject to standards prescribed by those agencies. Such standards may be greater or less than the City of Englewood standards.

5) **Variances**
   Variances will be considered on a case-by-case basis. Whenever there are practical difficulties involved in carrying out the provisions of the Manual, the Public Works Director may grant variances for individual cases, provided that the Public Works Director shall first find that special circumstances make these procedures impractical and that the variance is in conformance with the intent and purpose of the Manual, and providing that such variance does not lessen the intent of the design requirement or the level of safety, service and quality intended by the Manual.

   The Public Works Director shall require that sufficient evidence or proof be submitted to substantiate any variance request.

   If upon review and denial of any variance request, the Developer or Design Engineer may appeal to City of Englewood Water and Sewer Board.¹

### 1.5 DRAINAGE LAW

Drainage engineering and design revolves around drainage law as well as the physical laws of gravity and nature. An excellent summary of the general principles of Colorado drainage law made by the courts as well as the legislature have been summarized in the 2001 Urban Drainage Flood Control District Drainage Criteria Manual (Volume 1 – Drainage Law).

Summaries of certain key tenets of the Colorado drainage law follow:

- The owner of upstream property possesses a natural easement on land downstream for drainage of surface water flowing in its natural course. The upstream property owner may alter drainage conditions so long as the water is not sent down in a manner or quantity to do more harm to the downstream land than formerly. **Bittersweet Farms, Inc. v. Zimbelman, 976 P.2d 326 (Colo. App. 1998).**

- A natural watercourse may be used as conduit or outlet for the drainage of lands, at least where the augmented flow will not tax the stream beyond its capacity and cause flooding of adjacent lands. **Ambrosio v. Pearl-Mack Construction Co., 351 P.2d 803 (Colo. 1960).**

- Ditch corporations that own ditches owe a duty to those property owners through which their ditches pass to maintain their ditches using ordinary care so as to prevent damage to adjoining real property. **Oliver v. Amity Mutual Irrigation Co., 994 P.2d 495 (Colo. App. 1999).**

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¹ All appeals regarding floodplain or floodway issues must be made to the Planning and Zoning Commission.
• In imposing conditions during the land-use approval process, no local government shall require an owner of private property to dedicate real property to the public or pay money to a public entity in an amount that is determined on an individual and discretionary basis, unless there is an essential nexus between the dedication or payment and a legitimate local government interest and the dedication or payment is roughly proportional both in nature and extent to the impact of the proposed use or development of such property. 29-20-203 C.R.S.

• A professional engineer is required not only to serve the interests of his or her employer/client but is also required, as his or her primary obligation, to protect the safety, health, property, and welfare of the public. Rule I 2. of the Colorado Rules of Professional Conduct of the State Board of Registration for Professional Engineers and Professional Land Surveyors.

• Colorado has statutory or natural flow rule that places a natural easement or servitude upon the lower land of the drainage of surface water in its natural course. The natural flow of the water cannot be obstructed by the servient owner to the detriment of the dominant owner. The owner of the upper lands has an easement over lower lands for drainage of surface water and natural drainage conditions can be altered by the upper land owner provided the water is not sent down in a manner or quantity to cause more harm than formerly. Hankins v. Borland 163 Colo. 575, 431 P.2d 1007 (1967); H. Gordon Howard v. Cactus Hill Ranch Company, 529 P.2d 660 (1974); Hoff v. Ehrlich, 511 P.2d 523 (1973); Ambrosio v. Perl-Mack Construction Company, 143 Colo. 49, 351 P.2d 803 (1960).

1.6 PERMITS

Depending on the type of construction, type of improvement, and location of work, different permits will be required to complete the project. The following is a list of possible (but not necessarily a complete list of) permits required by concerned organizations:

City of Englewood:
  □ Building And Safety Division
    ○ Building Permit
    ○ Demolition Permit
  □ Department of Community Development
    ○ Flood Plain Zoning Permit
    ○ Flood Plain Development Permit
  □ Department of Public Works
    ○ Right-of-Way Permits
      • Public ROW Excavation Permit
      • Public ROW Concrete Permit
    ○ Storm Water Management Permit
    ○ Small Lot Grading Permit

State of Colorado:
  □ Colorado Department of Transportation
    ○ Utility Permit
  □ Colorado Department of Health
    ○ Stormwater Discharge Permit

United States:
  □ Army Corp of Engineers
    ○ 404 Permit to Disturb Wetlands
1.7 DEFINITIONS AND ABBREVIATIONS

The following list contains some of the technical terms and abbreviations used in this Manual:

404 Permit – A permit under Section 404 of the Federal Clean Water Act that is required for any activities impacting "waters of the United States and jurisdictional wetlands" from the U.S. Army Corps of Engineers.

A – Area
Ac – Acres
Base Flood – The flood caused by a 100-year storm event.
BFE - Base Flood Elevation—the water surface elevation for the 100-year flood.
BMPs – Best Management Practices – physical, structural, nonstructural, and/or managerial practices that are intended to prevent, mitigate, or reduce pollution of stormwater.
C – Coefficient of runoff that is a factor of the percentage of the impervious area and antecedent moisture conditions as used in the rational equation.
CCR – Colorado Code of Regulations
CRS – Colorado Revised Statutes
cfs – Flow rate of water measured in cubic feet per second.
Ct – Percent of impervious area
City – City of Englewood, Colorado, and its agents, representatives, and employees acting on its behalf.
CDOT – Colorado Department of Transportation
CDPS – Colorado Discharge Permit System – Colorado’s version of the NPDES program.
CLOMR – Conditional Letter of Map Revision
COE – US Army Corp of Engineers
Contractor – A person, partnership, corporation, or other legal entity who undertakes to construct, install, alter, move, remove, trim, demolish, repair, replace, excavate, or add to any improvements covered by this Manual, or any utility, or any other facility that requires work, workers, and/or equipment in the process of performing the above named operations.
CMP – Corrugated Metal Pipe
CMPA – Corrugated Metal Pipe Arch
CUHP – Colorado Urban Hydrograph Procedure
CWB – Constructed Wetlands Basin
CWC – Constructed Wetlands Channel
CWCB – Colorado Water Conservation Board
CWQCD – Colorado Department of Health and Environment, Colorado Water Quality Control Division
D – Depth (measured in feet)
d – Diameter of pipe (measured in inches)
d50 – Mean particle or stone size (identified by diameter or dimension), where the mean is determined by weight.
Design Engineer or Engineer – The engineer or corporation developing the engineering studies and designs that are covered by this Manual for a proposed development or improvement of property.

Developer – The person, partnership, corporation, or other legal entity who is proposing changes to a parcel of land within the City and who is legally responsible for the construction of the improvements.

Development – Any manmade change to an improved or unimproved parcel of land, including but not limited to buildings, other structures, dredging, filling, grading, paving, or excavations.

dh – Hydraulic Depth = (area/top width), as used in channel flow analysis

DRCOG – Denver Regional Council of Governments

EC – Elevation Certificate

EDB – Extended Detention Basin

EGL – Energy Grade Line—The total energy level of the water. It is the sum of the velocity head, pressure head and the elevation of the water surface.

E.M.C. – City of Englewood Municipal Code

Eo – Ratio of the flow in the depressed gutter section to the total flow.

EPA – Environmental Protection Agency

Erodibility – The susceptibility of a particular soil type to erosion by water or wind.

Erosion – The wearing away of soil or rock fragments by water, wind, or other geological agents.

Erosion Control Measures – Practices that slow or stop erosion.

ET – Evapotranspiration

FEMA – Federal Emergency Management Agency

FHBM – Flood Hazard Boundary Map

FHAD – Flood Hazard Area Delineation

Final Stabilization – Completion of all land disturbing activities, removal of all temporary sediment controls, establishment of vegetative cover on exposed soil areas, and installation of permanent improvements and stormwater BMPs.

FIRM – Federal Insurance Rate Map – The official map on which FEMA delineates flood hazard areas and risk zones.

Flood – A general and temporary condition of partial or complete inundation of normally dry land areas from the unusual and rapid accumulation of runoff of surface water from upstream areas.

Floodplain – The lowland area which may be temporarily covered by floodwaters attributed to the accumulation of storm runoff from adjoining or upstream areas in major storm events where special regulations have been adopted in order to protect the public, minimize flood damage and the need for rescue and relief efforts.

Floodplain Administrator – Director of Community Development or authorized representative

Floodway – The channel of a river or watercourse and the adjacent land area that must be reserved in order to discharge the Base Flood. Encroachments into the floodway area are prohibited.

ft – Feet

fps – Velocity measurement (feet per second)
Froude Number – A ratio used to determine whether the flow in an open channel or covered conduit with a free water surface is at critical velocity or equal to 1.0. Flow at or near the critical state (1.0) is not stable and must be avoided.

g – Rate of gravitational acceleration (32.2 fps/s)

GB – Grass Buffer

General Permit – A permit issued by the State Department of Public Health and Environment, Water Quality Control Division that authorizes discharges in compliance with the Clean Water Act, and authorizes activities and programs designed to reduce or prevent pollution of State Waters.

GIS – Geographical Information System

GS – Grass Swale

HERCP – Horizontal Elliptical Reinforced Concrete Pipe

Historic – May mean “existing conditions” prior to redevelopment or change in use, when adequate capacity in the existing drainage stormwater system exists; otherwise it shall mean the conditions that existed prior to any development or improvements made to the property.

HGL – Hydraulic Grade Line—The profile of the hydrostatic pressure of water as it flows through pipes; it represents the sum of the depth of flow and the pressure head.

Hydraulic Radius – Flow in channels are affected by the boundary roughness. To calculate - the actual perimeter of channel in contact with the fluid is divided into the area of the flowing fluid gives the hydraulic radius which is a major component in using Manning’s Equations to solve for uniform flow in open channels.

I – Rainfall intensity expressed in inches per hour.

In. – Inches

Inspector – The authorized representative of the Public Works Director assigned to make detailed inspection of construction work to assure compliance with this Manual and the plans approved by the City.

iph – Soil infiltration rate expressed in (inches per hour).

Levee – A manmade structure designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

Lowest Floor – The lowest enclosed habitable area of a building.

LOMA – Letter of Map Amendment

LOMR – Letter of Map Revision

Major Channel – Any channel or drainageway with 100 cfs or greater flow.


\[ Q = \frac{2^{3/2}}{n} \cdot 1.49aR_h^*S \]

Manning’s Equation

may – To be interpreted as can or able, or more permissive than the use of “shall” in this Manual.

MBP – Modular Block Porous Pavement

MDCIA – Minimizing Directly Connected Impervious Areas. The practice of routing concentrated flows from impervious areas over grassy areas to promote infiltration and slow down runoff.
MEP – Maximum Extent Practicable – the standard for evaluating permit compliance.

Minor Development – Developments that involve little change to existing drainage patterns. By definition therefore they must exhibit the following properties:

- Minor amount of grading work,
- Insignificant increase in runoff generated,
- Development actually improves drainage conditions,
- No additional runoff will be directed to adjacent private properties,
- Stormwater pollution is not currently a problem,
- And Development will not increase the potential for stormwater pollution.

MH – Manhole

MS4 – Municipal Separate Storm Sewer System

n – Manning’s n, which is a friction factor, assigned to the surface that the liquid is traveling over or through.

\[ N_f = \frac{v}{\sqrt{(g \cdot dh)}} \]

NFIP – National Flood Insurance Program

NOAA – National Oceanic & Atmospheric Administration

Nonstructural BMPs – Policies and practices and improvements designed to prevent or minimize the migration of pollutants into receiving waters.


NRCS – Natural Resource Conservation Service

Owner or Property Owner – Any individual, corporation, partnership, or other legal entity holding controlling title on property which is in some way impacted or involved by development or improving the property.

P – wetted perimeter used in finding the hydraulic radius.

PE – Professional Engineer licensed in the State of Colorado

PLD – Porous Landscape Detention

PLS – Professional Land Surveyor licensed in the State of Colorado

PPD – Porous Pavement Detention

Public Improvements – Improvements in the public way or in easements that are either in the control of (or ownership by) the City.

Public Works Director – The City of Englewood Public Works Director or authorized representative.

Q – Flow in cfs

\( R_h = \frac{a}{P} \)

RCBC – Reinforced Concrete Box Culvert

RCP – Reinforced Concrete Pipe

Record Drawings – The as-constructed drawings for all drainage improvements certified by a PE.

Regulation 61 – Colorado Discharge Permit System Regulations – includes stormwater regulations, (5 CCR 1002-61).
Responsible Party – Any individual, corporation, partnership, or other legal entity involved in developing improvements or maintaining BMPs covered by this Manual, includes subcontractors, contractors, developers, and owners, as applicable in the development process.

ROW – Right-of-Way – The total surface area, and the area above and below the surface that is dedicated, deeded, reserved by, plat or otherwise owned or controlled by the City, for public use for: infrastructure improvements, pedestrians, vehicular movement, parks, utilities, or storm drainage and runoff.

RP – Retention Pond

S – Slope of the ground or conveyance element in ft/ft or percent.

SCS – Soil Conservation Service, now it is an agency of the United States Department of Agriculture and called Natural Resources Conservation Service.

SFB – Sand Filter Extended Detention Basin

shall – An obligation or necessity to be interpreted as mandatory.

should – Advisory or recommendation, but not mandatory.

Specifications – Applicable specifications of agencies or organizations identified and shall mean the latest edition or as revised.

SPP - Structural Plate Pipe

SPPA - Structural Plate Pipe Arch

Standards and Specifications – The “Engineering and Construction Standards and Specifications” of the City of Englewood.

State Waters – Any and all surface and subsurface waters which are contained in or flow through the state of Colorado, except for waters in sewage systems or waters in potable water distribution systems.

Structural BMP – Facilities constructed to passively treat urban stormwater runoff before it enters the receiving waters. These facilities serve as stormwater quality treatment devices.

SWMP – Stormwater Management Plan, for the purposes of this Manual SWMPs are the Construction BMPs that deal with erosion control, sediment control, and drainageway protection.

T – Total spread of the water in the gutter and street in feet.

TMDL – Total Maximum Daily Load – the amount of a specific pollutant that a listed water body can assimilate without violating applicable water quality standards.

UBC – Uniform Building Code

UDFCD – Urban Drainage and Flood Control District

USBR – United States Bureau of Reclamation

USDA – United States Department of Agriculture

USDCM – Urban Storm Drainage Criteria Manual

USGS – United States Geological Survey

v – Average velocity of flow in fps

Wetlands – Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support vegetation typically adapted for life in saturated soil conditions.

WIR – Watershed Inches of Runoff
WQCV – Water Quality Capture Volume

1.8 REFERENCES

The primary references for this document are the "Urban Storm Drainage Criteria Manual" (USDCM) by the Urban Drainage and Flood Control District, the City of Lakewood, "Storm Drainage Criteria Manual", and the Greenwood Village, "Drainage Criteria Manual." Where specifically referenced, the guidelines and criteria of the referenced manuals shall become a part of this Manual. All manuals and criteria referenced in this manual shall pertain to the most recent edition.

The following references were used in developing this Manual:


Code of Colorado Regulations, Colorado Discharge Permit System, (5 CCR 1002-61)


1.9 DRAINAGE PUBLICATIONS FOR ENGLEWOOD

The following publications are documents that pertain to the City of Englewood’s drainage systems known at this time.

FHAD Studies:
- Big Dry Creek (Arapahoe County) and Tributaries, WRC Engineering, 11-96
- Harvard Gulch, West Harvard Gulch and Dry Gulch, Gingery Associates, 12-79

Master Plans:
- Big Dry Creek (Arapahoe County) and Tributaries Master Drainage Planning, Phase B, Preliminary Design Report, WRC Engineering, 4-98
- Big Dry Creek (Arapahoe County) and Tributaries Master Drainage Planning, Phase A, Evaluation of Alternatives Report, WRC Engineering, 7-96
- Big Dry Creek, Volume I, Major Drainageway Mater Plan Report, VTN, Inc., 6-75
- Big Dry Creek Major Drainageway Master Plan, VTN, Inc., 12-74
- Little Dry Creek, Volume I – Major Drainageway Planning Report, McCall-Ellingson and Morrill, Inc., 2-74
- Little Dry Creek Major Drainageway Planning, Volume 2 Drawing Report, McCall-Ellingson and Morrill, Inc., 2-74
- South Platte River – Chatfield Dam to Baseline Road, Phase B, Volume I Major Drainageway Planning Report, Wright Water Engineers, Inc., 11-85
- South Platte River – Chatfield Dam to Baseline Road, Phase B Volume II Recreation Plan, Major Drainageway Planning Report, Wright Water Engineers, Inc., 11-85

17
Outfall Studies:

Special Reports:
- City of Englewood Probable Areas Affected by Flooding from the 100-Year Storm, Turner Collie and Braden, Inc., 3/98
- Little Dry Creek, City of Englewood, Cherry Hills Village, Greenwood Village, Arapahoe County Hydrologic Evaluation, McLaughlin Water Engineers, 7-86
- South Platte River – A Plan For The Future – Chatfield to Brighton, a Friend, A Foe, UDFCD, 12-85
- South Platte River – Chatfield Reservoir to Brighton – Planning for the Future Brochure, 11-83
- South Platte River – Chatfield Dam to Baseline Road Stream Stability Investigation Final Report, Michael A. Stevens, Consultant, 12-83
- South Platte River Hydrologic Study – Chatfield to Sand Creek, Merrick and Company, 5-83
- City of Englewood Storm Drainage Plan, Sellards & Grigg, Inc. 1-71
SECTION 2.0
STORM DRAINAGE PLANNING & SUBMITTAL
REQUIREMENTS

2.1 GENERAL

The Public Works Department has established and the City Council has adopted construction standards and engineering regulations for Development. All subdivision plats, planned unit developments, or any other proposed construction submitted for approval shall include an adequate drainage system analysis, BMP analysis, stormwater management analysis and appropriate storm drainage system design. Plans, engineering analysis and calculations, diagrams, drainage reports and other data shall be submitted, as required by the Public Works Director, with each development proposal or application for permit. The Developer is encouraged to have his Engineer meet with the Public Works Department so that the technical aspects of the project can be discussed prior to submitting plans and reports.

The Public Works Department in conjunction with City staff in other departments review these submittals to insure conformance with City Standards. The City of Englewood is not responsible for the correctness of design, dimensions, details, or quantities. All submittals are to be prepared by a registered professional engineer licensed in the State of Colorado.

2.2 REVIEW PROCESS

Adequate time must be allocated in development planning to permit a complete review. The intent of this Manual is to more clearly define the City’s criteria and reduce the time and effort required to develop an acceptable drainage study. To improve the review process, all reports will receive an initial review using the checklist in Appendix B to determine if all essential information is present. Engineering review of the drainage plan will not be started until all essential information is present. Design Engineers are encouraged to refer to the Drainage Report Submittal Outline (Appendix C) and to substantiate that all the needed information has been provided, or explain why items were not provided.

2.3 SUBMITTALS

Two copies of plans and two copies of reports are required for each initial submittal. If additional copies are required for agency referrals, the applicant will be notified.

Drainage reports are required and must be submitted in accordance with the requirements stated in this Manual. Any comments made by the Public Works Department must be addressed and the documents resubmitted until an approval is given.

Checklists\(^2\) have been developed in order to identify the information that needs to be provided in drainage report submittals. The checklists may be used to determine the adequacy of the submittal. Incomplete or key information omitted from the report may result in the report being rejected for review, which could result in a significant delay in the development process.

An important part of the design and analysis of any hydraulic facility is the documentation. Drainage reports are required and must be submitted in accordance with the requirements stated in this Manual. Drainage Reports and Plans shall include, as a minimum, the information in Appendix C – Drainage Report Submittal Outline. The required submittal items for the different types of development are shown in Table 1.

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<td>Letter Report 8 Preliminary Report 9</td>
<td>Final Report</td>
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<td>BMP Required</td>
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</tbody>
</table>

2.4 **SUBMITTAL REQUIREMENTS**

1) **Drainage Report Format**

Drainage reports shall be prepared on standard size paper (8½ x 11). The full reports shall be suitably bound including cover, tabs, etc., but a letter report may be stapled if less than ten (10) pages. Every copy of the report shall include a "Drainage Plan Sheet", which may be either folded and bound with the report, or folded and placed in a pocket, which has been bound within the report.

2) **Drainage Plan Sheets**

The "Drainage Plan Sheets" shall consist of a 24-inch x 36-inch paper copies that are included with the reports. Any revisions to the drainage plan sheets shall be noted on the plans together with revision dates. Once deemed acceptable, two copies of the drainage plan(s), signed and sealed by the PE, shall be submitted.

The approved Drainage Plan Sheet shall be a part of the construction documents, plans and specifications for the proposed development. No building permit will be issued unless the approved Drainage Plan Sheet is included among the construction documents.

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3 For the purposes of this Manual SWMPs are the Construction BMPs that deal with erosion control, sediment control, and drainageway protection.

4 Best Management Practices – physical, structural, nonstructural, and/or managerial practices that are intended to prevent, mitigate, or reduce pollution of stormwater.

5 Drainage Report requirements may be waived when development meets all the conditions for a Minor Development. See Section 1.7. Definitions and Abbreviations for "Minor Development" definition and conditions.

6 If Letter Report indicates that all flows are going to be directed to a Public ROW and no flows are exiting the site onto adjoining private properties and there are no flood plain or drainage problems associated with the site, then no additional reports will be required.

7 Only required in cases where runoff must be directed onto adjoining private properties or flood plain or drainage problems are associated with the developing the site.

8 Optional

9 Required if parcel in question must go through the preliminary platting process, otherwise at the PE’s discretion either a preliminary report can be submitted or PE may elect to proceed to final.
3) **Stormwater Management Plans**
The Stormwater Management Plan must be included with the final report, but is not required for a preliminary report. USDCM (Volume 3 – Best Management Practices) shall be followed for developing construction BMP measures for the project site. The map symbols shown on Figure C-1 and C-1A in USDCM (Volume 3 – Construction BMPs), pages C-3 and C-4 shall be used on SWMP submittals. SWMPs shall be 24-inch x 36-inch paper copies included with the report.

Within reason, the SWMP may be included on the Drainage Plan Sheets. The details of both erosion control methods and drainage design must be legible and clear. If they are not clear when drawn together, or if the Public Works Department requests it, the plans shall be drawn separately.

No building permit will be issued unless the approved SWMP is included among the construction documents.

### 2.5 LETTER REPORT

1) **General Provisions**
A letter report replaces a preliminary report for development sites less than 1.0 acre; although, the Public Works Director has the right to require a drainage report, or any part of, if it is deemed necessary. The letter report shall include a letter written to the Public Works Department briefly summarizing the proposed development and include a completed “Small Lot Development Form”, found in the Appendix D of this Manual, and a site plan with the necessary information provided. The letter report will be submitted to the Public Works Department for review and comment or approval.

A letter report may also be submitted for a development or redevelopment that will not increase the historic runoff from the site, or in certain cases where the increased runoff will not exceed the allowable limits from the master plan studies as listed in Section 1.9, or when the increase in runoff is minor and it is obvious that the developed flows will not cause any hardship to downstream property owners, or overburden existing municipal systems. The letter report shall provide all necessary documentation in order to substantiate that the requirements for a letter report are met. The Public Works Department may approve the letter report if all the issues have been satisfactorily addressed. Letter report approvals are strictly at the discretion of the Public Works Director. If the Public Works Director determines that the flows from a development do not meet the criteria established for a letter report, then the applicant must provide a final drainage report that meets the criteria of the City.

2) **Procedure**
Two (2) copies of the letter report will be submitted for preliminary review. The Public Works Department will review and make any comments deemed necessary on the submitted drainage report and may return an annotated review copy to the submitter in cases where it would help to clarify the City’s comments or concerns.

If corrections are needed, the Public Works Department shall request the letter report be resubmitted with corrections. A resubmittal, if requested by the Public Works Department, must be accompanied with the annotated review copy containing the City’s comments. All resubmittals shall include a cover letter summarizing how the City comments were addressed. If Public Works requires the letter report be prepared by a PE then, letter reports and the plan sheets shall be signed and sealed by the PE that provided guidance, supervision, and is responsible for the design.

After the report is approved, then the construction plans submitted for building permit approval must contain sufficient information to document the assumptions and recommendations contained in the letter report.
2.6 PRELIMINARY REPORT

1) Purpose
The purpose of the preliminary report is to identify and define drainage problems associated with the proposed development, and to define conceptual solutions. For a detailed list of the submittal requirements, see Appendix C – Drainage Report Submittal Outline.

2) Rezoning Proposals
When a rezoning application and approval is conditional upon site plan approval, a preliminary report is required.

3) Procedure
Two (2) copies of the preliminary drainage report will be submitted for review. The Public Works Department will review and make any comments deemed necessary on the submitted drainage report and may return an annotated review copy to the submitter in cases where it would help to clarify the City’s comments or concerns.

If major corrections are needed the Public Works Department may request the preliminary report be resubmitted with corrections. A resubmittal, if requested by the City, must be accompanied with the annotated review copy containing the City’s comments. All resubmittals shall include a cover letter summarizing how the City comments were addressed.

In most cases the Public Works Department will request that the City’s review comments or concerns be addressed with the final drainage report. This can be accomplished by the City attaching a conditional approval letter to the preliminary report that will list the items that need to be addressed in the final drainage report. Approved preliminary reports and the plan sheets shall be signed and sealed by the PE that provided guidance, supervision, and is responsible for the design.

2.7 FINAL DRAINAGE REPORT

1) Purpose
The purpose of the final report is to transform the preliminary plans or conceptual plans to construction plans. Final drainage reports are normally prepared and submitted with any documents that will result in easements and rights-of-way to be recorded, or permanent structures being built, such as the final plat, planned development, site plan, or building permit. The final drainage report shall contain all calculations and information identified in Appendix C—Drainage Report Submittal Review Checklist.

2) Procedure
Three (3) copies of the final report will be submitted for Public Works Department approval. The Public Works Department will review and make any comments deemed necessary on the submitted drainage report and may return an annotated review copy to the submitter in cases where it might help to clarify the City’s comments or concerns. All City review comments must be addressed. All resubmittals shall include a cover letter summarizing how the City comments were addressed, and in cases where annotated plans were provided, the annotated review copy containing the City review comments should be included with the resubmittal. The final report will be resubmitted until all comments and correction requests are satisfactorily addressed.

When the Public Works Department deems the final drainage report acceptable, three (3) copies of the drainage report and the “Drainage Plan Sheet” must be submitted for approval. The reports and the plan sheets shall be signed and sealed by the PE that provided guidance, supervision, and is responsible for the design.

After the report is approved, then the construction plans submitted for building permit approval must contain sufficient information to document the assumptions and recommendations contained
in the final drainage report and plan. The building permit submittal package must include the SWMP and the approved drainage report and plans.

2.8 FLOOD HAZARD STUDY

1) General Provisions
Proposed development or improvements in the flood hazard zone shall meet the requirements of Title 16 of the Englewood Municipal Code – Unified Development Code. EMC Title 16-4: Flood Plain Overlay District can be found in Appendix H. The flood hazard study shall be in the form of a final drainage report and shall include all such computations necessary to show that the requirements of Title 16 are met.

Copies of the City of Englewood Flood Hazard Boundary Map or the Arapahoe County FIRMs maps may be obtained through the City Flood Plain Administrator.

2) Flood Plain Zoning Permit
A Flood Plain Zoning Permit and a Development Permit must be obtained from the Flood Plain Administrator before any major drainageway can be altered or relocated. Whenever a Development proposes to alter a major drainageway, the Developer is responsible for submitting construction plans and calculations that meet UDFCD criteria, and then to build the necessary improvements in accordance with UDFCD requirements so that the improvements will be eligible for UDFCD maintenance. In addition the CLOMR, and LOMR, and all other costs related to revising Floodplain or Floodway locations and limits, shall be borne by the Developer and shall be done in accordance with FEMA criteria. A CLOMR must be issued by FEMA prior to the City issuing a building permit for any structure where Floodplain modifications are necessary, and when construction is completed the Developer is required to prepare and submit all required documents for FEMA approval and issuance of a LOMR.

3) Flood Plain Development Permits
A Development Permit must be obtained from the Flood Plain Administrator prior to the use of any fill, construction of structures, or storage of materials in any portion of a flood plain.

4) Floodways
Because Floodways are extremely hazardous due to the velocity of floodwaters, which carry debris, and because the drainage conveyance capacity of the drainageway must be protected and maintained, all encroachments, fill, new construction, substantial improvements and all other development are prohibited in any area designated as a Floodway except for:

a) New improvements that are intended to increase the capacity or the storage capability of the Floodway.

b) New improvements that are intended to increase flood protection, decrease erosion, and improve channel hydraulics, or to provide stormwater quality benefits.

c) Utilities that are designed, located, and installed such that:
   (i) They are anchored and armored to withstand hydrostatic and hydrodynamic forces, and the effects of buoyancy.
   (ii) Equipment and appurtenances installed are resistant to flood damage.
   (iii) The utilities will not permit infiltration of floodwaters into the system and/or will not discharge from the system into the Floodway.

5) Disclaimer
The degree of flood protection required by Title 16 is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Larger floods than the 100-year design storm can occur. Conformance to the requirements in Title 16, or this Manual, does not imply that areas will be free from flooding or flood damage.
2.9 WETLANDS

Wetlands provide multiple important functions in an urban drainage system. A wetland can reduce the peak flow discharge, provide park and aesthetic benefits, as well as improve the water quality of storm runoff.

Existing Wetlands are protected by federal regulations. Disturbing or cutting wetland vegetation with designated wetland areas is prohibited except for the following:
- Hand cutting or removal by hand of noxious weeds;
- Thinning wetland vegetation to minimize mosquito habitat in accordance with a plan prepared by an environmental specialist, and approved by the City;
- Work performed to protect the public health, safety, and welfare.

The applicant shall identify existing wetland areas that potentially could be impacted by the proposed Development. Care should be taken not to encroach into a wetland, and to avoid causing changes that will affect the water sources to a wetland.

To the extent possible, no utility lines shall be located in wetlands. Prior to any disturbance to a wetland, the U.S. Army Corps of Engineers shall be contacted to determine if there are any 404 Permit requirements.

2.10 STORMWATER MANAGEMENT PLAN

1) General

The Federal Clean Water Act requires that stormwater discharges be authorized under stormwater discharge permits. A General Permit issued by the Colorado Department of Health and Environment, Water Quality Control Division covers stormwater discharges from the City of Englewood. Construction site stormwater runoff control is one of the minimum measures that Englewood must address in order to be in conformance with the Colorado Discharge Permit System, or CDPS, under Regulation 61. Disturbed lands are subject to erosion and can be a source of significant discharges of sediment and other pollutants to receiving waters downstream.

Disturbed lands include all property from which vegetation has been or is to be temporarily or permanently removed. A SWMP for the site is required if the disturbed area is greater than 10,000 square feet, or if the soil area is to be exposed for more than sixty (60) days. A SWMP for the site must be developed and submitted to the Department of Public Works to obtain a building, construction, or site-grading, paving, or development permit. This plan will identify the site specific control measures necessary to prevent and control soil erosion, sedimentation, and water pollution that may degrade receiving waters downstream.

2) Contractor Responsibility

The contractor shall provide control measures to prevent or minimize the impact to receiving waters as required by the plans and/or as directed by the Engineer in writing. The Contractor shall effectively prevent and control erosion and sedimentation on construction sites at the earliest practicable time. In general control measures will be implemented prior to the commencement of each construction operation or immediately after the area has been disturbed.

Construction staging areas and vehicle maintenance activities shall be managed and controlled so as to minimize the runoff of pollutants.

Disturbance of vegetation shall be minimized and limited to only what is shown on the construction plans or as directed by the Design Engineer in writing.

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10 Construction sites that disturb one acre or greater will need to obtain a State Stormwater Discharge Permit beginning on March 10, 2003. The City will be working with the CWQCD to remove the State Permit requirement and make the City the sole issuing authority as part of the City’s efforts to comply with EPA Stormwater Phase II requirements.
All erosion, sediment and water pollution controls will be maintained in good working order. On all projects where the disturbed area is equal to or greater than an acre, a rain gauge shall be provided by the Contractor and located on the project site. Within 24 hours of a rainfall event of 0.2 inches or more as measured at the project rain gauge, the Contractor will inspect the entire project to determine the condition of the control measures. Sediment will be removed and devices repaired as soon as practicable but not later than 7 days after the surrounding ground has dried sufficiently to prevent further damage from equipment needed for repair of control measures.

3) **Owner Responsibility**
   All construction stormwater best management practices (BMPs) developed are the documents that permit approvals are conditioned upon. The Owners and Developers of the real property are ultimately responsible for the proper installation and maintenance of all construction stormwater BMPs. If the Contractor/Developer fails in this responsibility the City shall provide a verbal warning to the Responsible Party, if the situation is not remedied, then a notice of violation shall be issued as well as a stop work order for any work at the site, except for work necessary for bringing the site into compliance with the SWMP. Failure to respond to the notice of violation will result in a municipal summons. If necessary, the City has the right to enter the property, perform maintenance on the BMPs, and require reimbursement for the costs that may be incurred.

   The control measures identified on the plan shall be installed and maintained throughout construction and these efforts shall be coordinated with the permanent pollution control features specified for the project’s post construction period. The Owner’s Representative shall inspect the construction BMP control measures after each storm event in excess of 0.2 inches. All deficiencies shall be noted and any necessary changes or maintenance will be completed within 24 hours. Modifications to the SWMP shall be submitted to the Public Works Department within seven days.

4) **Owner Acknowledgement**
   All SWMPs and BMPs shall include an “Owner Acknowledgement” block for the Property Owner’s signature. The format for the Owner Acknowledgement shall be:

   All stormwater best management practices (BMPs) developed and included in the development approval process are legally binding documents whereby the Owners of the real property associated with the BMPs are held ultimately responsible for the proper maintenance of all stormwater BMPs. If the Property Owner fails in this responsibility, the City has the right
   
   1. To enter the property, perform maintenance on the BMPs, and require reimbursement for the costs that may be incurred, or
   2. To declare the existence of a nuisance and issue Nuisance Abatement Notice to the responsible party. Failure to comply with the Nuisance Abatement Notice shall cause the person, corporation, partnership, or other entity violating the stormwater management provisions of the Manual to be subject to Title 15 of the Englewood Municipal Code.

   I have reviewed the stormwater best management practices that are proposed and I understand that the effective performance of BMP measures hinge upon proper maintenance of the BMPs used, and I will commit to provide the required maintenance and employee training program, in order to accomplish the goal of preventing or reducing pollutant runoff from this property.

   Owner                              Date
5) **Project Management Principles**

Careful project management and adherence to the following principles can achieve erosion and sediment control:

- Fit the Development to the existing topography, soils, and vegetation as much as possible.
- Schedule construction operations in order to minimize soil exposure.
- Minimize disturbance and soil exposure by retaining natural vegetation, adopting phased construction techniques, and using temporary cover.
- Vegetate and mulch all denuded areas to protect the soil from precipitation in order to minimize the raindrop impact on bare soil.
- Minimize the steepness of slopes and control lengths of slopes by utilizing benches, terraces, contour furrows, or diversion ditches.
- Utilize riprap, channel linings, or temporary structures in channels to slow runoff velocities and allow drainageways to handle increased runoff from developed areas.
- Keep sediment on-site by utilizing sediment basins, traps, or sediment barriers.
- Monitor and inspect sites frequently to assure the measures are functioning properly and correct problems promptly.

The following list is a quick guide of recommended construction BMPs:

**Table 2 - Construction BMP Control Measures**

<table>
<thead>
<tr>
<th>Construction BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Check Dam</td>
</tr>
<tr>
<td>- Construction Road Stabilization</td>
</tr>
<tr>
<td>- Curb Sock Inlet Protection</td>
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<tr>
<td>- Temporary Diversion Dike</td>
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<tr>
<td>- Temporary Channel Diversion</td>
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<tr>
<td>- Storm Drain Inlet Protection</td>
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<tr>
<td>- Mulching</td>
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<tr>
<td>- Outlet Protection</td>
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<tr>
<td>- Paved Flume</td>
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<tr>
<td>- Permanent Seeding</td>
</tr>
<tr>
<td>- Rough Cut Street Control</td>
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<tr>
<td>- Sediment Basin</td>
</tr>
<tr>
<td>- Temporary Stream Crossing</td>
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<tr>
<td>- Silt Fence</td>
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<tr>
<td>- Surface Roughening</td>
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<tr>
<td>- Sediment Trap</td>
</tr>
<tr>
<td>- Straw Bale Barrier</td>
</tr>
<tr>
<td>- Temporary Seeding</td>
</tr>
<tr>
<td>- Temporary Slope Drain</td>
</tr>
<tr>
<td>- Vehicle Tracking Control</td>
</tr>
<tr>
<td>- Vehicle Tracking Control with Wash Rack</td>
</tr>
<tr>
<td>- Waste Storage</td>
</tr>
<tr>
<td>- Fuel, Chemical, and Petroleum Product Storage</td>
</tr>
</tbody>
</table>

2.11 BEST MANAGEMENT PRACTICES PLAN

Englewood’s General Permit issued by the Colorado Department of Health and Environment mandates that adequate pollution control measures for both the construction and post construction periods are provided and maintained. All commercial and industrial developments, regardless of size and type, must provide an evaluation of the possible pollution sources that are common for the proposed uses and identify the Structural and Nonstructural controls that are going to be provided to mitigate adverse impacts to State Waters. The requirements for the Stormwater Quality Best Management Plan are outlined in Appendix G. BMP Owners are responsible for performing the required maintenance to ensure the long-term operation and viability of BMPs.

Water quality is an important part of the drainage design. With the NPDES regulations, it is essential that the City, the Design Engineer, the Property Owner, and Contractors work together to implement Best Management Practices (BMPs) to clean and/or prevent the pollution of stormwater. Pollutants come from stormwater runoff (rain) or non-stormwater runoff (such as sprinklers, hoses, or cleaning devices). The recommended Decision Tree for Water Quality Capture Volume (WQCV) Structural BMPs from USDCM Volume 3 is provided in Appendix F.

1) **WQCV Facilities**

In developing a new site, consideration must be given to the implementation of permanent BMPs that would increase the quality of site runoff. These BMPs are designed to capture and provide treatment for a specific volume of stormwater runoff. The UDFCD has analyzed precipitation data for the Denver Area. UDFCD has concluded that on average there are about 75 storm events each year. And in any given year, 90 percent of the storm events that occur in the Denver Area produce rainfall amounts less than 0.5 inches. Therefore the greatest benefit is derived from mitigating the impacts of urbanization if we concentrate our stormwater BMPs on capturing and treating these small and frequent storms.

WQCV facilities in Englewood shall be designed for the 80th percentile runoff event. This volume is equivalent to the stormwater runoff generated from one half of the 2-year storm. USDCM (Volume 3 – New Development Planning) gives a complete list and design criteria for WQCV Facilities. Alternate designs may be considered, but they must meet the functional requirements of the BMPs identified by UDFCD.

2) **Combination WQCV and Stormwater Detention Facilities**

Whenever possible, it is recommended that WQCV facilities be incorporated into stormwater quantity detention facilities. Because major storm flow calculations assume antecedent moisture conditions that would saturate soils, therefore when WQCV is incorporated into stormwater detention basins, the full WQCV plus the full minor and major storm detention volumes must be provided.

3) **Industrial and Commercial BMPs**

Special consideration should be given to industrial and commercial impacts to a site. If developing an industrial site USDCM (Volume 3 – Industrial/Commercial) should be followed.

The following is a quick guide of recommended BMP measures:
Table 3 – Structural and Nonstructural BMP Control Measures

<table>
<thead>
<tr>
<th>Structural BMPs (Treatment Practices)</th>
<th>Nonstructural BMPs (Prevention Practices)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Grass Buffer</td>
<td>• Disposal of Household Waste and Toxics</td>
</tr>
<tr>
<td>• Sand Filter Extended Detention Basin</td>
<td>• Limiting Use of Pesticides, Herbicides, and Fertilizer</td>
</tr>
<tr>
<td>• Modular Block Porous Pavement</td>
<td>• Illicit Discharge Controls</td>
</tr>
<tr>
<td>• Porous Pavement Detention</td>
<td>• Spill Prevention and Response Plans</td>
</tr>
<tr>
<td>• Porous Landscape Detention</td>
<td>• Preventative Maintenance</td>
</tr>
<tr>
<td>• Extended Detention Basin</td>
<td>• Stormwater Pollution Prevention Education</td>
</tr>
<tr>
<td>• Grass Swale</td>
<td>• Mitigation</td>
</tr>
<tr>
<td>• Constructed Wetlands Basin</td>
<td>• Good Housekeeping</td>
</tr>
<tr>
<td>• Retention Pond</td>
<td>• Exposure Minimization</td>
</tr>
<tr>
<td>• Constructed Wetland Channel</td>
<td>• Covering of Storage/Handling Areas</td>
</tr>
<tr>
<td></td>
<td>• Spill Containment and Control</td>
</tr>
</tbody>
</table>

Consideration must be given to the short and long term maintenance of all the BMPs. Long term success dictates that each BMP must be practical and useful. All stormwater best management practices (BMPs) developed and included in the development approval process are legally binding documents whereby the Owners of the real property associated with the BMPs are held ultimately responsible for the proper maintenance of all stormwater BMPs, if the Property Owner fails in this responsibility the City has the right to enter the property, perform maintenance on the BMPs, and require reimbursement for the costs that may be incurred.

Because the effective performance of BMP measures hinge upon proper maintenance of the BMPs used, signed acknowledgements by the Property Owner must be given to the Public Works Department that identify the Structural and Nonstructural controls, the required maintenance and employee training program, and their commitment to the goal of preventing or reducing pollutant runoff from their property.

Special consideration must be given to developments and redevelopments that include the following activities:

- **Fueling Areas**
  - Typical sources of contaminants are:
    - Spills and leaks during fueling or deliveries,
    - Spills and overfills due to operator error,
    - Structural failure of tanks
    - Allowing rainfall to run onto or through fueling areas,
    - Hosing or washing down of fuel areas,
    - Mobile fueling operations.

- **Vehicle and Equipment Maintenance and Storage**
  - Typical sources of contaminants are:
    - Parts cleaning,
    - Shop cleaning,
    - Spilled fuel, oil, or other solvents or materials,
    - Replacement of fluids, such as oil and oil filters, and hydraulic, transmission and radiator fluids,
    - Dripping fluids from vehicles and equipment,
    - Dripping fluids and other contaminants from trash dumpsters.
• Vehicle and Equipment Wash down Areas
  o Typical sources of contaminate are:
  • Outside equipment or vehicle cleaning, (washing, degreasing, or steam cleaning).
  • Wash water discharge to the ground or directly to storm drains,
  • Drippings from washed vehicles and equipment,
  • Hosing or washing down of cleaning areas,
  • Mobile fleet washing,
  • Pressure washing of buildings or windows,

• Loading And Unloading Areas
  o Typical sources of contaminate are:
  • Pumping of liquids or gases to or from trucks or rail cars,
  • Transfer of dry chemicals to or from vehicles,
  • Transfer of bags, boxes, drums, or other containers to and from vehicles
  • Hosing or washing down loading dock or terminal areas.

• Above Ground Tank Storage
  o Typical sources of contaminate are:
  • External corrosion and structural failure of tanks,
  • Installation problems,
  • Spills and overfills due to operator error,
  • Piping systems failure including pumps, flanges, couplings, hoses and valves,
  • Spills or leaking of liquids or gases during pumping to or from trucks or rail cars.

• Outside Manufacturing
  o Typical sources of contaminate are:
  • Processes or equipment that generate dust, vapors or other emissions that settle or attach to surroundings only to get washed away with precipitation events,
  • Outside storage of contaminate, hazardous materials and raw materials,
  • Dripping or leaking fluids from equipment or processes,
  • Concrete manufacturing or concrete construction operations.

• Waste Management
  o Typical sources of contaminate are:
  • Landfills,
  • Waste piles,
  • Wastewater and solid waste treatment and disposal,
  • Dumpsters,
  • 55-Gallon drums
  • Rainwater running through or seeping through materials and carrying contaminants into the stormwater collection system,
  • Contaminants

• Outside Storage
  o Typical sources of contaminate are:
  • Stormwater contamination occurs when solid materials wash off or dissolve in water and are carried off the site,
  • Fuels,
  • Raw materials,
  • By-products,
  • Process residuals
  • Wind-blown debris,
  • Leaking containers or spills.
Parking Areas

• Typical sources of contaminants are:
  • Any areas where customers park can be a source of contamination due to:
    • Improper disposal of trash,
    • Leaky vehicles resulting in oils or fuels deposited in the parking lot and washed into the storm collection system during a storm event.

4) Extended Detention Basin (EDB)

EDBs are effective in removing particulate matter and associated heavy metals and other pollutants. Land area requirements are not excessive, typical land requirements are in the 0.5 to 2 percent range of the tributary land area. EDBs should be designed as two stage basins. The bottom stage is called the inundation zone where only landscape treatments that are highly tolerant to saturated conditions are used. The bottom zone should be sized to accommodate 5 to 15 percent of the WQCV. The upper zone is sized to accommodate 85 to 95 percent of the WQCV, but greater flexibility of landscape materials can be permitted.

a) Basin Storage Volume: A storage volume equal to at least 120 percent of the WQCV for a 40-hour drain time. The additional 20 percent is for additional storage capacity to provide for sediment accumulation and the resultant loss in storage volume.

\[
\text{WIR} = 0.9 \cdot C_i^3 + 1.19 \cdot C_i^2 + 0.78 \cdot C_i
\]

Where: WIR = Watershed Inches of Runoff

\[
C_i = \text{Composite percentage of impervious area, expressed as a decimal point.}
\]

Where: Pavement and Paved Areas = 100 % impervious
Rooftop Areas = 90 % impervious
Sod and Grass Areas = 0 % impervious

And the design volume of WQCV in acre-feet is calculated by:

\[
\text{WQCV} = \frac{\text{WIR} \cdot A \cdot 1.2}{12}
\]

Where:

• A = The watershed tributary area to the pond in acres.
• 1.2 = 20 percent storage factor to account for sediment accumulation.
2.12 INSPECTION AND RECORD DRAWINGS

A PE retained by the Developer, preferably the Design Engineer, shall inspect the construction of the improvements for the purpose of determining conformance with the approved drainage plan. This inspection shall include verification that the following conform reasonably to the drainage plan:

- Finished floor elevations
- Sizes, grades, locations, and elevations of drainage structures, channels, pipes, etc.
- Drainage facilities are located within the dedicated drainage easements.
- Location of basin boundaries
- Detention pond volumes
- Facilities appear to be constructed in a workmanlike manner
- Facilities and onsite grading function as intended in accordance with the approved drainage report and plans.
- Stormwater Management control measures implemented or constructed.
- Best Management Plan measures implemented or constructed.
- Wetland mitigation measures implemented
- Floodplain boundaries certified
- Permanent field benchmark verified and certified

Any significant deviations from the approved drainage plan shall be annotated on the Record Drawings. Redline or cloud mark-ups of the approved construction drawings are the preferred method for indicating significant deviations. Significant deviations are those that exceed the following tolerances:

- Elevations .................± 0.2 ft. deviation from specified slope or grade,
- Slopes ..................± 10.0% (i.e. 0.2% deviation for a 2% design grade)
- Distances ..................± 1.0%
- Volumes ..................± 5.0%

The Engineer will note any significant deviations on the approved drainage plan sheet and place the certification and notations required for the “as-built” drainage plan. When the Design Engineer is satisfied with the work that was done, then the Engineer shall include the following statement on the Record Drawings:

I hereby declare that: I have performed a field review of the constructed drainage facilities on this plan. The facilities conform reasonably well to the approved drainage plan, they appear to have been constructed in a workmanlike manner, and the as-built improvements will function and perform in accordance with the intended purposes of the approved drawings and specifications.

______________________________
Registered P.E., State of Colorado
No. _______________________

(Seal and Date)

The document will then be returned to the Public Works Department for filing as the Drainage Plan Record Drawing. The Record Drawings must be on file before a Certificate of Occupancy will be issued.
SECTION 3.0
DRAINAGE POLICY

3.1 GENERAL
Providing for adequate drainage in Englewood is necessary in order to preserve and promote the general health, welfare and economic well being of the city and the surrounding area. Drainage is a regional issue that affects all governmental jurisdictions. As a result any successful drainage system will require an integrated approach to drainage that involves public and private concerns working together.

3.2 JURISDICTION BOUNDARIES
Since drainage considerations and problems do not respect jurisdictional boundaries, the policy of the City shall be to cooperate fully with neighboring jurisdictions and make every effort to address their issues and concerns. Drainage referrals will be sent out to UDFCD and neighboring jurisdictions when a Development is located in proximity to a major drainageway or a city boundary.

3.3 BASIN TRANSFERS
The diversion of storm runoff from one basin to another shall be avoided unless specific and prudent reasons justify and dictate such a transfer. In general inter-basin transfer must be prevented since it violates a basic principal of drainage law that upstream properties have a natural easement to discharge onto downstream properties so long as it is not sent down in a manner or quantity that causes more harm than formerly.

3.4 DRAINAGE IMPROVEMENT COSTS
Where drainage improvements are identified by site-specific drainage reports or by drainage master plans as needed in order to facilitate development or redevelopment then the costs to design and build the required drainage improvements shall be borne by the Developer. In other words, because the development is creating the need for the drainage improvements in order to facilitate development, then the costs for the improvements should be borne by the Development and not the citizens of the City of Englewood. Examples where developments should bear all the costs of drainage improvements are:

- All curbs, gutters, channels, detention areas, inlets, storm sewers, culverts, bridges, swales and other drainage facilities that are required to facilitate development of the site.
- All minor channel improvements required that must be built in order to maximize the use of the site.
- All major channel improvements in cases where the Developer chooses to maximize the use of the site and/or encroach into an official Floodplain as identified in Title 16 of the EMC. The Developer is creating the need for these improvements since filling in the Floodplain reduces valuable channel storage capacity and therefore increases downstream flow peaks.
- All extensions of the existing storm drainage system through or around the Development where pipe size is 24-inch diameter or smaller.
- Any changes or modifications to the existing storm drainage system that must be done to facilitate development.

The exceptions to this general policy are when the City requires that the new Development or redevelopment to install larger or additional drainage improvements than what is necessary to facilitate development. Examples where City participation should be provided are:

- Where detention areas are increased in order to require the Development to release flows at less than Historic rates, or to provide regional detention for offsite areas.
Where pipe sizes are greater than 24-inch diameter in order to accommodate offsite drainage.
Where pipe or channel sizes are increased to handle future developed flows from upstream areas, then the differential costs for increasing the pipe or channel size should be subject to City participation.
In cases where City exactions of drainage improvements are not proportional to the impacts caused by the Development.

3.5 STORMWATER RUNOFF DETENTION

Temporarily detaining runoff can significantly reduce downstream flood hazards as well as reduce pipe and channel improvement requirements. Detention storage also provides water quality benefits by collecting sediment and debris. However the benefits can only occur with consistent administration of the detention requirements and proper maintenance of the detention facilities. Therefore detention facilities shall be provided as specified below:

Any person, firm, corporation or business proposing to construct buildings, or develop or redevelop land within the City, shall be required to provide storm water runoff control meeting the requirements of the City of Englewood Storm Drainage Criteria Manual whenever the total area of land under identical ownership, including the land to be developed or upon which buildings are to be constructed, equals or exceeds those shown in the following table. This table applies to both building permits and subdivision of land.

Table 4 – Detention Requirements

<table>
<thead>
<tr>
<th>Type of Development</th>
<th>Zoning Classification</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>New and Infill</td>
<td>Residential Single and Multi-Dwelling Unit Districts (R-1-A, B, and C; R-2-A and B†)</td>
<td>2 acres</td>
</tr>
<tr>
<td>New and Infill</td>
<td>Mixed-Use Residential/Limited Office-Retail Districts, Mixed-Use Commercial Districts, Industrial Districts, and Special Purpose Districts (MU-R-3-A and B; MU-B-1 and 2; TSA; I-1, I-2; PUD)</td>
<td>1 acre</td>
</tr>
</tbody>
</table>

† Non-residential uses allowed in these zone districts shall be required to provide storm water detention for new and infill developments if the site exceeds one (1) acre.

Any person meeting the application provisions of this ordinance shall control the release rate of storm water runoff so that runoff after development shall not exceed the runoff from the same parcel of land in its Historic state for the 5 and 100-year storms respectively.

3.6 ROOFTOP DETENTION

Rooftop detention is highly discouraged and will only be considered when no other options are available. Rooftop detention does not provide the water quality benefits; ponding water on roofs lead to premature failure of roofing systems; and the City cannot readily monitor changes and alterations to roof detention facilities.
3.7 IRRIGATION FACILITIES

Irrigation ditches are designed with flat slopes and limited carrying capacity, which decreases in the downstream direction. As urbanization occurs, ditch rights are sold and irrigation ditches are abandoned. Developed stormwater runoff flows must be directed away from irrigation ditches. If the developed flows cannot be directed away from the ditch, then the ditch will either need to be piped or diversion structures installed downstream to remove excess storm flows from the ditch once the design capacity of the ditch is exceeded.

3.8 OFFSITE FLOWS

One of the precepts of drainage law is that upstream properties own a natural easement on downstream properties for surface waters flowing in its natural course. Therefore it is incumbent on downstream properties to analyze offsite areas that may contribute flows onto their property and mitigate the impacts of those flows. The offsite storm runoff shall be determined and included in the drainage system design. Available drainage reports for developed offsite areas affecting the property shall be reviewed and considered in the drainage system planning and design.

Runoff entering the site from offsite areas shall be computed using runoff coefficients based upon existing development or, for undeveloped land, based on values in Table 6 for offsite flow analysis. For the preliminary report, the system shall be designed for this runoff rate, or \( Q = 0.2 \times A \), for the initial storm, and \( Q = 1.0 \times A \), for the major storm, or whichever is greater.

3.9 EASEMENTS AND RIGHTS-OF-WAY

In the event that any watercourse, channel, stream, creek, or other natural drainage channel traverses part or all of a proposed development, the subdivider shall dedicate adequate easements for storm drainage and maintenance access purposes.

1) Public Drainage Easements

There are Public Drainage Easements that are provided to convey public drainage that are deedsed for the purposes of operation, repair, alteration, and maintenance of the storm water management system where the City has accepted maintenance and operation responsibilities. These easements shall be adequate in order to provide access for construction and maintenance and shall also cover the outlet structure, storm water pipes, detention area berms, and other parts of the storm water management system that the City deems necessary to be granted to the City. Public Drainage Easements shall provide covenants running with the land stating that no buildings, fills, excavations, structures, fences, or other alterations shall be constructed within the easement without the express written consent of the Public Works Department.

2) Drainage Conveyance Easements

There are also Drainage Conveyance Easements that are provided for storm drainage flows from upstream lots onto downstream lots in order for the flows to be conveyed to the public drainage system. Drainage Conveyance Easements are also provided to cover permanent drainage improvements that are a condition of development such as the detention pond, outlet structure, storm water pipes, channels, pipes, inlets, detention area berms, and other parts of the storm water management system built to benefit the site, or upstream or downstream properties. The maintenance and operation of these drainage improvements are the responsibility of the Property Owner. Drainage Conveyance Easements shall provide covenants running with the land stating that no buildings, fills, excavations, structures, fences, or other alterations shall be constructed within the easement without the express written consent of the Public Works Department.

If for some reason the property owner fails to provide adequate maintenance or impedes storm drainage flows, the City may enter the property in order to maintain and or re-establish the drainage capacity, and perform any necessary work, the cost of which shall be the responsibility of the property owner.
3.10 OPERATIONS AND MAINTENANCE

An important part of all storm drainage facilities is continued maintenance so that the system will continue to function as designed. Sediment and debris must be periodically removed from detention basins, channels and storm sewers. Trash racks, sidewalk chase drains, and inlets must be regularly cleared of debris to maintain system capacity. Channel bank erosion damage must be repaired to avoid progressive deterioration, reduced conveyance capacity, unsightliness, and structural failure. All sites will be designed to provide access for vehicles and the construction equipment necessary to provide continued minor and major maintenance.
SECTION 4.0
TECHNICAL DESIGN CRITERIA

4.1 GENERAL

The City of Englewood was incorporated in 1903. Englewood is a southern suburb of Denver and is surrounded by the cities of Denver, Littleton, Cherry Hills Village and Sheridan. The City of Englewood encompasses approximately 7 square miles. The City lies within the South Platte River watershed at the eastern foot of the Rocky Mountains and is exposed to the sudden, high intensity rainstorms typical of this region. A number of large drainage basins tributary to the South Platte River cut through the City (see Figure 1 – Englewood Drainage Basin Map). Because the City is mostly developed, there are existing storm drainage systems that are being used. There are also master plan studies that have been completed that evaluate the existing storm drainage systems and identify areas of need and recommended improvements. A list of the available master plans and studies can be found in Section 1.8—References, of this Manual.

4.2 RESPONSIBILITY

The Design Engineer is responsible for the design produced. The calculations must follow the guidelines in the Manual, but the accuracy and applicability of the calculations are the responsibility of the Design Engineer.

4.3 SOIL TYPES

The predominant soil types in the City of Englewood fall into NCRS Hydrologic Soil Groups B and C. These primarily consist of sands, loams, and clays. Large portions of the city have loamy foothill material in the Nunn association in the “C” hydrologic soil group. The Floodplain areas for the South Platte River, Little Dry Creek and Big Dry Creek are alluvial lands also of the Nunn association. There are also large portions of the city that consist of well-drained soils of the Bresser association that are in the “B” hydrologic soil group. There are also pockets of gravelly areas along the Platte River. For “B” hydrologic soil groups, an initial infiltration rate of 4.5 inches per hour (iph) and the final infiltration rate of 0.6 iph can be used. For “C” hydrologic soil groups, the initial infiltration rate is 3.0 iph and the final rate is 0.5 iph. Figure 3 – Englewood Soils Classification Map identifies locations and soil classifications for the Englewood area. If the Design Engineer has site-specific soil test data available, then the site specific data should be used.

4.4 HYDROLOGY

The UDFCD has concluded that NOAA Atlas rainfall information provides reasonable rainfall information that should be used to develop design rainstorms. The Intensity-Duration Curves found in Figure 2 are derived from the USDCM, Volume 1-Rainfall Chapter. The preliminary and final drainage reports shall take into consideration two separate storms: the initial storm and the major storm. Historic and developed runoffs shall be determined for both storms for the site, including the entire basin tributary to the site.

1) Storm Frequency

The storm frequency to be used in drainage system design will be the storm frequency applicable for the facility being designed as described in a) and b) of this section.

a) Initial Storm: The initial storm occurs at fairly frequent intervals. Drainage systems for the initial storm are to be designed to minimize inconvenience, protect against minor damage, and reduce maintenance costs.
The design frequency intervals for the initial storm are:
- ½ the two (2) year storm for sizing WQCV facilities,
- the two (2) year storm for analyzing storm runoff in streets, private driveway culverts, and for self cleansing velocity checks in storm sewer designs and culvert designs,
- and the five (5) year storm for historic and developed condition drainage analysis, and detention pond designs.

b) **Major Storm:** The design frequency interval for the major storm is the 100-year storm. The drainage system for the major storm is to be designed to protect against loss of life, substantial property damage, and maintain critical or emergency services.

2) **Rainfall Intensity**

Runoff for both the initial and major storm shall be based on the Rainfall Intensity – Duration Curves for Englewood, Colorado shown in *Figure 2.*

**Table 5 – Rainfall Depths for 1 and 6-Hour Storms**

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>1-Hour Storm</th>
<th>6-Hour Storm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Year</td>
<td>0.95</td>
<td>1.50</td>
</tr>
<tr>
<td>5-Year</td>
<td>1.35</td>
<td>2.00</td>
</tr>
<tr>
<td>10-Year</td>
<td>1.55</td>
<td>2.30</td>
</tr>
<tr>
<td>25-Year</td>
<td>2.00</td>
<td>2.80</td>
</tr>
<tr>
<td>50-Year</td>
<td>2.25</td>
<td>3.10</td>
</tr>
<tr>
<td>100-Year</td>
<td>2.60</td>
<td>3.50</td>
</tr>
</tbody>
</table>

According to UDFCD analysis, the most intense rainstorms in the Denver area typically begin and end in the first hour of the storm. It is these short-duration, intense rainstorms that appear to cause the most flooding problems. Therefore, it is the short duration, convective type storm, which is used to provide the design storms used in this manual.

3) **Runoff Computations**

Both the initial and major storm runoff quantities shall be computed using the Colorado Urban Hydrograph Procedure for basins between 90 and 130 acres. The Rational Method may be used for basins less than 90 acres.

a) **Rational Method:** The formula \( Q = CIA \) is well known and assumed familiar to the user. The Rational Method is adequate method of approximating the peak rate of runoff from a rainstorm for small basins. Peak flow rates for each sub-basin should be calculated and these values together with the design points shall be identified on the drainage plan.

\[
Q = CIA \text{ where:} \\
Q = \text{discharge in cfs} \\
C = \text{runoff coefficient} \\
I = \text{rainfall intensity in in/hr} \\
A = \text{area in acres}
\]

1. **Runoff Coefficients:** For offsite or preliminary drainage report analysis, the runoff coefficients used with the Rational Method shall be based on land use as given in Table 6. This table includes the adjustment factor \( C_0 \) for antecedent moisture conditions, so no adjustment needs to be made to the runoff coefficients from Table 6. For final drainage reports, a site specific percent of impervious area shall be calculated, and then based upon the percent of imperviousness, Table 7 shall be utilized to determine the runoff coefficient \( C_0 \).
Table 6 – Runoff Coefficients Based on Assumed Development

<table>
<thead>
<tr>
<th>LAND USE</th>
<th>PERCENT IMPERVIOUS</th>
<th>RUNOFF COEFFICIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FREQUENCY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Type C Soils)</td>
</tr>
<tr>
<td>Business:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Areas</td>
<td>95</td>
<td>.80</td>
</tr>
<tr>
<td>Neighborhood Areas</td>
<td>85</td>
<td>.66</td>
</tr>
<tr>
<td>Residential:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-Family</td>
<td>55</td>
<td>.37</td>
</tr>
<tr>
<td>Multi-Unit (detached)</td>
<td>60</td>
<td>.41</td>
</tr>
<tr>
<td>Multi-Unit (attached)</td>
<td>75</td>
<td>.54</td>
</tr>
<tr>
<td>½ Acre Lots or Larger</td>
<td>40</td>
<td>.28</td>
</tr>
<tr>
<td>Apartments</td>
<td>80</td>
<td>.60</td>
</tr>
<tr>
<td>Industrial:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Areas</td>
<td>80</td>
<td>.60</td>
</tr>
<tr>
<td>Heavy Areas</td>
<td>90</td>
<td>.73</td>
</tr>
<tr>
<td>Parks, Cemeteries</td>
<td>5</td>
<td>.08</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>10</td>
<td>.11</td>
</tr>
<tr>
<td>Schools</td>
<td>50</td>
<td>.34</td>
</tr>
<tr>
<td>Railroad Yard Areas</td>
<td>15</td>
<td>.14</td>
</tr>
<tr>
<td>Undeveloped Areas:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Historic Flow Analysis,</td>
<td>2</td>
<td>.04</td>
</tr>
<tr>
<td>Greenbelts, Agricultural,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Vegetation,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clayey Soils, Sandy Soils,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offsite Flow Analysis,</td>
<td>45</td>
<td>.31</td>
</tr>
<tr>
<td>(When land use not defined)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paved</td>
<td>100</td>
<td>.89</td>
</tr>
<tr>
<td>Gravel</td>
<td>40</td>
<td>.28</td>
</tr>
<tr>
<td>Drives and Walks</td>
<td>90</td>
<td>.73</td>
</tr>
<tr>
<td>Roofs</td>
<td>90</td>
<td>.73</td>
</tr>
<tr>
<td>Lawns</td>
<td>0</td>
<td>.04</td>
</tr>
</tbody>
</table>
### Table 7 – Runoff Coefficients – Based on Percent of Imperviousness

<table>
<thead>
<tr>
<th>Percent of Impervious Area</th>
<th>Type C Hydrologic Soils</th>
<th>Type B Hydrologic Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Runoff Coefficients</td>
<td>Runoff Coefficients</td>
</tr>
<tr>
<td></td>
<td>2-yr</td>
<td>5-yr</td>
</tr>
<tr>
<td>0%</td>
<td>0.04</td>
<td>0.15</td>
</tr>
<tr>
<td>5%</td>
<td>0.08</td>
<td>0.18</td>
</tr>
<tr>
<td>10%</td>
<td>0.11</td>
<td>0.21</td>
</tr>
<tr>
<td>15%</td>
<td>0.14</td>
<td>0.24</td>
</tr>
<tr>
<td>20%</td>
<td>0.17</td>
<td>0.26</td>
</tr>
<tr>
<td>25%</td>
<td>0.20</td>
<td>0.28</td>
</tr>
<tr>
<td>30%</td>
<td>0.22</td>
<td>0.30</td>
</tr>
<tr>
<td>35%</td>
<td>0.25</td>
<td>0.33</td>
</tr>
<tr>
<td>40%</td>
<td>0.28</td>
<td>0.35</td>
</tr>
<tr>
<td>45%</td>
<td>0.31</td>
<td>0.37</td>
</tr>
<tr>
<td>50%</td>
<td>0.34</td>
<td>0.40</td>
</tr>
<tr>
<td>55%</td>
<td>0.37</td>
<td>0.43</td>
</tr>
<tr>
<td>60%</td>
<td>0.41</td>
<td>0.46</td>
</tr>
<tr>
<td>65%</td>
<td>0.45</td>
<td>0.49</td>
</tr>
<tr>
<td>70%</td>
<td>0.49</td>
<td>0.53</td>
</tr>
<tr>
<td>75%</td>
<td>0.54</td>
<td>0.58</td>
</tr>
<tr>
<td>80%</td>
<td>0.60</td>
<td>0.63</td>
</tr>
<tr>
<td>85%</td>
<td>0.66</td>
<td>0.68</td>
</tr>
<tr>
<td>90%</td>
<td>0.73</td>
<td>0.75</td>
</tr>
<tr>
<td>95%</td>
<td>0.80</td>
<td>0.82</td>
</tr>
<tr>
<td>100%</td>
<td>0.89</td>
<td>0.90</td>
</tr>
</tbody>
</table>

2. **Time of Concentration:** The time of concentration is necessary for use of the *Rainfall Intensity – Duration Curves (Figure 2)*. A separate time of concentration is necessary for the overall basin and each sub-basin or design point. The time of concentration is also known as the “inlet time” and represents the time for a unit of water to travel from the most remote portion of the basin to the design point. The time of concentration \( T_c \) is composed of the overland flow time \( t_o \) and channel or conduit flow time \( t_i \). The time of concentration formula shown below. The 5-year coefficient factor shall be used to obtain the rainfall intensity for all frequencies of storms. The minimum time of concentration shall be assumed to be ten (10) minutes.

\[
T_c = t_o + t_i
\]

Where

- \( T_c \) = time of concentration, minutes (ten minutes minimum)
- \( t_o \) = overland flow time
- \( t_i \) = channel or conduit flow time

From USDA-SCM, the overland flow time \( t_o \) may be taken as:

\[
t_o = 0.395 \frac{(1.1 - C_s) L^{1/3}}{(S)^{1/3}}
\]

Where:

- \( t_o \) = time of overland flow, minutes
- \( L \) = distance of overland flow, ft (not to exceed 500 ft for non-urban land uses, & 300 ft maximum for urban land uses.)
- \( S \) = average slope of basin, in percent
- \( C_s \) = runoff coefficient for 5-year storm
Figure 4 – Ground Cover Velocities may be used to determine the velocity in the following formula for $t_o$.

$$t_o = \frac{L}{60v}$$

Where: $t_o =$ overland flow time in minutes  
$L =$ travel distance of overland flow from the most remote location in the basin or sub-basin (ft)  
$v =$ average velocity of flow (fps)  

Or, for developed watersheds only,

$$t_o = \frac{L}{180} + 10 \text{ (min)}$$

Whichever is lesser for $t_o$ from these two equations.

The channel or conduit flow time ($t_i$) is to be determined from the velocity of flow computed for the hydraulic properties of the channel, ditch, gutter, pipe or sewer. Manning’s equation for channel flow is useful for these calculations:

$$t_i = \frac{L}{60v}$$

Where: $t_i =$ conduit flow time in minutes  
$L =$ distance of flow along hydraulic structure (ft)  
$v =$ average velocity of flow (fps)

For swales or shallow gutter flow, Figure 5 – Channel or Conduit Flow Time Nomograph may be used to determine $t_i$.

b) Colorado Urban Hydrograph Procedure (CUHP): Runoff for basins between 90 and 130 acres must be determined using the Colorado Urban Hydrograph Procedure. This procedure is detailed in USDCM (Volume 1 - Runoff).
SECTION 5.0
HYDRAULIC STRUCTURES

5.1 GENERAL
The preliminary and final designs of hydraulic structures shall be as specified in this section and
in accordance with USDCM (Volumes 1 and 2).

5.2 OPEN CHANNELS
Open channels are subdivided into two classes: major channels and minor channels. Major channels
include all drainageways and all other channels, which convey major storm discharges greater than
100 cfs, or any channel that has a designated flood plain on the City’s Official Flood Hazard Map.
Any major channel constructed must meet the "Maintenance Eligibility Guidelines" established by
the UDFCD. All other channels are minor channels.

Computation of the water-surface profile shall be provided for all open channels utilizing standard
backwater methods, taking into consideration losses due to changes in velocity, changes in channel
cross section, drops, junctions, or obstructions.

1) Grass Lined
Only grass lined or natural-like channels will be considered acceptable for major drainageways
unless physical constraints caused by existing development makes their use infeasible. Grass
lined or natural-like channels are the preferred channels because they provide channel storage,
lower velocities, pollution removal, and greenbelt multiple use benefits. Natural-like channels
are drainageways that are carved by nature before urbanization and then improved so that they
can withstand the effects of urbanization. Any design, however, which has characteristics outside
of the limits of Tables 8 and 9, shall receive special scrutiny in the review.

2) Concrete Lined Channels
Concrete lined channels are to be avoided. Concrete lining will be considered when hydraulic,
topographic, or limited right-of-way prohibits the use of grass lined or natural-like channels. If
flow in open channel is unstable or supercritical and/or right-of-way is insufficient for a grass
lined channel, then a concrete channel may be the best solution. If project constraints dictate the
use of concrete lined channel then the Design Engineer must present the concept with justification
to the Public Works Department for approval. For design criteria for concrete lined channels
refer to USDCM (Volume 1 – Major Structures). Concrete lined channels must be used if the
Froude Number exceeds 0.8, unless velocity data can be confirmed to be less than 4.5 feet per
second.

3) Rock Lined Channels
Riprap lined channels will be permitted only in areas of existing development where available
right-of-way prohibits the use of grass lined channels. If project constraints dictate the use of
riprap lining, then the Design Engineer must present the concept, with justification to the Public
Works Department for approval. Riprap lined channels shall be designed to have a Froude No.
less than 0.8 and be designed in accordance with USDCM (Volume 1 – Major Structures).

4) Trickle Channels
Low flows and the base flows from urban areas especially in the summer tend to be continuous
due to lawn irrigation return flows and other sources. Continuous flow over grasses will destroy
the grass, cause boggy nuisance conditions, and increase the erodibility of the soils. A trickle
channel or low flow channel shall be provided in major channels to provide acceptable flow
characteristics at low flows. Trickle channels shall be lined with natural-like linings in order to
provide habitat benefits and water quality treatment. When necessary riprap or concrete low
flow/trickle channels will be considered. The design capacity of the trickle channel shall be 2% of the 100-year design flow of the channel.

Table 8 – Major Channel Design Criteria

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Grass: Erosive Soils</th>
<th>Grass: Erosion Resistant Soils</th>
<th>Riprap</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum 100-Year Velocity</td>
<td>5.0 fps</td>
<td>7.0 fps</td>
<td>12.0 fps</td>
<td>18.0 fps</td>
</tr>
<tr>
<td>Minimum Manning's n:</td>
<td>0.03</td>
<td>0.03</td>
<td>0.023</td>
<td>0.014</td>
</tr>
<tr>
<td>For computing velocity, assessing scour potential and flow regime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Manning's n:</td>
<td>0.035</td>
<td>0.035</td>
<td>0.033</td>
<td>0.016</td>
</tr>
<tr>
<td>For computing depth of flow and channel capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Froude Number*</td>
<td>0.5</td>
<td>0.8</td>
<td>0.8</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum Depth (excluding trickle channel)</td>
<td>5.0 ft.</td>
<td>5.0 ft</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum Longitudinal Grade</td>
<td>0.6 %</td>
<td>0.6 %</td>
<td>1.0 %</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum Side Slope</td>
<td>Not Steeper than 4 H: 1 V</td>
<td>Not Steeper than 4 H: 1 V</td>
<td>Not Steeper than 2.5 : 1</td>
<td>N/A</td>
</tr>
<tr>
<td>Minimum Centerline Radius</td>
<td>Radius = 2 x top width of channel, but not less than 100 ft.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Freeboard Subcritical Flow Straight Sections:</td>
<td>1.0 ft.</td>
<td>1.0 ft</td>
<td>2.0 ft</td>
<td>2.0 ft</td>
</tr>
<tr>
<td>Subcritical Flow Curved Sections -- increase minimum by</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supercritical Flow – increase minimum by</td>
<td>N/A</td>
<td>N/A</td>
<td>0.025 * v* y</td>
<td></td>
</tr>
<tr>
<td>Trickle/Low Flow Channel</td>
<td>Design to contain 2% of the major storm flow.</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Maintenance Access</td>
<td>10 feet minimum width</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outfalls into Channel</td>
<td>Not less than 1 ft above channel invert.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Froude No. \( (N_F = \frac{V}{(gD)^{1/3}}) \), where "D" is the hydraulic depth = (area/top width).

Table 9 – Design Criteria, Minor Grass Lined Channels

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Runoff Discharge (Initial and Major Storms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity</td>
<td>Less than 7.0 fps</td>
</tr>
<tr>
<td>Depth</td>
<td>Less than 2.0 ft.</td>
</tr>
<tr>
<td>Side Slopes</td>
<td>Not steeper than 2:1</td>
</tr>
<tr>
<td>Freeboard</td>
<td>At least 0.5 ft.</td>
</tr>
<tr>
<td>Top Width (major storm)</td>
<td>Less than 10.0 ft.</td>
</tr>
<tr>
<td>Froude No.</td>
<td>Less than 0.7</td>
</tr>
<tr>
<td>Minimum Longitudinal Grade</td>
<td>2.0 %*</td>
</tr>
</tbody>
</table>
*If minimum longitudinal grade is less than 2%, then a trickle/low flow channel must be provided.
<table>
<thead>
<tr>
<th>Channel Type</th>
<th>n-value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Earth Lined (Ditches and Canals)</strong></td>
<td></td>
</tr>
<tr>
<td>1. Clean, after weathering</td>
<td>0.018 to 0.020</td>
</tr>
<tr>
<td>2. Short grass, some weeds</td>
<td>0.022 to 0.027</td>
</tr>
<tr>
<td>3. Grass, some weeds</td>
<td>0.025 to 0.030</td>
</tr>
<tr>
<td>4. Dense Weeds</td>
<td>0.030 to 0.035</td>
</tr>
<tr>
<td>5. Sides clean, gravel bottom</td>
<td>0.025 to 0.030</td>
</tr>
<tr>
<td>6. Sides clean, cobble bottom</td>
<td>0.030 to 0.040</td>
</tr>
<tr>
<td><strong>B. Natural Streams</strong></td>
<td></td>
</tr>
<tr>
<td>1. Some grass and weeds, no brush</td>
<td>0.030 to 0.035</td>
</tr>
<tr>
<td>2. Dense weeds</td>
<td>0.035 to 0.050</td>
</tr>
<tr>
<td>3. Some weeds, light brush on banks</td>
<td>0.035 to 0.050</td>
</tr>
<tr>
<td>4. Some weeds, heavy brush on banks</td>
<td>0.050 to 0.070</td>
</tr>
<tr>
<td>5. Some weeds, dense willows on banks</td>
<td>0.060 to 0.080</td>
</tr>
<tr>
<td>6. Trees in channel, with branches submerged at high stage.</td>
<td>0.01 to 0.02</td>
</tr>
<tr>
<td>Increase values above by...</td>
<td></td>
</tr>
<tr>
<td>7. Irregular section, with pools, meandering channel.</td>
<td>0.01 to 0.02</td>
</tr>
<tr>
<td>Increase values above by...</td>
<td></td>
</tr>
<tr>
<td>8. Bottom gravel, cobbles with few boulders</td>
<td>0.04 to 0.05</td>
</tr>
<tr>
<td>9. Bottom cobble, with large boulders</td>
<td>0.05 to 0.07</td>
</tr>
<tr>
<td><strong>Grass-Lined (Man-Made) (Flow Depths up to 0.7 foot) &amp; Velocities between 2 &amp; 7 fps:</strong></td>
<td></td>
</tr>
<tr>
<td>10. Bermuda, Kentucky, or Buffalo grass</td>
<td></td>
</tr>
<tr>
<td>a. Mowed to 2 inches</td>
<td>0.045 to 0.07</td>
</tr>
<tr>
<td>b. Mowed to 4 to 6 inches</td>
<td>0.05 to 0.09</td>
</tr>
<tr>
<td>11. Good stand any grass</td>
<td></td>
</tr>
<tr>
<td>a. Up to 12 inches</td>
<td>0.08 to 0.14</td>
</tr>
<tr>
<td>b. Up to 24 inches</td>
<td>0.15 to 0.30</td>
</tr>
<tr>
<td>12. Fair stand of any grass</td>
<td></td>
</tr>
<tr>
<td>a. Up to 12 inches</td>
<td>0.08 to 0.14</td>
</tr>
<tr>
<td>b. Up to 24 inches</td>
<td>0.13 to 0.25</td>
</tr>
<tr>
<td><strong>Grass-Lined (Man-Made) (Flow Depths 0.7 ft to 1.5 ft) &amp; Velocities between 2 &amp; 7 fps:</strong></td>
<td></td>
</tr>
<tr>
<td>13. Bermuda, Kentucky, or Buffalo grass</td>
<td></td>
</tr>
<tr>
<td>a. Mowed to 2 inches</td>
<td>0.035 to 0.05</td>
</tr>
<tr>
<td>b. 4 to 6 inches</td>
<td>0.04 to 0.06</td>
</tr>
<tr>
<td>14. Good stand any grass</td>
<td></td>
</tr>
<tr>
<td>a. Up to 12 inches</td>
<td>0.07 to 0.12</td>
</tr>
<tr>
<td>b. Up to 24 inches</td>
<td>0.10 to 0.20</td>
</tr>
<tr>
<td>15. Fair stand of any grass</td>
<td></td>
</tr>
<tr>
<td>a. Up to 12 inches</td>
<td>0.06 to 0.10</td>
</tr>
<tr>
<td>b. Up to 24 inches</td>
<td>0.09 to 0.17</td>
</tr>
<tr>
<td><strong>C. Riprap Lined</strong></td>
<td></td>
</tr>
<tr>
<td>a. Ordinary Riprap</td>
<td>0.0395*ds0</td>
</tr>
<tr>
<td>b. Grouted Riprap</td>
<td>0.035 to 0.045</td>
</tr>
<tr>
<td><strong>D. Concrete Lined</strong></td>
<td></td>
</tr>
<tr>
<td>a. Float finish</td>
<td>0.014</td>
</tr>
<tr>
<td>b. Broom finish</td>
<td>0.016</td>
</tr>
</tbody>
</table>

11 Where ds0 = the mean stone size in feet. Note--This equation does not apply to very shallow flow.
5.2 CULVERTS

Culverts are to be sized so that in the 2-year storm a minimum cleansing velocity of 3 fps is provided. The major storm design criteria are governed by the allowable street inundation as provided in Table 11. Culverts at a minimum shall be sized to convey the 5-year storm without overtopping, and convey the difference between the 100-year storm and the allowable street overtopping, whichever is larger. Private driveway crossings over roadside ditches are required at a minimum to convey the 2-year storm.

All culverts shall be designed with headwalls and wing walls, or with flared end sections at the inlet and outlet. All culverts shall be designed and installed to be resistant to damage from mowing equipment and errant vehicles. All culverts shall be designed in accordance with the procedures in USDCM (Volume 2 - Culverts, and Volume 1 - Storm Sewers).

Outlet velocities of all culverts must be checked. When the outlet velocity exceeds the maximum permissible channel velocity listed in Table 8 or Table 9, outlet protection shall be provided to minimize potential Erosion at outlet. Guidelines to design riprap outlet protection and energy dissipaters can be found in USDCM (Volume 2 - Hydraulic Structures).

Conduit materials acceptable for use in culvert construction include concrete, corrugated metal pipes, and HDPE pipe.

5.3 RIRAP

The design of riprap protection for culverts, channel protection, check drops, bridges, or other areas subject to Erosion shall be in accordance with USDCM (Volume 1 – Major Drainage and Volume 2 – Hydraulic Structures)

5.4 STORM RUNOFF IN STREETS

The primary use of streets is for movement of people and providing access to homes and businesses. Streets are also an important component of the urban storm drainage system. Storm flows from public and private properties are normally directed to the public way, where these flows are collected in curbs and gutters, until excess flows are directed into inlets and the storm sewer system, then the flows are conveyed to a stormwater management facility or a receiving water body. Stormwater flows in curbs and streets can cause vehicle hydroplaning as well as exert momentum forces on cars, pavement, and pedestrians. When street flooding occurs traffic is interrupted. Therefore, it is necessary to set limits on flow velocities and depths in order to limit the hazards and inconvenience associated with heavy street flows. The allowable gutter flow in streets shall not exceed the values given in Figure 6 – Street Flows – Allowable Capacities.

The allowable flow figures provided were obtained using the Modified Manning’s Formula, limiting the depth of flow for in the streets for storm runoff by the criteria in Table 11, and then applying reduction factors that limit flow velocities and account for reductions due to parked and moving vehicles that obstruct flows. If the Design Engineer encounters street cross slopes that are not 2 percent, then theoretical flow can be calculated using the Modified Manning’s Formula for each flow segment and applying the reduction factors found in Figure 7 – Reduction Factors for Allowable Gutter Capacity.

Modified Manning’s Formula for approximating flow in shallow triangular channels:

\[ Q = 0.56 \cdot z/n \cdot s \cdot y \]

Where:
- \( Q \) = Flow in cfs
- \( z \) = reciprocal of the cross slope
- \( n \) = Manning Roughness Coefficient
- \( y \) = depth of flow in the deepest part of the channel
Calculating street flows involves determining the flow for each segment with a different cross slope and Manning's Roughness Coefficient and summing the gutter, pavement, sidewalk, and landscaped segments together.

### Table 11 – Allowable Street Inundation

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Initial Storm Runoff – 2- Year Storm</th>
<th>Maximum Encroachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>No curb overtopping. Flow may spread to crown of street.</td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td>No curb overtopping. Flow must leave at least one 10' wide lane free of water.</td>
<td></td>
</tr>
<tr>
<td>Arterial</td>
<td>No curb overtopping. Flow spread must leave at least one 10' wide lane free of water in each direction.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Maximum Encroachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local and Collectors with Mountable Curbs</td>
<td>The depth of water over the gutter flowline shall not exceed 7.5 inches.*</td>
</tr>
<tr>
<td>Local and Collectors with Vertical Curbs</td>
<td>The depth of water over the gutter flowline shall not exceed 9.5 inches.*</td>
</tr>
<tr>
<td>Arterials</td>
<td>Depth of water shall not exceed 6 inches at the street crown, in order to allow operation of emergency vehicles, and not exceed 9.5 inches at the gutter flowline, whichever is more restrictive.*</td>
</tr>
</tbody>
</table>

*RResidential, public, commercial, and industrial development occurred prior to street improvements in most areas of Englewood. Streets were built to best-fit existing improvements. Therefore finish floor elevations are not necessarily elevated above the back of walk.

### 5.5 Inlets

The storm sewer and inlet system design is dependent upon the following factors: street classification, the allowable street inundation, and the allowable street flows. Therefore where the accumulated stormwater flows in the street is close to the allowable capacity as determined by the factors identified above, then a street inlet shall be installed.

1) **Standard Inlets**

The standard inlets permitted for use in the City are:

### Table 12 – Standard Inlets Permitted

<table>
<thead>
<tr>
<th>Inlet Type</th>
<th>Standard Detail</th>
<th>Permitted Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 16 Open Throat Inlet</td>
<td>D-2-4</td>
<td>All Street Types</td>
</tr>
<tr>
<td>Type C Inlet</td>
<td>D-10</td>
<td>Medians and Detention Ponds where vehicle and pedestrian traffic is not permitted.</td>
</tr>
<tr>
<td>Type 13 Inlet</td>
<td>D-6-8</td>
<td>Alleys and Private Drives and Streets</td>
</tr>
<tr>
<td>Type R Curb Inlet</td>
<td>D-9</td>
<td>All Street Types</td>
</tr>
</tbody>
</table>
2) **Inlet Hydraulics**

a) **Continuous Grade Condition:** Inlet capacity on a continuous grade depends on flow depth, street cross slope, height and length of curb opening, depression at the inlet, inlet grate geometry, and debris and trash on the street. UDFCD has computer software design aids on their web site at [http://www.udfcd.org/](http://www.udfcd.org/)

1. **Type 13 Inlets:** In order to determine the efficiency of a grate inlet, gutter flow is divided into two parts: frontal flow and side flow. Frontal flow is that portion of the street flow that is within the width of the grate. The portion of street flow outside the width of the grate is side flow. Frontal flow can be calculated as:

   \[ Q_w = Q - Q_s \]

   Where:
   - \( Q_w \) = Frontal flow within the width of the grate (W)
   - \( Q \) = Total gutter and street flow in cfs
   - \( Q_s \) = Side flow (i.e. the flow outside the width of the inlet grate) in cfs

   The Federal Highway Administration (FHWA) has developed equations for calculating flow rates in gutters with composite cross slopes.

   \[ Q_s = Q \times (1 - E_o) \]

   \[ E_o = \frac{1}{1 + \sqrt[4]{\frac{Sw}{S_x} \left[ 1 + \frac{Sw}{S_x} \right] \frac{T}{W} - 1}} \]

   *Figure 8 - \( E_o \) in FHWA Equation for Composite Slopes*, provides approximate values of \( E_o \), if \( T \) and the street cross slope are known.

![Diagram of Type 13 Inlets](image)

- **W** = Width of the grate
- **T** = Total spread of the water in the gutter and street in ft.

The ratio of the frontal flow intercepted by the inlet to the total frontal flow is:

\[ R_f = \frac{Q_{wi}}{Q_w} = 1.0 - 0.09 (V - V_o), \text{ for } V > V_o, \text{ otherwise } R_f = 1.0 \]

Where:
- \( Q_{wi} \) = Frontal flow intercepted by the inlet in cfs
- \( V \) = Velocity of flow in the gutter in fps
- \( V_o \) = Splash-over velocity in fps
Splash-over velocity is the minimum velocity causing some water in the gutter to shoot over the grate. Since the splash-over velocity is a function of the grate length and type, and since Type 16 inlets are the only permissible street grate inlet type, the formula becomes:

$$V_o = 0.30 + 4.85L - 1.31L^2 + 0.15L^3$$

Where: \( L \) = Length of grate inlet

The ratio of the side flow intercepted by the inlet to the total side flow is:

$$R_s = \frac{1}{\frac{1.8}{1 + 0.15V} - \frac{2.3}{S_s \cdot L}}$$

Where: \( V \) = Velocity of flow in the gutter and street fps
\( L \) = Length of grate inlet

The capture efficiency, \( E \), of the grate inlet is:

$$E = Rf \cdot \left(\frac{Q_s}{Q}\right) + R_s \cdot \left(\frac{Q_s}{Q}\right)$$

Then the flow intercepted by the inlet is given by:

$$Q_1 = E \cdot Q$$

2. **Type R Curb Inlets:** The efficiency of a curb-opening inlet is:

$$E = 1 - \left(1 - \frac{L}{L_T}\right)^{1.8}$$

Where: \( L \) = Curb-opening length
\( L_T \) = Curb-opening length required to capture 100% of gutter flow in ft

For a depressed curb-opening inlet such as the required Type R and Type 16 inlets:

$$L_T = 0.6 \cdot Q \cdot St. \cdot \left[\frac{1}{n \cdot S_e}\right]^{0.42 \cdot 0.3 \cdot 0.6}$$

Where: \( Q \) = Total gutter and street flow in c
\( St. \) = Longitudinal street grade in ft/ft.
\( S_e \) = The equivalent cross slope for the composite slopes

$$S_e = S_x + \left(a/W\right) \cdot E_o$$

Where: \( a \) = Gutter depression in ft
\( W \) = Width of the gutter
\( E_o \) = Ratio of the flow in the depressed gutter section to the total flow

For standard conditions, i.e. 2-inch gutter depression, 2-ft wide gutter pan:

$$S_e = S_x + \left(0.085\right) \cdot E_o$$

3. **Type 16 Open Throat Inlets:** Combination inlets take advantage of the debris removal capabilities of the curb-opening inlet and the capture efficiency of the grate inlet. The interception capacity is found by calculating the interception capabilities of the grate. This is because the curb opening does not add any length to the weir equation used in calculating the interception rate.
b) **Sump Condition:**

Inlets in sumps function as weirs for shallow depths, but as depth of stormwater increases, they begin to function like an orifice. The UDSCM – Volume 1, Streets/Inlets/Storm Sewers, provides the procedure for this analysis. The street ponding depths are governed by the allowable street inundation values indicated in Table 11. Therefore street public way inlets should be sized in accordance with the following weir equation:

\[
Q = (1 - C) \times C_v \times L_v \times d
\]

Where:
- \(Q\) = Inlet capacity in cfs
- \(C\) = Inlet clogging factor
- \(C_v\) = Weir discharge coefficient
- \(L_v\) = Weir length
- \(d\) = Flow depth in ft

<table>
<thead>
<tr>
<th>Inlet Type</th>
<th>(C_v)</th>
<th>(L_v)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type R Curb Inlet*</td>
<td>2.30</td>
<td>(L + 1.8W)</td>
</tr>
<tr>
<td>Grated Type 13 Inlet</td>
<td>3.00</td>
<td>(L + 2W)</td>
</tr>
<tr>
<td>Combination Type 16 Open Throat Inlet(^{12})</td>
<td>3.00</td>
<td>(L + 2W)</td>
</tr>
<tr>
<td>* If (L)&gt;12-feet, then use-----------------------------------------------</td>
<td>3.00</td>
<td>(L)</td>
</tr>
</tbody>
</table>

Inlets placed in sumps typically function in a submerged condition, where velocities are low. It is typical for street flows to carry debris during a storm event, and because of the low velocities and the restricted entrance to the inlet, the debris accumulates at the inlet. Therefore sizing inlets placed in sumps must include a clogging factor. Because the amount of clogging tends to decrease as the inlet length increases, a variable clogging factor shall be used:

**Table 14- Variable Clogging Factors**

<table>
<thead>
<tr>
<th>Inlet Type</th>
<th>Single Unit Clogging Factor</th>
<th>Double Unit Clogging Factor</th>
<th>Triple Unit Clogging Factor</th>
<th>Quadruple Unit Clogging Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grated Type 13 Inlet</td>
<td>0.5</td>
<td>0.375</td>
<td>0.292</td>
<td>0.23</td>
</tr>
<tr>
<td>Type R Curb Inlet</td>
<td>0.1</td>
<td>0.063</td>
<td>0.044</td>
<td>0.033</td>
</tr>
<tr>
<td>Combination Type 16 Open Throat Inlet</td>
<td>0.25</td>
<td>0.156</td>
<td>0.109</td>
<td>0.083</td>
</tr>
</tbody>
</table>

Or the Clogging Factor may be calculated from the following equations:

\[
C = \frac{2^3 \times 4^{N-1}}{N}
\]

Or when \(N\) becomes very large, this equation converges to:

\[
C = \frac{C_0}{N (1 - \epsilon)}
\]

\(^{12}\) For weir flow, the capacity of the combination inlet is equal to the capacity of the grate portion only. This is because the curb opening does not add any length to the weir equation. However Englewood allows a smaller clogging factor and smaller decay ratio in recognition that combination inlets are less likely to clog.
Where: 
\[ C = \text{Multiple unit clogging factor} \]
\[ C_0 = \text{Single unit clogging factor} \]
\[ e = \text{Decay ratio} - 0.50 \text{ for grate inlets,} \]
\[ 0.25 \text{ for curb opening and combination inlets} \]
\[ N = \text{Number of units} \]

5.6 **STORM SEWERS**

1) **Design Criteria**

The hydraulic analysis of storm sewer systems shall be in accordance with the criteria presented in the USDCM, Volume 1 – Streets, Inlets, and Storm Sewers. Final grades, street geometries, types of construction, and all other street details relative to the design, construction, or operation of the storm sewer system must be approved by the Public Works Director.

Storm Sewer Design Criteria shall be as shown in Table 15.

**Table 15 – Storm Sewer Design Criteria**

<table>
<thead>
<tr>
<th></th>
<th>Initial Storm</th>
<th>Major Storm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Velocity</td>
<td>3.0 fps</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum Velocity</td>
<td>16.0 fps</td>
<td>20.0 fps</td>
</tr>
</tbody>
</table>

The design of the storm sewer system shall include hydraulic analysis of both the minor and the major storm events. The hydraulic grade line (HGL) shall be calculated by accounting for pipe friction losses, expansion, contraction, bend, and junction losses. The methods for estimating these losses are provided in USDCM (Volume 1 – Storm Sewers). The HGL shall be plotted for all storm sewers. The HGL shall not be higher than 6-inches below the gutter flowline. When the hydraulic grade line cannot meet the 6-inch criteria then the capacity of the storm sewer will need to be improved by increasing pipe sizes.

a) **Construction Materials:** Storm sewers shall be constructed of reinforced concrete (Class III is the required minimum) meeting current CDOT Specifications. The systems shall be designed to handle anticipated loads. Other types of pipe material and sizes may be acceptable on private property, but the owner will be responsible for it. The Public Works Department may allow alternative pipe materials, if justified.

b) **Minimum Pipe Diameter:** The minimum pipe diameter of storm sewers shall be 15 inches.

c) **Horizontal Alignment:** Storm sewers shall usually be straight between manholes. Long radius curves are permitted for pipe diameters equal or larger than 24 inches. The radius of curvature shall not be less than 100 feet.

Storm sewers shall be no closer than 5 feet, horizontally from a sanitary sewer or water line.

Spacing of manholes shall conform to Table 16. Manholes shall conform to **Figure 14 – Standard Manhole Details.**

**Table 16 – Manhole Spacing**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 inches to 36 inches</td>
<td>400 feet</td>
</tr>
<tr>
<td>42 inches or greater</td>
<td>500 feet</td>
</tr>
</tbody>
</table>

The minimum width of easement for installation of a storm sewer shall be the pipe diameter plus 15 feet with the pipe normally centered in the easement.
d) **Vertical Alignment:** Whenever possible, the crowns of the inlet and exit pipe should be aligned when the downstream pipe is larger than the upstream pipe within a manhole, in order to minimize backwater effects. The elevation drop through a manhole shall be no less than 0.2 feet. See in USDCM (Volume 1 - Storm Sewers) for guidelines about shaping manhole bottoms and other details.

Storm sewer grades shall be such that a minimum 18 inches cover over the crown of the RCP is maintained. If less cover is shown, the Engineer shall submit his pipe structural design to the Public Works Director for approval. Uniform slopes shall be maintained between manholes. Final grades shall be set with full consideration to capacity required, sedimentation problems, and other design parameters. The minimum slope shall be capable of producing a velocity of 3 feet per second when the sewer is conveying initial storm flows.

When an existing culvert is to be extended and the grade changes, a concrete collar as shown in *Figure 15 – Concrete Pipe Collar Detail* shall be used.

Storm sewer shall be no closer than 18 inches vertically from any other utility line.

e) **Storm Sewer Outlets:** Erosion protection shall be provided at the outlet in accordance with the criteria presented in the Riprap and Culvert Sections of this Chapter. All storm sewer outlets into open channels shall be constructed with a headwall and wing walls or a flared end section.

### 5.7 BRIDGES

The hydraulic design of bridges in Englewood shall be in accordance with USDCM (Volume 2 – Hydraulic Structures).
SECTION 6.0
DETENTION FACILITIES

6.1 GENERAL
Detention ponds shall be provided to control the peak stormwater runoff rates for all new land developments or redevelopments. Detention ponds should be constructed outside of major drainage ways. If this cannot be done, then the required volume and release rates shall be based upon site requirements, and the additional emergency overflow and freeboard requirements will be based upon the entire basin tributary to the drainage way. Offsite runoff should be routed around the detention pond, otherwise the required volume and release rates shall be based upon site requirements, and the additional emergency overflow and freeboard requirements will be based upon the entire basin tributary to the detention facility.

6.2 VOLUME AND RELEASE CRITERIA
Detention of storm water is intended to reduce the impact of development upon the peak discharge of the drainage basin. Controlling the rate of discharge of storm water runoff at calculated Historic levels for a number of small sites often will not reduce the discharge to historic levels for the entire watershed if each individual site is allowed to release storm flows at the peak historic rate for extended periods of time. Therefore in order to control the combined discharges at more nearly historic levels, detention facilities are to be provided which meet the following criteria as developed by the City of Lakewood:

\[
\begin{align*}
\text{5-Year Storm} & : & V_5 &= (36 \, C_1 \, A) \\
& & Q_5 &= .2 \, A \\
\text{100-Year Storm} & : & V_{100} &= (66 \, C_1 \, A) \\
& & Q_{100} &= 1.0 \, A \\
\end{align*}
\]

where:

- \( V \) = Volume of pond in cubic feet
- \( C_1 \) = Percent Imperviousness of basin
- \( A \) = Area of Basin in Acres *
- \( Q_s \) = Release rate in cfs for design storm being considered

*Note: The area of basin for purpose of computing pond volumes shall be the area being developed. The area of basin used for determining the release rate shall be the entire basin tributary to the detention facility, which may include, in some instances, offsite contributing areas, as well as deductions for portions of the site that cannot be graded to drain to the detention pond.

6.3 DETENTION FACILITY CONSTRUCTION CRITERIA

1) Detention Pond Requirements
All detention ponds built in landscaped areas or natural areas shall be covered with topsoil and landscaped and/or revegetated. Detention ponds when properly landscaped can be an attractive part of a development. Other detention pond requirements include:

- Minimum turf slope 2%, if detention pond bottom is less than 2%, then a trickle/low flow channel must be provided
- Minimum paved slope (asphalt parking areas = 0.75%, concrete parking areas = 0.50%)
- Minimum concrete gutter or trickle pan slope – 0.50%
0 Pond embankment side slopes:
    4:1 desirable
    3:1 maximum

    If steeper side slopes are desired, then engineered segmental block or stacked rock
    walls will be considered.

0 Minimum freeboard at 100-year depth = 1.0 foot
    = 0.25 feet for parking lots and cul-de-sacs

0 Outlet pipe diameter – 12 inches minimum with orifice control if required.

0 Minimum orifice diameter is 3-inches, weir control outlets should be used in lieu of
    small diameter orifices.

0 Minimum rectangular weir width is 2-inches, V-notch weir control should be used in
    lieu of small rectangular weirs.

2) Release Structures
   The release structure shown in USDCM (Volume 3 — Best Management Practices)
   is to be used unless specific site related circumstances dictate otherwise.

3) Maximum Detention Durations:
   If children are apt to play in the vicinity of the impoundment, then flat side slopes should be
   utilized and steep slopes and sudden drop-offs avoided around the edges to the detention pond.
   Providing features that discourage public entry is also encouraged. This can be done by installing
   thick or thorny shrubs or other features around the periphery and near the outlet. In addition it is
   best to avoid long detention periods. The maximum detention periods allowed are:

   Land Use                  5-year         100-year
   Parks, Playgrounds, Other 6 hrs          24 hrs
   Parking Lots              2.5 hours¹⁴  4 hours¹⁴

4) Detention Pond Depths in Parking Areas¹⁵
   5-year storm   - 0.5 foot maximum¹⁴
   100-year storm - 1.0 foot maximum¹⁴

5) Maintenance
   The Owner and subsequent owners, heirs, successors, and assigns shall maintain Stormwater
   detention ponds. In the event that the maintenance is not performed by said owner, the City of
   Englewood shall have the right to enter such area(s) and perform the necessary work, the cost of
   which said owner, heirs, successors, will be responsible for paying upon billing. Detention
   facilities shall be designed so that they are accessible to maintenance equipment as well as for
   removal of silt and debris and for repairs that may need to occur.

6) Emergency Stormwater Passage
   The detention pond shall be so designed to safely pass the maximum peak discharge for a major
   storm (100-year) assuming the outlet structure is inoperative and the upstream watershed is fully
   developed to current zoning or current development, whichever provides the greater runoff. No
   buildings or structures shall be constructed in the path of the emergency storm water passage.

¹³ These values may be doubled for extended detention basins designed to mitigate the impacts of urbanization.
¹⁴ These values may be doubled for remote, little used areas of parking lots. Detention pond advisory signs will
    need to be provided in parking lots anywhere design depths exceed 6-inches.
¹⁵ Any time parking lot detention is proposed a letter signed by the owner shall be provided to the City which shall
    be recorded that states that the owner agrees to have the pond re-evaluated prior to resurfacing activities to
    determine the impact those activities will have on detention volumes and release rates.
7) **Drainage Plan Detention Pond Notes**

The following notes shall be included on the “Drainage Plan Sheets” for detention ponds.

a) Detention pond embankment shall have a minimum relative compaction of 95% at optimum moisture content of standard proctor. Provisions shall be made for watering of all native seeded areas until it is established.

b) The detention pond shall be blue top staked by the Developer prior to paving or sodding.

c) The detention pond volumes and all related drainage appurtenances (including basin boundaries) shall be determined and certified by a registered professional engineer prior to issuance of the certificate of occupancy for any structure on the site or in the Development.

d) No building or structure will be constructed in the detention areas and no changes or alterations affecting the hydraulic characteristics of the detention areas will be made without the approval of the Public Works Director.

e) Maintenance and operation of the detention areas will remain the responsibility of the property owner, if the property owner fails in this responsibility the City has the right to enter the property, maintain the detention areas, and require reimbursement for the costs that may be incurred.

8) **Plat Detention Pond Notes**

The following notes shall be included on plats when stormwater detention pond areas are required:

a) The storm water detention area(s) shown hereon shall be constructed and maintained by the owner and subsequent owners, heirs, successors, and assigns. In the event that said construction and maintenance is not performed by said owner, the City of Englewood shall have the right to enter such area(s) and perform the necessary work, the cost of which said owner, heirs, successors, and assigns agrees to pay upon billing.

b) No building or structure will be constructed in the detention area(s) and no changes or alterations affecting the hydraulic characteristics of the detention area(s) will be made without the approval of the Public Works Director.

For public stormwater detention or drainage easements, the following notes shall be included on the face of the plat.

a) The storm water detention / (drainage easement(s)) shown hereon are hereby granted to the City. This (these) easement(s) is (are) being conveyed for the purposes of operation, repair, alteration, and maintenance of the storm water management system. The maintenance and operation of the said facility (facilities) shall be the responsibility of the City providing the design, construction, and maintenance criteria of the City are followed and the said facility (facilities) has (have) been accepted. The City has the right to enter the property for the purposes for which this (these) easement(s) has (have) been granted.

b) No buildings, fills, excavations, structures, fences, or other alterations shall be constructed within a storm water detention (retention) / (drainage easement(s)) without the express written consent of the Public Works Director.
BY AUTHORITY

ORDINANCE NO. 28 SERIES OF 2005
COUNCIL BILL NO. 27
INTRODUCED BY COUNCIL MEMBER BRADSHAW

AN ORDINANCE AUTHORIZING THE ADOPTION OF THE "ENGLEWOOD STORM DRAINAGE CRITERIA MANUAL" FOR THE REGULATION OF THE STORMWATER UTILITY WITHIN THE CITY OF ENGLEWOOD, COLORADO.

WHEREAS, The Federal Clean Water Act requires stormwater discharges be authorized under a General Permit for Stormwater Discharge issued by the Colorado Department of Health and Environment, Water Quality Control Division; and

WHEREAS, the Colorado Discharge Permit System, Regulation 61, states that the City is responsible for the quality of the stormwater discharged from its jurisdiction; and

WHEREAS, rules and regulations regarding the Stormwater Utility are authorized under 12-5-1 EMC; and

WHEREAS, the City of Englewood has developed "Englewood Storm Drainage Criteria Manual" for the purpose of granting the authority to address drainage and water quality mandates that have been imposed by the Environmental Protection Agency (EPA) and the Colorado Department of Health and Environment; and

WHEREAS, the "Englewood Storm Drainage Criteria Manual" will affect large developments and will not be a burden on small lot development in the City of Englewood; and

WHEREAS, the "Englewood Storm Drainage Criteria Manual" gives the City and design engineers concise directions on what is required to meet the intent of the EPA mandates; and

WHEREAS, the Englewood Water and Sewer Board recommended Council approval of the "Englewood Storm Drainage Criteria Manual" at their June 7, 2005 meeting;

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF ENGLEWOOD, COLORADO, AS FOLLOWS:
Section 1. The City Council of the City of Englewood, Colorado hereby authorizes the adoption of the “Englewood Storm Drainage Criteria Manual” of May 23, 2005, as a requirement and regulation for the City of Englewood.

Section 2. Pursuant to Article V, Section 40, of the Englewood Home Rule Charter, the City Council has determined that this Ordinance shall be published by title because of its size. A copy of the Englewood Storm Drainage Criteria Manual is available in the Office of the Englewood City Clerk.

Introduced, read in full, and passed on first reading on the 20th day of June, 2005.

Published as a Bill for an Ordinance on the 24th day of June, 2005.

Read by title and passed on final reading on the 11th day of July, 2005.

Published by title as Ordinance No. 28, Series of 2005, on the 15th day of July, 2005.

ATTEST

Lourcshia A. Ellis, City Clerk

Douglas Garrett, Mayor

I, Lourcshia A. Ellis, City Clerk of the City of Englewood,Colorado, hereby certify that the above and foregoing is a true copy of the Ordinance passed on final reading and published by title as Ordinance No. 28, Series of 2005.

Lourcshia A. Ellis
INITIAL REVIEW CHECKLIST

Developer or Design Engineer:

The drainage report for the location described below has been received and lacks the required information noted. All the missing information must be provided before this report will be accepted for review. If you have any questions, call the City Review Engineer. This checklist must be returned with your submittal.

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Initial Review Checklist
Appendix B

V. OTHER

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* Not required for Preliminary Reports
# DRAINAGE REPORT REVIEW CHECKLIST

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<td>4. Offsite drainage flow patterns and impacts.</td>
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<td>K. Design Point Flow Data Shown (Initial and Major)</td>
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<td>L. Street Names and Grades</td>
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<td>M. Property Lines &amp; ROW Lines</td>
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<td>N. Easements</td>
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<td>O. Storm Sewer Layout with Sizes</td>
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<td>P. Storm Inlet Locations</td>
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<td>Q. Cross Pan Locations</td>
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<td>R. Open Channel Drainageways</td>
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<td>S. Detention Pond Location(s)</td>
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<td>4. Release Rates</td>
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<td>5. 5-year and 100 year Depths*</td>
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<td>6. 5-year and 100-year Volumes</td>
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<td>T. Location and Elevation of Outfall Points</td>
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<td>4. Historic Initial and Major</td>
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<td>U. Irrigation Ditch</td>
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<td>V. Flood Plain and Floodway Information</td>
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<td>W. Critical Minimum Finish Floor Elevations</td>
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<td>AA. <em>Standard Notes</em></td>
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<td>V. OTHER</td>
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City Review Engineer: Date: Phone:
SMALL LOT DEVELOPMENT FORM

This form shall be used for the development and/or redevelopment of infill lots that are less than 1.0 acre in size. Attach any additional information as required.

Project Name: _____________________________

Site Address: _______________________________

Subdivision Name: _________________________

Preparer:
Firm: ___________________________ Individual: __________________
Phone: ________________________________

Site Description: Address existing conditions such as topography, present land use, existing structures, and pavement areas.

Proposed Project Description: Address any and all proposed changes and land use.

Existing Drainage Pattern: Address flows, direction of flows, concentrated vs. sheet flows, where do flows go, any offsite flows, irrigation ditches, existing drainage structures, and flood plain or flood hazard issues.

Proposed Drainage Pattern: Describe any proposed changes to the existing pattern or drainage system.

Pervious & Impervious Area Calculations:

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<th>Pervious Areas:</th>
<th>Existing (sf)</th>
<th>Proposed (sf)</th>
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<td>Gravel Areas</td>
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<td>Native Areas</td>
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<tr>
<td>Grass Landscape Areas</td>
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Development Impact Analysis: Address the beneficial and detrimental impacts that the proposed development/redevelopment will have.

Best Management Practices Plan: Evaluate the possible pollution sources that are common for the proposed type of development and indicate the controls recommended to mitigate adverse impacts.

Site Plan Provided:

☐ Scale  ☐ North Arrow  ☐ Property Lines  ☐ Easements  ☐ Existing Utilities

☐ Adjacent Streets  ☐ Drainage Flow Arrows  ☐ Existing and Proposed Site Improvements
# DRAINAGE CONSTRUCTION PLAN CHECKLIST

**Project Name:**

**Site Address:**

**Subdivision Name:**

**Preparer:**
- Firm: 
- Individual: 
- Phone: 

**Date Submitted:**

**Review Comments Sent:**

**2nd Submittal:**

**Review Comments Sent:**

**3rd Submittal:**

**Date Approved:**

## I. BASIC DATA

- **A. Map of Drainage Basin**
- **B. Location Map with Site Location Shown**
- **C. Street Information**
  - Grades and Cross Slopes
  - Street Dimensions
- **D. Soil and Water Table Information**
  - Test Hole Locations

## II. HYDROLOGY

- **A. Design Flows for Initial and Major Storms**
  - Peak Surface Flows
  - Inlet Flows Intercepted
  - Inlet Bypass Flows
  - Pipe Flows
    - a. Hydraulic Grade Lines
    - b. Pipe Capacities
- **B. Detention Pond Storage Data**
  - Required Pond Volumes
  - Provided Pond Volumes
  - Initial and Major Stormwater Depths
  - Pond Release Rates

## III. PLAN

- **A. Title Block**
- **B. Scale**
- **C. North Arrow**
- **D. Legend**
- **E. Date and Revisions**
- **F. Professional Engineer and/or Firm**
- **G. PE Seal**
- **H. Specifications**
- **I. Drawing Numbers**
- **J. Proposed and Existing Contours**
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<td>O.</td>
<td>Sub-Basin Boundaries</td>
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<td>3. Hydraulic Grade Lines</td>
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<td>6. Bedding Details</td>
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<td>V. Standard Notes</td>
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<td>W. Can it be constructed from the plans?</td>
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**IV. OTHER**


City Review Engineer: | Date: | Phone:
Appendix F
DECISION TREE FOR WQCV STRUCTURAL BMPs

Depth to Bedrock or WT > 5 feet and NRCS Type A or B Soils?

NO

NO

NO

NO

NO

NO

NO

Drainage Area > 1 Acre?

YES

Drainage Area > 20 Acres?

YES

Water Available for Evapotranspiration?

YES

Suitable WQCV BMP:

Porous Pavement Detention (PPD) with Underdrain

Porous Pavement Detention (PPD) with Infiltration

Porous Landscape Detention (PLD) with Underdrain

Porous Landscape Detention (PLD) with Underdrain

Extended Detention Basin (EDB)

Sand Filter Extended Detention Basin (SFB)

Construction Wetland Basin (CWB)

Retention Pond (RP)

Note: Larger developments may divided into sub-basins to allow use of alternate BMPs.

 관한 UDCM Volume 3 - New Development Planning Chapter
STORMWATER QUALITY MANAGEMENT PLAN REQUIREMENTS

1. TITLE PAGE
   A. Report Type
   B. Project Name
   C. Preparer Name, Firm, Address and Phone Number, Date
   D. PE Seal and Signature

II. INTRODUCTION
   A. Site Description
      1. Area in acres
      2. Existing Conditions
         a. Existing Topography
         b. Existing Vegetation
         c. Existing Drainage Patterns
         d. Existing Wetlands
      3. Proposed Project Description
         a. Description of Land Disturbance Activities
         b. Area of Proposed Disturbance Activities
            i. Locations
            ii. Surface Area in Acres
         c. Estimated Cut and Fill Quantities
         d. Estimated Amount of import or Export of Dirt to or from Project
   B. Soil and Water Table Information
      1. Soil Type
      2. Erodibility
      3. Permeability
      4. Boring and Sampling Locations
   C. Adjacent Area Analysis
      1. Adjacent Development or Improvements which may be impacted by Land Disturbance Activities
      2. Adjacent or Nearby Receiving Waters
   D. Project Schedule
      1. Anticipated Start Date for Grading as well as Construction Operations
      2. Anticipated Completion Date for Grading as well as Construction Operations
      3. Installation and Removal of Erosion and Sediment Control Measures-Tied to Construction Activities and Locations
   E. Construction Stormwater Management
      1. Identify Erosion and Sediment Control Measures
      2. Identify how Stormwater Runoff will routed through and from the Site during Construction
      3. Identify Required Inspections and any Routine Maintenance Requirements
Stormwater Quality Best Management Practices Plan Submittal Requirements
Appendix G

F. Post-Construction Stormwater Management and Stormwater Quality Control Measures
   1. Permanent Stabilization Measures
   2. Stormwater Management and Stormwater Quality Control Measures
   3. Installation Timelines
   4. Specifications for Permanent Improvements
   5. Identify Required Inspections and any Routine Maintenance Requirements for the Post Construction Improvements.

G. Calculations
   1. Design Calculations for Sediment Basins, Drainage Channels or Swales, Runoff, and Detention Basins

H. Owner Acknowledgement:

All stormwater best management practices (BMPs) developed and included in the development approval process are legally binding documents whereby the Owners of the real property associated with the BMPs are held ultimately responsible for the proper maintenance of all stormwater BMPs. If the Property Owner fails in this responsibility, the City has the right
   1. To enter the property, perform maintenance on the BMPs, and require reimbursement for the costs that may be incurred, or
   2. To declare the existence of a nuisance and issue Nuisance Abatement Notice to the responsible party. Failure to comply with the Nuisance Abatement Notice shall cause the person, corporation, partnership, or other entity violating the stormwater management provisions of the Manual to be subject to Title 15 of the Englewood Municipal Code.

I have reviewed the stormwater best management practices that are proposed and I understand that the effective performance of BMP measures hinge upon proper maintenance of the BMPs used, and I will commit to provide the required maintenance and employee training program, in order to accomplish the goal of preventing or reducing pollutant runoff from this property.

Owner

Date

III. SITE PLAN
   A. General Location Map
   B. Property Lines
   C. Existing Topography at one-foot or two foot contour intervals.
      1. Contours shall extend a minimum of 100 feet beyond the property lines.
   D. Location of any existing structures on site or within 100 feet of the site.
E. Location of any existing hydrologic features on the site or within 100 feet of the site.

Stormwater Quality Best Management Practices Plan Submittal Requirements
Appendix G

F. Proposed Topography at one or two-foot contour intervals.
   1. Elevations, dimensions, locations, grades of all proposed grading
   2. Cut and Fill Locations identified and volumes indicated.
   3. Limits of all clearing and grubbing.
   4. Location of soil stockpile locations.

G. Areas designated for equipment, fuel, lubricants, chemical and waste storage.

H. Locations of all proposed structures or improvements.
   1. Streets
   2. Inlets
   3. Storm Sewers and Culverts
   4. Open Channels and Drainage Swales
      a. Typical Channel Sections and Lining Details
   5. Detention Ponds
   6. Existing and Proposed Utilities

I. Locations of temporary roads and access points.

J. Locations of erosion control measures using the USDCM Standard Map Symbols

K. Locations of permanent soil erosion and stormwater quality control measures.

L. Construction phasing plans if required.

M. Construction Details

N. Construction Notes:
   1. Additional erosion control measures may be required of the owner and his or her
      agents due to unforeseen erosion control problems, or if the plan as submitted and
      approved is not function as intended.
FLOOD PLAIN OVERLAY DISTRICT

16-4-1: Statement of Purpose and Intent.
16-4-2: Jurisdiction and Applicability.
16-4-3: Special Provisions.
16-4-4: Permitted Uses.
16-4-5: Development Permit Criteria.
16-4-6: Similar Uses.
16-4-7: Undesignated Floodways.
16-4-8: Development in Floodways.
16-4-9: Administration.
16-4-10: Minimum Floodproofing Criteria.
16-4-11: Certificate of Compliance.
16-4-12: Flood Plain District Amendments.
16-4-13: Nonconforming Uses.
16-4-14: Subdivision Plats.
16-4-15: Flood Plain Variances.

16-4-1: Statement of Purpose and Intent.

A. General Statement of Purpose. This Chapter identifies areas of special flood hazard. Provisions of this Chapter prohibit certain uses dangerous to life and property within the overlay district, restrict uses hazardous to public health, and require floodproofing for those uses permitted in Flood Plain Districts. Provisions of this Chapter protect against flood damage by regulating the design and method of construction of all structures within the district and protect the public from the burden of extraordinary financial expenditures in a manner consistent with reasonable flood plain management, and preserve the water-carrying characteristics and capacities of watercourses both natural and artificial for the conveyance of storm and flood waters.

B. Findings of Fact. The legislature of the State has in Title 31, Article 33, C.R.S. 1973, as amended delegated the responsibility to local governmental units to adopt regulations designed to promote the public health, safety, and general welfare of its citizenry. Therefore, the Council does find as follows:

1. The flood hazard areas of the City are subject to periodic inundation that results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety, and general welfare.

2. These flood losses are caused by the cumulative effect of obstructions in areas of special flood hazards that increase flood heights and velocities, and when inadequately anchored, damage uses in other areas. Uses that are inadequately floodproofed, elevated or otherwise protected from flood damage also contribute to the flood loss.

C. Specific Purpose and Intent. To promote the health, safety, and welfare of the public; to
minimize flood losses in areas subject to flood hazards; and to promote wise use of the flood plain, this Chapter's regulations have been established to regulate the use and development of property located within the 100-year flood plain and the flood plain zone district. The areas of special flood hazard are identified by the Federal Emergency Management Agency on Flood Hazard Boundary Maps and Flood Insurance Rate Maps, which maps are on file in the Englewood Civic Center in the offices of the City Clerk, Public Works, and Community Development. By adopting these regulations, the following specific purposes are intended:

1. To reduce the hazard of floods to life and property through:
   a. Prohibiting certain uses which are dangerous to life or property in time of flood.
   b. Restricting uses that would be hazardous to the public health in time of flood.
   c. Restricting uses that are particularly susceptible to flood damage, so as to alleviate hardship and reduce demands for public expenditures for relief and protection.
   d. Requiring permitted flood plain uses, including public facilities that serve such uses, to be protected against floods by providing floodproofing and general flood protection at the time of initial construction.

2. To protect the flood plain occupants from a flood which is or may be caused by their own, or other, land use and which is or may be undertaken without full realization of danger, through:
   a. Regulating the manner in which structures designed for human occupancy may be constructed so as to prevent danger to human life within such structures.
   b. Regulating the method of construction of water supply and sanitation systems so as to prevent disease, contamination, and unsanitary conditions.
   c. Delineating and describing areas that could be inundated by flood so as to protect individuals from purchasing flood plain lands for purposes that are not in fact suitable.

3. To protect the public from the burden of extraordinary financial expenditures for flood control and relief by regulating all uses within the flood plain areas so as to produce a method of construction and a pattern of development which will minimize the probability of damage to property and loss of life or injury to the
inhabitants of the flood hazard areas.

4. To protect the natural areas required to convey flood flows so that they develop in a manner consistent with reasonable flood plain management.

5. To protect and preserve the water-carrying characteristics and capacities of all watercourses, including gulches, sloughs, and artificial water channels used for the conveyance of storm and floodwater.

6. To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public.

7. To minimize prolonged business interruptions.

8. To help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas.

9. To ensure that those who occupy the areas of special flood hazards assume responsibility for their actions.

(Ord. 04-5)

16-4-2: Jurisdiction and Applicability.

A. Description of District. The Flood Plain District covers that area of the City that is within the 100-year flood plain, which is defined by computing the 100-year flood plain limits under existing channel and flood plain conditions.

B. Jurisdiction. The jurisdiction of this overlay district includes all lands adjacent to any watercourse within the City that would be inundated by the 100-year flood for that "watercourse" as defined in Chapter 16-11 EMC.

C. Flood Plain District Boundaries. The boundaries of the Flood Plain District shall be identical to the areas of special flood hazard identified by the Federal Emergency Management Agency in the Flood Insurance Study dated August 16, 1995, and the accompanying Flood Insurance Rate Map (FIRM) encompassing the City.

December, 1979, Gingery Associates, Inc., and Plate 4 of the Storm Drainage Plan for the City of Englewood, Colorado, January, 1971, Sellards and Grigg, Inc., are hereby declared to be a part of this Title, and the official study and maps shall be on file in the offices of the City Clerk, Public Works and Community Development Departments.

D. Applications for Building Permits in the Flood Plain District. Applications for building permits shall be reviewed on a case-by-case basis by the Flood Plain Zoning Administrator to assure:

1. That the building site will be reasonably safe from flooding.

2. That all necessary permits have been obtained from the Federal, State, or local governmental agencies from which prior approval is required.

3. That where the building site is in a location that may have a flood hazard, all new construction and substantial repairs, improvements, or alterations will be made in accordance with the minimum floodproofing criteria specified in Section 16-4-10 EMC, or elevation criteria in Section 16-4-5.B.2 EMC.

4. That all development permits are reviewed to determine if the proposed development is located in the floodway. If located in the floodway, to assure that the encroachment provisions of Section 16-4-5 EMC, are met.

5. That approval of a building permit shall be deemed to neither limit nor repeal any other powers granted under State Statutes.

E. Interpretation. In their interpretation and application, the provisions of this Chapter shall be held to be minimum requirements and shall be liberally construed in favor of the City.

F. Warning and Disclaimer of Liability. The degree of flood protection intended to be provided by this Chapter is considered reasonable for regulatory purposes and is based on engineering and scientific methods of study. Larger floods may occur on occasions, or the flood height may be increased by man-made or natural causes, such as ice jams and bridge openings restricted by debris. This Chapter does not imply that the areas outside of the flood plain area boundaries or land uses permitted within such areas will always be totally free from flooding or flood damages. Nor shall there be liability on the part of, or a cause of action against, the City or any officer or employee thereof for any flood damages that may result from reliance on this Chapter.

G. Application of Flood Plain Regulations. The regulations set forth in this Chapter shall apply to those lands within the 100-year flood plain as mapped and designated on the official FIRM. The regulations of this Chapter shall be construed as being supplementary to the regulations imposed on the same lands by the underlying zone classification. When the Flood Plain District and the underlying zone district regulations conflict with one another, the most restrictive regulations shall control.
H. *General Provisions for Development in the Flood Plain District.* No structure or land located in the Flood Plain District shall hereafter be constructed, located, extended, converted, or altered without full compliance with the terms of this Chapter and all other applicable regulations.

I. *Applicability.* This Chapter is not intended to repeal, abrogate, or impair any existing easement, covenants, or deed restrictions. However, where this Chapter and other ordinance, easement, covenant, and deed restriction conflict or overlap, whichever imposes the more stringent restrictions shall apply.

(Ord. 04-5)

16-4-3: Special Provisions.

The following regulations shall apply to all uses within the Flood Plain District, notwithstanding that such uses may be specifically permitted under the terms of this Chapter.

A. The flood protection elevation or height shall correspond to a point one foot (1') above the elevation or "flood profile" shown on or attached to the FIRM.

B. No flood plain uses shall adversely affect the efficiency of, or unduly restrict the capacity of any channel, any tributary to any main stream, drainage ditch, or any other drainage facility or systems; nor shall any watercourse be altered or restricted unless the flood-carrying capacity of the watercourse shall be maintained.

(Ord. 04-5)

16-4-4: Permitted Uses.

The following open uses shall be permitted within the Flood Plain District to the extent that they are not prohibited in a particular area by any underlying zone district classification:

A. Agricultural uses, such as general farming and the raising of plants, flowers, and nursery stock.

B. Public and private recreational uses not requiring permanent or temporary structures designed for human habitation such as: parks, swimming areas, golf courses, driving ranges, picnic grounds, fishing, and hiking and biking trails.

C. Utility facilities such as: flowage areas, transmission lines, pipelines, water monitoring devices, roadways and bridges.

D. All uses allowed by the underlying zone district classification within the Flood Plain District shall be permitted as long as the conditions set forth in Section 16-4-5 EMC, Development Permit Criteria, are complied with.

(Ord. 04-5)
16-4-5: Development Permit Criteria.

Any use enumerated in this Section may be permitted only upon application to the Flood Plain Administrator as provided in subsection 16-4-9.F EMC, "Process to be Followed for Development Permits."

A. Structures Accessory to Open Uses. Structures accessory to open uses permitted in Subsection 16-4-4 EMC, "Permitted Uses," whether temporary or permanent, may be permitted only upon a determination by the Administrator, pursuant to a finding under the procedure required by Section 16-4-9.F EMC, "Process to be Followed for Development Permits," that:

1. Structures will not be designed for human habitation.

2. Structures will have low flood damage potential.

3. The structure or structures, if permitted, will be constructed and placed on the building site so as to offer the minimum obstruction to the flow of floodwaters.
   a. Whenever possible, structures will be constructed with the longitudinal axis parallel to the direction of flow of floodwaters.
   b. So far as is practicable, structures will be placed so that their longitudinal axes are approximately on the same line as those of adjoining structures.

4. Structures will be firmly anchored to prevent the structure or building from floating away and thus threatening to further restrict bridge openings and other restricted sections of the stream or river.

5. All new construction and substantial improvements shall be constructed with materials and utility equipment resistant to flood damage.

6. All new construction and substantial improvements shall be constructed using methods and practices that minimize flood damage.

7. All new construction and substantial improvements shall be constructed with electrical, heating, ventilation, plumbing, and air-conditioning equipment and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

B. Other Structures, Temporary or Permanent, to be Occupied by People. Other structures, whether temporary or permanent, which are to be occupied by people, may be permitted only upon a finding by the Flood Plain Administrator that:

1. Such structures shall comply with subsection 16-4-9.F EMC, "Process to be
Followed for Development Permits;" and Section 16-4-10 EMC, "Minimum Floodproofing Criteria."

2. The lowest floor, including the basement, of any structure to be erected, constructed, reconstructed, or moved on or within the Flood Plain District, shall be constructed at or above a point one foot (1') above the 100-year flood elevation for the particular area and the fill shall extend at such elevation at least fifteen feet (15') beyond the limits of any structure or building erected thereon.

3. No basement shall be permitted in any residential structure.

4. All new construction and substantial improvements shall be anchored to prevent flotation, collapse, or lateral movement of the structure and to withstand hydrodynamic loads.

C. Fills or Deposition of Materials. Fills or deposition of materials may be permitted only upon a finding by the Administrator that:

1. Any fill or deposition of materials will comply with applicable sections of Chapter 16-6 EMC, "Development Standards."

2. The fill or deposition of materials will have some beneficial purpose and the amount thereof will not be greater than is necessary to achieve that purpose, as demonstrated by a plan submitted by the owner showing the final dimensions of the proposed fill or other material and the use to which the filled land will be put.

3. The fill or deposition of materials does not encroach on that portion of the flood plain, which would have significant, and perceptible flow during the flood, and which for that reason would help convey the floodwaters.

4. The fill or other materials will be protected against erosion by riprap, strong vegetative cover, or bulkheading.

D. Storage or Processing of Materials. The storage or processing of materials that are buoyant, flammable, explosive, or in time of flooding, could be injurious to human, animal or plant life, shall be above the flood protection elevation for the particular area or floodproofed in compliance with Section 16-4-10 EMC, "Minimum Floodproofing Criteria." Solid waste disposal facilities, such as salvage yards or areas for the dumping of refuse or the storage of non-operable vehicles, shall not be permitted.

E. Manufactured Housing.

1. All manufactured homes or those to be substantially improved shall be elevated on a permanent foundation such that the lowest floor of the manufactured home is at or above the base flood elevation and is securely anchored to an adequately
anchored foundation system. This subsection applies to manufactured homes to be placed or substantially improved in an expansion to an existing manufactured home park or subdivision. This paragraph does not apply to manufactured homes to be placed or substantially improved in an existing manufactured home park or subdivision except where the repair, reconstruction, or improvement of the streets, utilities and pads equals or exceeds fifty percent (50%) of the value of the streets, utilities and pads before the repair, reconstruction or improvement has commenced. Manufactured homes shall be anchored as follows:

<table>
<thead>
<tr>
<th></th>
<th>Over-the-Top Ties</th>
<th>Frame Ties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufactured Homes(less than 50 feet long)</td>
<td>3 per side (one at each of the four corners plus one additional tie per side)</td>
<td>6 per side (one at each corner plus four additional ties per side)</td>
</tr>
<tr>
<td>Manufactured Homes(greater than 50 feet long)</td>
<td>4 per side (one at each of the four corners plus two additional ties at intermediate locations)</td>
<td>7 per side (one at each corner plus five additional ties per side at intermediate locations)</td>
</tr>
</tbody>
</table>

a. All components of the anchoring system shall be capable of carrying a force of four thousand eight hundred (4,800) pounds, and manufacturer's specifications of the components to be used in the anchoring system shall be submitted to the Administrator to demonstrate compliance with this requirement.

b. Any additions to the manufactured home shall be similarly anchored.

2. After the effective date of this Title, all new manufactured home parks and manufactured home subdivisions and all existing manufactured home parks and manufactured home subdivisions that are expanded, or in which parks or subdivisions the repair, reconstruction or improvement of the streets, utilities and pads, equals or exceeds fifty percent (50%) of the value before the repair, reconstruction or improvement has commenced, shall in addition to the requirements in E.1 above, comply with the following:

a. Stands for lots shall be elevated on compacted fill or on piling so that the lowest floor of the manufactured home will be at or above the base flood level.

b. Adequate surface drainage and access for a hauler shall be provided.

c. In the instance of elevation on pilings:

(1) Lots shall be large enough to permit steps.

(2) Piling foundations shall be designed by a registered engineer.

3. No manufactured home shall be maintained for temporary or permanent living
purposes upon any private or public property in the City unless the property is registered as a manufactured home park.

4. The City shall establish an evacuation plan for manufactured home parks and file the same with the appropriate disaster preparedness authorities.

(Ord. 04-5)

16-4-6: Similar Uses.

Uses very similar in nature to permitted uses may be allowed by the Flood Plain Administrator, provided that they are consistent with the provisions of this Section.

(Ord. 04-5)

16-4-7: Undesignated Floodways.

Until a regulatory floodway is designated, it must be demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot (1') at any point, before any new construction, substantial improvements or other development, including fill, is permitted within zones A--AE as shown on the FIRM.

(Ord. 04-5)

16-4-8: Development in Floodways.

Located within areas of special flood hazard established in Section 16-4-2.A EMC, are areas designated as floodways. Since the floodway is an extremely hazardous area due to the velocity of floodwaters that carry debris, potential projectiles, and erosion potential, the following provisions shall apply to public facilities or utilities only:

A. Prohibit encroachments, including fill, new construction, substantial improvements, and other development unless certification by a registered professional engineer is provided demonstrating that encroachments shall not result in any increase in flood levels during the occurrence of the base flood discharge.

B. If subsection A, above, is satisfied, all new construction and substantial improvements shall comply with all applicable flood hazard reduction provisions of this Section.

1. The Administrator shall act on an application in the manner above described within thirty (30) days from receiving the application.

(Ord. 04-5)

16-4-9: Administration.

A. **Flood Plain Administrator.** The City Manager or designee shall be the Flood Plain Administrator and shall enforce the provisions of this Chapter. The Department of Engineering Services shall provide the Flood Plain Administrator with a technical
review of all applications to build within the flood plain or a drainage way prior to the issuance of a flood plain permit.

B. **Flood Plain Zoning Permit.** A flood plain zoning permit must be obtained from the Flood Plain Administrator before a building permit can be issued for any use subject to the provisions of this Chapter and before any watercourse can be altered or relocated. In the event of an application requesting an alteration or relocation of a watercourse, all adjacent communities and the Colorado Water Conservation Board shall be notified prior to any action. Copies of said notification shall be submitted to the Federal Emergency Management Agency.

C. **Use of Other Base Flood Data.** When base flood elevation data have not been provided in accordance with Section 16-4-3 EMC, "Special Provisions," the Flood Plain Administrator shall obtain, review, and reasonably utilize any base flood elevation and floodway data available from a Federal, State, or other source in order to administer this Chapter.

D. **Information to be Obtained and Maintained.** The Flood Plain Administrator shall obtain and maintain the following information:

1. Obtain and record the actual elevation (in relation to mean sea level) of the lowest floor (including basement) of all new or substantially improved structures.

2. For all new or substantially improved floodproofed structures:
   a. Verify and record the actual elevation (in relation to mean sea level to which the structure has been floodproofed), and
   b. Maintain the floodproofing certifications required in Section 16-4-10.B EMC, "Minimum Floodproofing Criteria."

3. Maintain for public inspection all records pertaining to the provisions of this Title.

E. **Interpretation of FIRM Boundaries.** The Flood Plain Administrator shall make interpretations, where needed, as to the exact location of the boundaries of the areas of special flood hazards or flood danger (for example, where there appears to be a conflict between a mapped boundary and actual field conditions). The person contesting the location of the boundary shall be given a reasonable opportunity to present a case to the Flood Plain Administrator and to submit supporting technical evidence. The decision of the Flood Plain Administrator may be appealed as provided in Section 16-4-15 EMC, "Flood Plain Variances."

F. **Process to be Followed for Development Permits.**

1. Application. Any use listed in this Chapter as requiring a development permit
may be allowed only upon application to and the issuance of a development permit by the Flood Plain Administrator.

2. Procedure for Passing on Development Permits. Upon receiving an application for a development permit involving the use of fill, construction of structures, or storage of materials, the Administrator shall require the applicant to submit the following:

a. Two (2) copies of an aerial photograph of the area, or a plan certified by a registered engineer competent in open channel hydraulics, which accurately locates the flood plain proposal with respect to the district limits, channel of the stream, existing flood plain developments, together with all pertinent information such as the nature of the proposal, legal description of the property, fill limits and elevations, building floor elevations, and floodproofing measures.

b. In order to render a decision on the proposed flood plain use, the Administrator may require the applicant to furnish the following additional information:

(1) A typical valley cross-section showing the channel of the stream, the floodplain adjoining each side of the channel, cross-sectional area to be occupied by the proposed development, and high water information.

(2) Plan (surface view) showing elevation or contours of the ground; pertinent structure, fill or storage elevations; size, location and spatial arrangement of all proposed and existing structures on the site; location and elevations of streets, water supply, sanitary facilities, and soil types and other pertinent information.

(3) Profile showing the slope of the bottom of the channel or thalweg of the stream.

(4) Specifications for building construction and materials, floodproofing, filling, dredging, grading, channel improvement, storage of materials, water supply, and sanitary facilities.

(5) Description of the extent to which any watercourse will be altered or relocated as a result of proposed development.

3. Decision of Administrator to be Based on Certain Factors. The determination of the Administrator on each development permit shall be based on the effects of the proposed project with respect to the objectives and purposes of the flood plain development standards, as stated in Section 16-4-1 EMC, "Statement of Purpose and Intent."
4. Administrator Decisions on Permits for Public Facilities or Utility Development in a Floodway. Subject to Section 16-4-8 EMC, "Development in Floodways," the Administrator shall act on an application for public facilities or utility development in a floodway within thirty (30) days from receiving the application.

G. *Conditions Attached to Development Permits.* Upon consideration of the factors listed above and the purposes of this Chapter, the Flood Plain Administrator shall attach such conditions, in addition to those required by the development permit, as is necessary to further the purposes of this Chapter. Such conditions may include specifications for, without limitation because of, specific enumeration, modification of waste disposal methods and facilities, landscaping, period of operation, operational controls, sureties, deed restriction, and adequate floodproofing.

(Ord. 04-5)

16-4-10: Minimum Floodproofing Criteria.

A. All new construction and substantial improvements of nonresidential structures within zones A-AE on the FIRM that do not have the lowest floor, including basement, elevated to or above the base flood level shall be floodproofed. All floodproofed structures, together with attendant utility and sanitary facilities, shall be so designed that below the base flood level, the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. The Administrator shall require that the applicant submit a plan or document certified by a registered professional engineer that the floodproofing measures are consistent with the flood protection elevation for the particular area.

B. Floodproofing measures include the following:

1. Anchorage to resist flotation and lateral movement.

2. Installation of watertight doors, bulkheads and shutters.

3. Reinforcement of walls to resist water pressures.

4. Use of waterproof paints, membranes, or mortars to reduce seepage of water through walls.

5. Addition of mass or weight to structures to resist flotation.

6. Installation of pumps to lower water levels in structures.

7. New and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the system.
8. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems and discharge from the systems into the floodwaters.

9. Pumping facilities for subsurface drainage systems for buildings to relieve external foundation wall and basement floor pressures.

10. Construction to resist rupture or collapse caused by water pressure or floating debris.

11. Cutoff valves on sewer lines or the elimination of gravity flow basement drains.

12. On-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

C. Provide that where a nonresidential structure is intended to be made watertight below the base flood level.

1. A registered professional engineer shall develop and/or review structural design, specifications, and plans for the construction, and shall certify that the design and methods of construction are in accordance with accepted standards of practice for meeting the applicable provisions of Section 16-4-5 EMC, "Development Permit Criteria."

(Ord. 04-5)

16-4-11: Certificate of Compliance.

A. No vacant land shall be occupied or used and no building shall be hereafter erected, altered, or moved on the flood plains of any watercourse, nor shall such buildings be occupied, until a certificate of compliance has been issued by the Flood Plain Administrator.

B. The applicant shall submit a certification by a registered professional engineer to the Flood Plain Administrator that the finished fill and building floor elevations, floodproofing measures, or other protection factors were accomplished in compliance with the provisions of this Chapter. This certification shall also state whether or not the structure contains a basement. Within ten (10) days after receipt of such certification from the applicant, the Administrator shall issue a certificate of compliance only if the building or premises and the proposed use thereof, conform with all of the requirements of this Chapter and shall maintain a permanent record thereof.

(Ord. 04-5)

16-4-12: Flood Plain District Amendments.

The boundaries of the flood plain district shall be subject to periodic review and shall be
amended in the manner provided by law, to conform with any revised, corrected or additional hydrological data available from Federal, State or regional agencies or from a consulting engineer retained by the City.
(Ord. 04-5)

16-4-13: Nonconforming Uses.

Existing nonconforming uses in the Flood Plain District may be modified, altered, or repaired to incorporate floodproofing measures; but such nonconforming uses shall not be expanded.
(Ord. 04-5)

16-4-14: Subdivision Plats.

A. All subdivision proposals shall be designed to minimize flood damage.

B. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage.

C. All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage.

D. Base flood elevation data shall be provided for subdivision proposals and other proposed developments that contain at least fifty (50) lots or five (5) acres, whichever is less.
(Ord. 04-5)

16-4-15: Flood Plain Variances.

A. The Planning Commission shall hear and decide the appeals and requests for variances from the requirements of this Chapter 16-4 EMC.

B. The Commission shall hear and decide appeals when it is alleged there is an error in any requirement, decision, or determination made by the Flood Plain Administrator in the enforcement or administration of this Chapter.

C. Those aggrieved by the decision of the Commission, or any taxpayer, may appeal such decision to a court of record having jurisdiction thereof.

D. In passing upon a Flood Plain Variance application, the Commission shall consider all technical evaluations, all relevant factors, standards specified in other sections of this Title, and:

1. The danger that materials may be swept onto other lands to the injury of others.

2. The danger to life and property due to flooding or erosion damage.
3. The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner.

4. The importance of the services provided by the proposed facility to the community.

5. The availability of alternative locations for the proposed use that are not subject to flooding or erosion damage.

6. The compatibility of the proposed use with existing and anticipated development.

7. The relationship of the proposed use to the Comprehensive Plan and Flood Plain Management Program for that area.

8. The safety of access to the property in times of flood for ordinary and emergency vehicles.

9. The expected heights, velocity, duration, rate of rise, and sediment transport of the floodwaters and the effects of wave action, if applicable, expected at the site.

10. The costs of providing governmental services during and after flood conditions, including maintenance and repair of public utilities and facilities such as sewer, gas, electrical, and water systems, and streets and bridges.

11. Flood Plain Variances may be issued for new construction and substantial improvements to be erected on a lot of one-half (1/2) acre or less in size contiguous to and surrounded by lots with existing structures constructed below the base flood level, providing items 1 through 10 above have been fully considered. As the lot size increases beyond the one-half (1/2) acre, the technical justification required for issuing the variance increases.

12. Flood Plain Variances shall not be issued within any designated floodway if any increase in flood levels during the base flood discharge would result.

13. Upon consideration of the factors of this Chapter and the purposes of this Title, the Commission may attach such conditions to the granting of Flood Plain Variances as it deems necessary to further the purposes of this Title.

14. The Flood Plain Administrator shall maintain the records of all appeal actions and report any variances to the Federal Emergency Management Agency upon request.

E. Criteria for Flood Plain Variances.

1. Flood Plain Variances may be issued for the reconstruction, rehabilitation or
restoration of structures listed on the National Register of Historic Places or the State Inventory of Historic Places, without regard to the procedures set forth in the remainder of this Section.

2. Flood Plain Variances shall only be issued upon a determination that the variance is the minimum necessary, considering the flood hazard, to afford relief.

3. Flood Plain Variances shall only be issued upon:
   
a. A showing of good and sufficient cause;

b. A determination that failure to grant the Flood Plain Variance would result in exceptional hardship to the applicant; and

c. A determination that the granting of a Flood Plain Variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public as identified in Section 16-4-15.D EMC, or conflict with existing local laws.

Any applicant to whom a variance is granted to build the lowest floor elevation below the base flood elevation shall be given written notice that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced lowest floor elevation.

(Ord. 04-5)

Scale: 1 inch = 1,000 feet
Revised: August 13, 2004
### Soil Legend

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<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AsD</td>
<td>Ascalon sandy loam, 5% to 9% slopes</td>
</tr>
<tr>
<td>BtB</td>
<td>Bresser loam, gravelly subsoil variant, 1% to 3% slopes</td>
</tr>
<tr>
<td>BvC</td>
<td>Bresser-Truckton sandy loams, 3% to 5% slopes</td>
</tr>
<tr>
<td>BvE</td>
<td>Bresser-Truckton sandy loams, 5% to 20% slopes</td>
</tr>
<tr>
<td>EdB</td>
<td>Edgewater loam, 0% to 3% slopes</td>
</tr>
<tr>
<td>FgD</td>
<td>Fondis-Ascalon, gravelly subsoil variant, complex, 1% to 9% slopes</td>
</tr>
<tr>
<td>Gr</td>
<td>Gravelly land</td>
</tr>
<tr>
<td>Lv</td>
<td>Loamy alluvial land</td>
</tr>
<tr>
<td>NIB</td>
<td>Nunn Loam, 0% to 3% slopes</td>
</tr>
<tr>
<td>RhE</td>
<td>Renohill-Buick loams, 9% to 20% slopes</td>
</tr>
<tr>
<td>RID</td>
<td>Renohill-Little clay loams, 3% to 9% slopes</td>
</tr>
<tr>
<td>RtE</td>
<td>Renohill-Little-Thedalund complex, 9% to 30% slopes</td>
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</tr>
<tr>
<td>X</td>
<td>Gravel pit</td>
</tr>
<tr>
<td>Z</td>
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</table>

**Notes:**
Figure 5

CHANNEL OR CONDUIT FLOW TIME NOMOGRAPH

City of Englewood

FLOW DISTANCE IN FEET

ROUGHNESS COEFFICIENT n

0.1
0.02
0.03
0.04
0.05
0.06
0.10

L = 400'
n = 0.012
s = 3.4 %
t = 1.0 minute

SURFACE SLOPE IN PERCENT

0.1
0.5
1.0
5.0
10.0
20.0

CHANNEL OR CONDUIT FLOW TIME

4
3
2
1.5
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Figure 6

Street Flows - Allowable Capacities

Street cross slope = 2%

Where:

\[ Q = F \times \frac{0.56}{s^{0.6}} \text{ (in cfs)} \]

\( s \) is the slope of the street.

City of Enfieldwood
Figure 8

IN FHWA EQUATION FOR COMPOSITE CROSS SLOPES

\[ Q = \frac{Q}{1 - E} \]

(for standard 2-inch gutter depression)

Street Cross Slope = 2.0 %
Street Cross Slope = 1.5 %
Street Cross Slope = 4.0 %

<table>
<thead>
<tr>
<th>( E )</th>
<th>0</th>
<th>0.1</th>
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<td>0.1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

T IN FEET

City of Englewood
Figure 9
(1-E₀) VALUES FROM FHWA EQUATION

\[ Q = \left( \frac{Q_s}{1 - E_0} \right) \]

Where:  Street Cross Slope = 2%

City of Englewood
GENERAL NOTES:
1. CAST IRON SHALL CONFORM TO AASHTO M115/ASTM A48, CLASS 358, MINIMUM.
2. CASTINGS SHALL COMPLY WITH AASHTO M308-99 FOR CASTING PROOF LOADING (DESIGNED FOR AASHTO HS-20 LOADING).
3. SEE CITY OF ENGLEWOOD DETAIL AND TECHNICAL SPECIFICATIONS, AND OTHER RELATED STANDARD DETAIL DRAWINGS.
4. CASTINGS SHALL BE MANUFACTURED WITH SPECIAL LETTERING IN THE CURB HEAD THAT PROHIBITS DUMPING. (I.E.: NO DUMPING DRAINS TO RIVER)
TYPICAL CURB & GUTTER  TYPICAL CURB/WALK

PLAN VIEW

TOP OF CURB

TOP OF CURB BOX

EXPANSION JOINT

CONTRACTION JOINT

#4 3/8" @ 12" (MAX) E.W. (TYP.)

GUTTER

LEAN CONCRETE FILL

LEAN CONCRETE FILL

CONSTRUCTION JOINT

SUITABLE SUBGRADE (SEE NOTE 10)

SECTION

REFERENCE FOR INLET BOX TO BE CAST WITH SPECIAL
CONSTRUCTION THAT PROHIBITS DUMPING EXPANSION
JOINTS 3" CL.

1 1/2" CL.

3/4" LAP

TOP OF CURB

TOP OF CURB BOX

FLOW DIRECTION

TOP OF CURB

2 1/2" CL.

TOP OF CURB BOX

EXPANSION JOINT

CONSTRUCTION JOINT

BACKFILL AROUND STRUCTURE TO BE HAND TAMPED IN 6" LAPS.

#4 3/8" @ 12" (MAX) E.W. (TYP.)

#4 3/8" @ 12" (MAX) E.W. (TYP.)

REBAR PLACEMENT AROUND CONNECTOR

GENERAL NOTES:
1. FOR PAVEMENT PURPOSES, INLET STRUCTURES SHALL ALSO INCLUDE 3 1/2" CURB & GUTTER TRANSITION SECTIONS AT EACH END OF INLET PLUS SEADWALK SECTIONS WHERE REQUIRED BEHIND INLET STRUCTURE AND TRANSITION SECTIONS.
2. FLOOR SLOPES MAY BE POLISHED MONOLITHIC WITH BASE.
3. S = SLOPE OF CONNECTOR = 1.5 MIN.
4. UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS OR OTHERWISE APPROVED, ALL #16 INLETS SHALL BE CONSTRUCTED WITH AN ADJACENT 3 1/2" CURB BOX.
5. DESIGN CONDITIONS FOR INLET ALLOW DEPTHS OF 6" (MAX). FOR INLETS MORE THAN 6 FEET IN DEPTH, SHOP DRAWINGS AND DESIGN ANALYSIS SHALL BE SUBMITTED FOR APPROVAL.
6. ALL REINFORCING STEEL SHALL BE ASTM A-615, GRADE 60, OCTAGONAL. DIAMETER OF BEND MEASURED ON THE RADIUS OF THE BEND SHALL BE A MINIMUM OF 6 BAR DIAMETER.
7. STEPS SHALL BE PROVIDED WHEN INLET DEPTH EXCEEDS 5'-6" AND SHALL BE IN ACCORDANCE WITH GUIDELINES.
8. CONCRETE SHALL HAVE A 28 DAY COMpressive STRENGTH OF 4000 PSI.
9. NO FORM WORK SHALL REMAIN INSIDE STRUCTURE WHEN COMPLETE.
10. SUBGRADE SHALL BE OVERGRADED AND BROADCAST WITH APPROVED REINFORCEMENT MATERIAL COMPAKED TO THE CITY OF ENGLEWOOD SPECIFICATIONS.
11. SLICING OF REINFORCING STEEL SHALL BE PERMITTED ONLY WHERE DETAIL SPECIFIED.
12. INLET WALLS SHALL BE FORMED BOTH INSIDE AND OUTSIDE CASTING OF SEADWALKS AGAINST EARTH IS NOT PERMITTED.
13. LEAN CONCRETE FILL TO BE Fc = 2000 PSI.

DETAIL NO. D-2

SINGLE TYPE 16 OPEN THROAT INLET
ADJUSTABLE CURB BOX

FILE INFORMATION

DEPARTMENT OF PUBLIC WORKS
DRAWN BY: WBA
DRAFTING FILE NAME: F04-022a.jpg
DATE: 03/04/04

PROJECT DETAIL REVISED

DATE

COMMENTS

CITY OF ENGLEWOOD
1000 ENGLEWOOD PARKWAY
ENGLEWOOD, CO 80110
PHONE: (303) 792-2300
GENERAL NOTES:
1. FOR PAYMENT PURPOSES, INLET STRUCTURES SHALL ALSO INCLUDE 2'-6" CURB & GUTTER TRANSITION SECTION AT EACH END OF INLET PLUS SIDEWALK SECTIONS WHERE REQUIRED DOI NG INLET STRUCTURE AND TRANSITION SECTIONS.
2. FLOOR SLOPE MAY BE DETERMINED BY BASE.
3. UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS OR OTHERWISE APPROVED, ALL 1/4 X 1/2 INLETS SHALL BE CONSTRUCTED WITH AN ADJUSTABLE LI CQ CURB BOX.
4. DESIGN CONDITIONS FOR INLET ALLOW DEPTHS OF 8'-0" MAX., FOR INLETS MORE THAN 8 FEET IN DEPTH, SHOP DRAWINGS AND DESIGN ANALYSIS SHALL BE SUBMITTED FOR APPROVAL.
5. ALL REINFORCED STEEL SHALL BE GS, A-615, GRADE 60 SIZED BAR SIZE AND BAR DIAMETER MEASURED ON THE INSIDE OF THE BAR SHALL BE A MINIMUM OF 8 BAR DIAMETER.
6. STEPS SHALL BE PROVIDED WHEN INLET DEPTH EXCEEDS 3'-0" AND SHALL BE IN ACCORDANCE WITH HARDWOOD.
7. CONCRETE SHALL HAVE A 28DAY COMpressive STRENGTH OF 4000 PSI.
8. NO FORMWORK SHALL BE USED WHERE STRUCTURE ENSURES COMPLETE.
9. SUBGRADE SHALL BE OVERGRADED AND INCORPORATED WITH APPROVED BANDING MATERIAL.
10. SPALING OF REINFORCED STEEL SHALL BE PERMITTED ONLY WHERE DETAILED IN DRAWINGS.
11. STEEL INLETS SHALL BE TURNED BOTH INSIDE AND OUTSIDE, CASTING OF SIDEWALKS AGAINST DEPTH IS NOT PERMITTED.
12. LOCAL CONCRETE FILL TO BE FC = 2000 PSI.
GENERAL NOTES:
1. CAST IRON SHALL CONFORM TO AASHTO M1105/ASTM A48, CLASS 33B, MINIMUM.
2. CASTINGS SHALL COMPLY WITH AASHTO M366–89 FOR CASTING PROOF LOADING (DESIGNED FOR AASHTO HS–20 LOADING)
3. SEE CITY OF ENGLEWOOD DETAIL AND TECHNICAL SPECIFICATIONS, AND OTHER RELATED STANDARD DETAIL DRAWINGS.

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File Information
DEPARTMENT OF PUBLIC WORKS
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Drawing File Name: FD94-005.dwg
DATE: 03/04/94

Type 13
Grate and Frame Details

Detail No. D-5
GENERAL NOTES:
1. FOR PAVEMENT PURPOSES, INLET STRUCTURES SHALL ALSO INCLUDE 2"-6" CURB & CURB GUTTER TRANSITION SECTION AT EACH END OF INLET PLUS SEVEN (7) SECTIONS WHERE REQUIRED BEHIND INLET STRUCTURE AND TRANSITION SECTIONS.
2. FLOOR SLAB MAY BE Poured Monolithically WITH BASE.
3. SL = SLIP OF CONNECTOR = 12" MIN.
4. GALVANIZED STEEL ONLY SPECIFIED ON THE DRAWINGS OR OTHERWISE APPROVED. ALL OTHER MATERIAL SHALL BE CONSTRUCTED WITH AN APPROVED CURB BOX BEAM.
5. DESIGN CONDITIONS FOR INLET ALLOWED DEPTHS OF 6" (MAX.) FOR INLETS MORE THAN 6 FEET IN DEPTH, SHOWN IN DRAWINGS AND OTHER ANALYSIS SHALL BE SUBMITTED FOR APPROVAL.
6. ALL REINFORCING STEEL SHALL BE ASTM A-915, STI-REO Diameter of Bend Measured on the Outside of the Bar Shall Be a Minimum of 8 BAR Diameter.
7. STEPS SHALL BE PROVIDED WHEN INLET DEPTH EXCEEDS 3'-6" AND SHALL BE IN ACCORDANCE WITH ASTRO N180.
8. CONCRETE SHALL HAVE A 28 DAY COMpressive STRENGTH OF 4000 PSI.
9. ALL REINFORCING STEEL SHALL BE ORTHOGONAL TO STRUCTURE WHEN COMPLETE.
10. ALL REINFORCING STEEL SHALL BE ORTHOGONAL TO STRUCTURE WHEN COMPLETE.
11. GROOVING OF REINFORCING STEEL SHALL BE PERMITTED ONLY WHERE DETAILED IN DRAWINGS.
12. INLET WALLS SHALL BE CRIMPED BOTH INSIDE AND OUTSIDE, CUTTING OF (DECK) WELLS AGAINST CURB NOT PERMITTED.
13. LEAD CONCRETE FILL TO BE F6 = 2000 PSI.

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File Information
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DRAFTING FILE NAME: P004-907A.dwg
DATE: 03/10/04

DOUBLE TYPE 13 INLET

DETAIL NO. D-7

TYPICAL CORNER
DETAIL REBAR PLACEMENT

DETAIL ANCHOR BAR (T)

Curb Box Beam

PLAN
SECTION
SECTION
SECTION

LIP OF GUTTER
#4'S @ 12" (MAX.) E.W.

1 1/2" CL. (TYP.)
8" (TYP.)

RCP PIPE

1 1/2" (TYP.)
1 1/2" (TYP.)

1 1/2" (TYP.)
2 - #4 x 3'-6" @ 45°

CONCRETE
W5x15 W SHAPE
8" (TYP.)
11'-11"

1 1/2" CL. (TYP.)
8" (TYP.)

1 1/2" CL. (TYP.)

FLOW DIRECTION

#4'S @ 12"

CUR (TYP.)
CUR (TYP.)

DEPHT VARIABLES
2'-0" - 2'-6" MAX.

SLOPE = 1/4" PER FT. MIN.

#4'S @ 12" (MAX.) E.W.

CURB (TYP.)
CURB (TYP.)

GRATE E

LIP OF CONCRETE GUTTER

1 1/2" CL. (TYP.)
6" (TYP.)

#4'S @ 12" (MAX.) E.W.

1 1/2" CL. (TYP.)
5" (TYP.)

1 1/2" CL. (TYP.)
1 1/2" CL. (TYP.)

1 1/2" CL. (TYP.)
1 1/2" CL. (TYP.)

2 - #4'S @ 45°

2 - #4'S @ 45°

1 1/2" (TYP.)

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.

SLOPE = 1/4" PER FT. MIN.

DEEP CONCRETE
1 1/2" CL.
1 1/2" CL.
GENERAL NOTES:
1. FOR PAVING PURPOSES, INLET STRUCTURES SHALL ALSO INCLUDE 3'-6" CURB & GUTTER TRANSITION
   SECTIONS AT EACH END OF INLET PLUS SIDEWALK SECTIONS WHERE REQUIRED BEHIND INLET STRUCTURE
   AND TRANSITION SECTIONS.
2. FLOOR SLOPE MAY BE POURRED MONOLITHIC WITH BASE.
3. $S = SLIP OF CONCRETE = 1/8 MIN.
4. UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS OR OTHERWISE APPROVED, ALL TYPE 13 INLETS SHALL
   BE CONSTRUCTED WITH DURABLE, CAL. CURB BOX.
5. DESIGN CONDITIONS FOR INLET ALLOW SLOPE DEPTHS OF 6" MAX., FOR INLETS MORE THAN 6 FEET IN
   DEPTH. SHOP DRAWINGS AND DESIGN ANALYSIS SHALL BE SUBMITTED FOR APPROVAL.
6. ALL REINFORCING STEEL SHALL BE ASTM A-615, GRADE 60 DEFORMED BARS. DIAMETER OF BEND
   MEASURED ON THE INSIDE OF THE BAR SHALL BE A MINIMUM OF 6 BAR DIAMETER.
7. STEPS SHALL BE PROVIDED WHEN INLET DEPTHS EXCEED 3'-6" AND SHALL BE
   IN ACCORDANCE WITH ASGIO NO. 908.
8. CURB BOX SHALL HAVE A 28-DAY COMPRESSIVE STRENGTH OF 4000 PSI
9. NO FORMWORKS SHALL REMAIN INSIDE STRUCTURE WHEN COMPLETE.
10. SUB-DRAINAGE SHALL BE OVER EXCAVATED AND BACKFILLED WITH APPROVED BIDDING MATERIAL
   COMPACTED FOR THE CITY OF ENGLEWOOD SPECIFICATIONS.
11. SPACING OF REINFORCING STEEL SHALL BE PERMITTED ONLY WHERE DETAILED IN DRAWINGS.
12. INLET WALLS SHALL BE FORMED BOTH INSIDE AND OUTSIDE LAYING OF SIDEWALKS AGAINST
    EARTH IS NOT PERMITTED.
13. LEAN CONCRETE FILL TO BE F1 = 2000 PSI.

REBAR REPLACEMENT
DETAIL INLET WALL
PENETRATION (TYP)

FRAME PLACEMENT
DETAIL ON SUPPORT RAIL

CURB BOX BEAM
DETAIL ANCHOR BAR (T)

TURN BAR INTO PLANE OF CURB
BOX BEAM.

TYPICAL CORNER
DETAIL REBAR PLACEMENT

SUITABLE SUBGRADE (SEE NOTE 10)

BACKFILL AROUND STRUCTURE TO BE HAND TAMPERED IN 6" LIFTS (BACKFILL METHOD B)

3'-6" CL (TYP)

2'-6" 45°

2 - #4 x 3'-9" 45°

LOAN CONC. FIL.

BORING = 1/4" PER FT. MIN.

11'-4" LAP (TYP)

10'-6"

8" (TYP)

6'-0" MAX.

3'-6"

5'-0"

1'-6"

2'-6"

CURB PIPE CENTERED UNDER
DOWNSTREAM GRATE

3'-6"

5'-0"

1'-10"

1'-11"

8" (TYP)

4'-0"

3'-0"

8'-0" (TYP)

10'-0" (TYP)

12'-0"

1'-1/2" CL (TYP)

1'-1/2" CL (TYP)

8'-0" (TYP)

12'-0"

1/4" (TYP)

8'-0" (TYP)

4'-0"

3'-0"

2'-6"

1'-6"

6'-0" MAX.

6'-0" STD.

4'-0" (MAX.) E.W.

3'-0"

8'-0" (MAX.) E.W.

1'-11"

8" (TYP)

#4's @ 12" (MAX.)

#4's @ 12" (MAX.)

#4's @ 12"

#4's @ 12" (MAX.)

W5x16 W SHAPE

W5x16 W SHAPE

W5x16 W SHAPE

W5x16 W SHAPE

D-6

D-6

D-6

D-6
CITY OF ENGLEWOOD
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FILE INFORMATION
DEPARTMENT OF PUBLIC WORKS
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DATE: 02/08/04

PROJECT DETAIL REVISED

FILE NAME: FOI-10K.dwg
DATE: 02/08/04

FILE INFORMATION
DEPARTMENT OF PUBLIC WORKS
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DATE: 02/08/04

PROJECT DETAIL REVISED

FILE NAME: FOI-10K.dwg
DATE: 02/08/04

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PROJECT DETAIL REVISED

FILE NAME: FOI-10K.dwg
DATE: 02/08/04
**T-BASE MANHOLES**

1. The T-BASE SECTION shall be shop-fabricated for delivery to the construction site as a complete unit.
2. These details shall only be construed to show conceptual and standard dimensional requirements for Type T-BASE MANHOLES. The Contractor shall furnish detailed shop drawings for approval prior to fabrication. The details shown herein apply only to 48-inch diameter pipe and larger.
3. Except for class of pipe, specifications to be met for the manhole shall be the same as those required for the adjoining pipe, cover or elbow.
4. The T-BASE SECTION shall maintain its internal shape and flow area with any grouting, etc. applied so as to not restrict the normal flow or reduce the area.

**SECTION F-F**

- Adjust manhole 20° or less
- Modify manhole greater than 20°
- Concrete collar or full depth asphalt patching
- Hot bituminous pavement
- Brick courses, 2 in. 6 in.
- Precast concrete grade rings
- Slope: 1/4 in. 1/2 in.
- MAX 20° from final ring and cover elevation to first step
- 1/4 recess
- Cement mortar
- Hot bituminous pavement
- Note: Thickness may be uniform with other slope changes.

**CIRCULAR RCP (LONGITUDINAL SECTION)**

- Manhole ring and cover
- Grade rings or brick courses
- MAX 20° from final ring and cover elevation and the first step
- MAX 20° from final ring and cover elevation and the first step
- Step 1/4 in. 1/2 in.
- Grade rings or brick courses
- JOINT DETAIL TO BE APPROVED PRIOR TO FABRICATION
- 4 in. 8 in. MH riser sections
- Standard 4 in. MH riser sections
- FLEXIBLE JOINT SEAL
- CONFORMING TO AASHTO M 158 TYPE A (TPV)

**CIRCULAR RCP (TRANSVERSE SECTION)**

- T-BASE section
- Manhole T-BASE

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**CITY OF ENGLEWOOD**

**DEPARTMENT OF PUBLIC WORKS**

**DRAWN BY: N.B.**

**DATE: 02/09/04**

**FILE INFORMATION**

- Drawing File Name: TD92-011A.dwg
- Date: 02/09/04

**DETAIL NO. D-11**
RIN AND COVER, AND MANHOLE STEPS
SHALL BE POSITIONED OVER THE LARGEST
BENCH AREA. STAGGERED MANHOLE STEPS
ARE NOT PERMITTED.

FINAL RING AND COVER ELEVATIONS
SHALL BE IN ACCORDANCE WITH THE
CITY PLANNING REQUIREMENTS.

MANHOLE RING AND COVER SHALL BE ADJUSTED
TO FINAL GRADE USING A MAXIMUM OF 4" GRADE
RING(S) AND A MAXIMUM OF 12" GRADE RING(S).
BRICK COURSES ARE ALIGNED, 2 MIN. 4 MAX.

NOTES:
1. GENERAL – THIS DETAIL IS FOR STANDARD MANHOLES WHERE INCOMING/OUTGOING LINES HAVE A MINIMUM COVER OF THREE (3) FEET OVER THE TOP OF PIPE. MANHOLE INSTALLATIONS PROPOSED TO HAVE LESS THAN THE THREE (3) FEET OF COVER OVER INCOMING/OUTGOING PIPES REQUIRE PRIOR CITY OF ENGLEWOOD APPROVAL AND SHALL BE CONSTRUCTED IN CONFORMANCE WITH THE MINIMUM DEPTH OF MANHOLE DETAIL.

2. MANHOLE SIZING – GENERALLY MANHOLE SIZES SHALL BE SIZED IN ACCORDANCE WITH THE FOLLOWING TABLE. THE DISTRICT MAY REQUIRE LARGER MANHOLES WHERE DESIGN ANGLES OF THE PIPES AT THE MANHOLES DO NOT PERMIT CONSTRUCTION OF A BENCH LARGE ENOUGH TO ACCOMMODATE MAINTENANCE AND INSPECTION OF THE SYSTEM.

   A. TWO WAY MANHOLES
   - MAXIMUM NOMINAL MINIMUM MANHOLE PIPE SIZE
   - 30" OR SMALLER 4"-0" 5'-0"
   - 33" OR 36" 5'-0" 5'-0"
   - 42" AND UP SIZING BY ENGINEER

   THREE AND FOUR WAY MANHOLES HAVING A PIPE LARGER THAN 18" SHALL BE SIZED BY THE ENGINEER.

3. MANHOLE BASES
   - EITHER PRECAST MANHOLE OR CAST IN PLACE MANHOLE BASES MAY BE USED.
   - MANHOLE BASES SHALL SLOPE 1" PER FOOT TOWARDS THE MANHOLE INLET AND HAVE A BRUSHED NON-SKID FINISH.
   - MANHOLE INLETS SHALL BE FORMED OR SHAPED AND SHALL BE SMOOTH FINISH.

   SEE MANHOLE BASE DETECTOR DETAIL FOR REQUIRED DROPS THROUGH MANHOLES.

4. RING AND COVER REQUIREMENTS – ALL RING AND COVERS SHALL BE CAST IRON. ALUMINUM RING AND COVERS ARE NOT PERMITTED. RING AND COVERS SHALL BE 24- INCHES IN DIAMETER. REFER TO D-14 FOR APPROPRIATE RING AND COVER DETAIL AND ADDITIONAL REQUIREMENTS.

5. INTERMEDIATE PLATFORMS – MANHOLES HAVING A HEIGHT OF SEVENTEEN (17) FEET OR MORE FROM RM TO INLET REQUIRE INTERMEDIATE MANHOLE PLATFORMS. SEE INTERMEDIATE PLATFORM CONSTRUCTION DETAIL (D-13) FOR ADDITIONAL INFORMATION.

SECTION
STANDARD MANHOLE

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DEPARTMENT OF PUBLIC WORKS
DRAWN BY: NBL
DATE: 02/06/94

File Information

File Name: F040-012A.DWG

Project Detail Revised

DETAIL NO. D-12

MANHOLES
SECTION

ALUMINUM STEP

REINFORCING

CONCRETE WALL SECTION

STEPS TO BE HOELED BEHIND REINFORCING STEEL WHEN CONCRETE SECTIONS ARE CAST.

VERTICAL, SPACING WITH BOTTOM STEP 8" ABOVE BENCH AND TOP STEP 15" MAX BELOW RIM.

TYPICAL INSTALLATION

ALUMINUM STEP

NOTE:
1. ALL JOINTS TO BE SET IN FLEXIBLE BUTYL RESIN SEALING COMPOUND AND PLASTERED WITH MORRIM SAVETECH 50/50 THICK AND EXTENDING 4" EACH SIDE OF JOINT INWALL AND OUTSIDE.

PLASTIC STEP

SECTION A-A

1. ALUMINUM ALLOY SPEC:
   A) FED. SPEC. QQ-A-400/B
   B) MIN. TENSILE STRENGTH = 36,000 PSI
   C) MIN. YIELD STRENGTH = 35,000 PSI
   D) MIN. ELONGATION = 10% IN 2".

2. MIN. LOAD CAPACITY (APPLIED CENTER OF STEPS):
   A) 1,000 LB. WITH 6" PROJECTION FROM WALL.
   B) 1,500 LB. WITH 4" PROJECTION FROM WALL.

3. WEIGHT PER STEP = 22.3 LBS.

4. STEPS TO BE CAST, UNALIGNED, IN MANHOLE WALL IN A STRAIGHT LINE, VERTICALLY AT THE SAME TIME THE COARSE OR CORE SECTIONS ARE CAST.

6 3/8" 2 1/2" 9 3/4" 1/2" GRADE 60 STEEL REINFORCEMENT

15/16" ALUMINUM GRATING, 3/16" x 1 1/4" BEARING BARS.

PLAN

ATTACH HINGE TO GRATING WITH (2) 3/8" DIA. BOLTS x 1" O.C. W/ HEX MATE. ATTACH HINGE TO PLATFORM WITH (2) 3/8" DIA. x 3" LD. RED HEADS OR EQUAL.

RING

SAFETY HANDHOLD TO PLATFORM

STANDARD PRECAST FLAT TOP WITH 4x4, 4x4 MESH

ALOCK STEPS ABOVE & OPPOSITE PLATFORM OPENING AS SHOWN TO TOP OF MANHOLE

TO BE USED WHEN THE DISTANCE FROM INWARD TO TOP OF COVER EXCEEDS 17 FT.
STORM CONNECTOR PIPE CLOSURE DETAIL

[To be used only where necessary and as authorized by the Engineer]

1. CONCRETE COLLAR P. REQUIRED WHERE THE CHANGE IN SLOPE EXCEEDS 0.50 OF A FOOT PER FOOT.
2. GAP LIMITS CAN NOT EXCEED MANUFACTURER'S TOLERANCES.
3. CONCRETE COLLAR SHALL NOT BE USED FOR A SIZEM CHANGE ON THE MAIN LINE.
4. WHERE CONNECTORS IS REQUIRED THE DIAMETER OF THE CIRCULAR TIE SHALL BE SHOWN ON THE DETAILS.
5. EXTINGUISHMENT SHALL BE USED WHERE THE SPACES BETWEEN THE EXTREME OUTER ENDS IS 2 1/2" OR LARGER.

GENERAL NOTES

1. A CONCRETE COLLAR P. REQUIRED WHERE THE CHANGE IN SLOPE EXCEEDS 0.50 OF A FOOT PER FOOT.
2. GAP LIMITS CAN NOT EXCEED MANUFACTURER'S TOLERANCES.
3. CONCRETE COLLAR SHALL NOT BE USED FOR A SIZEM CHANGE ON THE MAIN LINE.
4. WHERE CONNECTORS IS REQUIRED THE DIAMETER OF THE CIRCULAR TIE SHALL BE SHOWN ON THE DETAILS.
5. EXTINGUISHMENT SHALL BE USED WHERE THE SPACES BETWEEN THE EXTREME OUTER ENDS IS 2 1/2" OR LARGER.

VERTICAL SECTION

CUT NO. 1: CUTO THE TUBE AT AN ANGLE OF 45 DEGREE. REVERSE ONE SECTION AND INSERT BOTH SECTIONS TOGETHER FORMING THE DEPTION ANGLE A.

CUT NO. 2: CUTO THE TUBE CONSIDERABLY REMOVING A STRIP 3/16 (0.046) INCHES WIDE ON THE SIDE OPPOSITE THE OPEN END. MAKE THE END OF THE TUBE TOGETHER AND INSERT THE TUBE IN THE PIPE.

DETAIL "A"

SUGGESTED SIZE OR EQUAL. EXTERIOR FINISH.

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FILE INFORMATION

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CONCRETE ENCASMENT CLOSURE
OF RIGID CONDUITS

DETAIL NO. D-16
LANDSCAPED AREA
GRADED TO DRAIN TOWARD
SIDEWALK CHASE

TREAD PLATE

3" R TYP 2

#3 BAR 6" LONG
WELDED TO ANGLE
IRON AT 12" O.C.
EACH SIDE (1/2"
ANCHOR BOLT MAY
BE USED).

1/2" x 1"
FLATHEAD MACH. SCREW
BRASS OR ELECTRO-GALVANIZED
FINISH, 2" O.C.

NON-SLIP RAISED PATTERN
STEEL TREAD 1/2" PLATE

ANGLE IRON TO BE
DRILLED AND THREADED
TO ALLOW SCREW

CONCRETE TO BE DRILLED
TO ALLOW FOR SCREW

SIDEWALK DRAIN
N.T.S.

SECTION A-A