ORDINANCE NO. ORD-2017-10008

AN ORDINANCE AMENDING SECTIONS 35-26 THROUGH 35-35 OF DIVISION 5, ARTICLE III, PART IV, OF THE IRVING LAND DEVELOPMENT CODE, FOR STORMWATER MANAGEMENT AND DRAINAGE; PROVIDING FOR PENALTY; AND PROVIDING A SEVERABILITY CLAUSE.

WHEREAS, the Irving City Council finds that this ordinance will minimize damage to public and private property and infrastructure, safeguard the environment, and protect water resources; and

WHEREAS, the Irving City Council finds that this ordinance will protect, maintain, and enhance the environment by establishing minimum standards to control the adverse effects of increased post-development stormwater runoff and nonpoint source pollution associated with new development and redevelopment in the City of Irving; and

WHEREAS, this ordinance is necessary to preserve and protect the health, safety, and welfare of the City of Irving and its citizens, the region, and the state of Texas.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF IRVING, TEXAS:

SECTION I. That all matters stated hereinabove are found to be true and correct and are incorporated herein by reference as if copied in their entirety.

SECTION II. That Division 5, Article III, Part IV, entitled “Drainage” of the Irving Land Development Code is hereby amended by deleting the current “Division 5 - Drainage” in its entirety and replacing it with a new “Division 5 - Stormwater Management and Drainage” to read as follows:

DIVISION 5. - STORMWATER MANAGEMENT AND DRAINAGE

Sec. 35-26. - Purpose.

The City finds that the proper management of post-development stormwater runoff will minimize damage to public and private property and infrastructure, safeguard the public health, safety, environment, and general welfare, and protect water resources. These purposes are accomplished by:

(1) Protecting the integrity of the local and regional watersheds and preserving the health of water resources;

(2) Requiring that new development and redevelopment maintain a designated discharge rate after the development of property in order to prevent increased flooding, erosion, nonpoint source pollution, and to maintain the integrity of stream channels and riparian habitats;

(3) Establishing minimum post-development stormwater management standards and design criteria for the regulation and control of stormwater runoff quantity and quality;
(4) Establishing design and application criteria for the construction and use of structural stormwater control facilities that can be used to meet the minimum post-development stormwater management standards;

(5) Minimizing the expenditure of public funding and resources for drainage related projects;

(6) Minimizing the damage caused by drainage to public and private facilities and utilities; including, but not limited to, water, sanitary sewer, electrical, telephone, cable, gas lines, streets, sidewalks, and bridges;

(7) Making information available to potential buyers and existing property owners concerning areas of special flood hazard;

(8) Promoting a stable tax base and preserving land values;

(9) Preserving the natural beauty and aesthetics of the City;

(10) Encouraging the use of nonstructural stormwater management and better site design practices to preserve greenspace and other conservation areas; and

(11) Providing for the long-term responsibility for and maintenance of structural stormwater control facilities and nonstructural stormwater management practices to ensure continued functionality, maintenance, and protection for the public health, safety, and welfare.

Sec. 35-27. - Definitions.

The definitions in this section shall apply to Sections 35-26 through 35-36 of the Irving Land Development Code, as amended:

(1) **Allowable Headwater** - Maximum depth of flow at the upstream face, measured from the invert, minus the required freeboard.

(2) **Conduit** - Any closed drainage system designed for conveying water.

(3) **Conveyance** - 25-year, 24-hour storm event.

(4) **Culvert** - A culvert (or box culvert) is a component of an open drainage system that conveys flow under roads, driveways, and other improvements that cross the drainage system.

(5) **Design Flood** - A flood having a one percent chance of being equaled or exceeded in any given year based upon fully developed watershed conditions.

(6) **Detention Basin** - A dry or wet basin or depression constructed for the purpose of temporarily storing stormwater runoff and discharging water over time at a reduced rate.

(7) **Developer** - A person, partnership, corporation, or any other legal entity engaged in Development, and not excluded by exemption under state or federal law or this ordinance.
(8) Development - Any man-made change to improved or unimproved real estate, including, but not limited to, construction of buildings, structures, or other improvements, mining, dredging, filling, grading, paving, excavation, drilling operations, grading, or clearing.

(9) Discharge - Rate of stormwater for flood waters flowing in a river, creek, channel, storm sewer system, conduit, culvert, or other stormwater conveyance system.

(10) Dry Detention - An excavated area installed on, or adjacent to, tributaries of rivers, streams, lakes or bays to protect against flooding and, in some cases, downstream erosion by storing water for a limited period of time.

(11) Erosion - The wearing away of the land surface by water, wind, ice, or other geological agents, including such processes as gravitational creep.

(12) Extended Detention (ED) - A facility constructed through filling and/or excavation that provides temporary storage of stormwater runoff and includes an outlet structure that detains and attenuates runoff inflows and promotes the settlement of pollutants.

(13) Facility - Any building, structure, installation, process, or activity from which there is or may be a discharge of pollutant.

(14) Federal Emergency Management Agency (FEMA) - Federal agency which administers the National Flood Insurance Program.

(15) Flood or Flooding - A general and temporary condition of partial or complete inundation of normally dry land areas from the overflow of inland waters, or rapid accumulation or runoff of surface waters from any source.

(16) Floodplain - Any land area susceptible to being inundated by water from any source.

(17) Flood Mitigation - 100-year, 24-hour storm event.

(18) Flume - Any open conduit on a prepared grade, trestle, or bridge.

(19) Freeboard - The vertical distance between the design flood elevation and the top of an open channel, dam, levee, or detention basin to allow for wave action, floating debris, or any other condition or emergency without overflowing the structure.

(20) Hydraulic Gradient or Hydraulic Grade Line (HGL) - A line representing the pressure head available at any given point within the drainage system.

(21) Levee - A man-made structure, usually an earthen embankment, 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.

(22) Levee System - A flood protection system which consists of a levee, or levees, and associated structures, such as closure and drainage devices, which are constructed and operated in accordance with sound engineering practices.
(23) **Manning Equation or Manning Formula** - The uniform flow equation used to relate velocity, hydraulic radius, and energy gradient slope.

(24) **Natural Drainage** - The dispersal of surface waters through ground absorption and by drainage channels formed by the existing surface topography or formed by man-made changes in the surface topography existing at the time of adoption of this ordinance.

(25) **NCTCOG-iSWM** - The North Central Texas Council of Governments Integrated Stormwater Management design criteria and technical manuals, as amended.

(26) **Open Channel** - A channel in which water flows with a free surface.

(27) **Owner or Property Owner** - The person who owns all or part of a facility or property, including any person controlling the facility or property or acting on behalf of the Owner, including, but not limited to, the Owner's agents, assigns, developers, and contractors. Owner or Property Owner does not include the City of Irving.

(28) **Person** - Any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, governmental entity, or any other legal entity, or their legal representatives, agents, or assigns. This definition includes all federal, state, and local governmental entities, unless otherwise exempted by law or this ordinance.

(29) **Privately Maintained Easement Area** - A floodplain or flood-prone area that is not dedicated to the City of Irving as an easement.

(30) **Probable Maximum Flood (PMF)** - The flood magnitude that may be expected from the most critical combination meteorological and hydrologic conditions that are reasonably possible for a given watershed.

(31) **Rational Method** - The means of relating runoff with the area being drained and the intensity of the storm rainfall.

(32) **Registered Professional Engineer** - A person who has been duly licensed and registered by the State Board of Registration for Professional Engineers to engage in the practice of engineering in the State of Texas.

(33) **Sediment** - The soil particles deposited through the process of sedimentation as a product of erosion. These soil particles settle out of runoff at variable rates based on the size of the particle and soil type.

(34) **Site** - The land or water area where any drainage or floodplain improvements, facility, or activity is physically located or conducted, including adjacent land used in connection with the drainage or floodplain improvements, facility, or activity.

(35) **Streambank Protection** - 1-year, 24-hour storm event.

(36) **Stormwater** - Stormwater runoff, snow melt runoff, surface runoff, and surface drainage.
(37) **Use** - Any purpose for which a building or other structure or a tract of land may be designed, arranged, intended, maintained, or occupied; or any activity, occupation, business, or operation carried on, or intended to be carried on, in a building or other structure or on a tract of land.

(38) **Watershed** - The area drained by a stream or drainage system.

(39) **Water Quality** - Criteria based on a volume of 1.5 inches of rainfall, not a storm frequency.

**Sec. 35-28. – Generally.**

(a) All stormwater management improvements shall be installed by the Owner.

(b) All storm sewer systems shall be installed in accordance with the plans and specifications approved by the City Engineer.

(c) If improvements are dedicated to the City, the City Council will render a final decision as to the size and type of the improvements.

(d) For improvements that are dedicated to the City, no additional fill shall be placed above the system and no structural alterations shall be made to the system after the improvements are accepted for dedication by the City.

(e) Where drainage originates upstream and passes through a subdivision or lot, the Owner shall be responsible for all drainage improvements within said subdivision or lot required to handle off-site drainage.

(f) The Owner shall be responsible for all drainage improvements of whatever size required to adequately handle drainage originating within a subdivision or lot.

**Sec. 35-29. – Design Criteria.**

(a) Storm drainage improvements shall be designed for the following storm events as shown in table 35-29A:

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Design Storm Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 100 acres</td>
<td>25-year frequency design</td>
</tr>
<tr>
<td>100 acres to 640 acres</td>
<td>50-year frequency design</td>
</tr>
<tr>
<td>Over 640 acres</td>
<td>100-year frequency design</td>
</tr>
</tbody>
</table>

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(b) Computations to determine whether the lots, land, or subdivision will be flooded by rainfall and the sizes of drainage facilities adequate to prevent flooding shall be based upon the standards and specifications in NCTCOG-iSWM.

(c) Enclosed storm sewers, open drainage ditches, bridges, and culverts of a permanent design, adequate to carry off rainfall, shall be installed by the Owner throughout the entire length of the drainage area within the subdivision in accordance with plans and specifications approved by the City Engineer.

(d) Drainage channels shall consist of natural banks and slopes where possible. Reinforced concrete pipe or concrete lining is permitted only where the City Engineer or City Council finds that this treatment is needed to maintain sufficient land area to accommodate development on an infill site that is designated in the Comprehensive Plan adopted by the City of Irving, as amended, or where a channel or grass lined channel cannot withstand the runoff velocities created from offsite drainage.

(e) Fully developed watershed conditions shall be used for determining runoff for the conveyance storm and the flood mitigation storm.

(f) The Owner shall show that the 100-year fully developed design storm event is contained within the right-of-way, drainage easements, and road low points.

(g) Drainage from residential areas, such as roof tops, must be allowed to flow overland before joining the storm sewer system.

(h) Seepage into basements or sub-surface structures that is pumped to ground level, seepage from springs, and runoff from roof drains on non-residential buildings that would flow onto or across driveways, sidewalks, or other areas commonly crossed by pedestrians must not create hazards or nuisances to pedestrians. If hazards or nuisances are, or would be created, the basement and rooftop drains shall be tied directly to the nearest storm sewer, provided that pumped lines from basements have backflow preventers and the water is uncontaminated.

(i) All storm sewer systems must be installed in accordance with the plans and specifications approved by the City Engineer. After acceptance of the drainage system by the City Engineer, no additional fill shall be placed above the system nor shall structural alterations be made to the system without the prior written approval of the City Engineer.
<table>
<thead>
<tr>
<th>Design Focus Area</th>
<th>Required Downstream Assessment</th>
<th>Design Options</th>
</tr>
</thead>
</table>
| Water Quality Protection          | No                            | **Option 1:** Use integrated site design practices for conserving natural features, reducing impervious cover, and using natural drainage systems.  
**Option 2:** Treat the Water Quality Protection Volume (WQv) by reducing total suspended solids from the development site for runoff resulting from rainfalls of up to 1.5 inches (85\textsuperscript{th} percentile storm).  
**Option 3:** Assist in implementing off-site community stormwater pollution prevention programs/activities as designated in an approved stormwater master plan or Texas Pollutant Discharge Elimination System (TPDES) Stormwater permit. |
| Streambank Protection             | Yes                           | **Option 1:** Reinforce/stabilize downstream conditions.  
**Option 2:** Install stormwater controls to maintain or improve existing downstream conditions.  
**Option 3:** Provide on-site controlled release of the 1-year, 24 hour storm event over a period of 24 hours (Streambank Protection Volume, SPv) |
| Flood Mitigation and Conveyance   | Yes                           | **Flood Mitigation**  
**Option 1:** Provide adequate downstream conveyance systems.  
**Option 2:** Install Stormwater controls on-site to maintain or improve existing downstream conditions.  
**Option 3:** In lieu of a downstream assessment, maintain existing on site runoff conditions.  
**Conveyance:** Minimize localized site flooding of streets, sidewalks, and properties by a combination of onsite stormwater controls and conveyance systems. |

Sec. 35-29.1. - On-Site Drainage

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The Owner is responsible for all drainage improvements (regardless of size) required to adequately handle drainage originating within the Owner’s subdivision or lot.

Sec. 35-29.2. - Off-Site Drainage

Where drainage originates upstream and passes through a subdivision or lot, the Owner shall be responsible for all drainage improvements within the subdivision or lot that are required to handle off-site drainage.

Sec. 35-29.3. - Open Channels

(a) Open channels, including all natural or structural channels, swales, and ditches shall be designed for the flood mitigation storm event.

(b) Open channels shall be designed with multiple stages. A low flow channel section shall contain the streambank protection flows and a high flow section shall contain the conveyance and flood mitigation storms to improve stability and better mimic natural channel dimensions.

(c) Trapezoidal open channels shall have a minimum channel bottom width of 8 feet.

(d) Open channels with bottom widths greater than 8 feet shall be designed with a minimum bottom cross slope of 12 to 1 or with compound cross sections.

(e) Open channel side slopes shall be stable throughout the entire length and the side slope shall depend on the channel material. Open channel side slopes and roadside ditches with a side slope steeper than 3:1 shall require detailed geotechnical and slope stability analysis to justify slopes steeper than 3:1. Any slope that is less than 3:1 must be approved by the City Engineer.

(f) For vegetative open channels, flow velocities within the channel shall not exceed the maximum permissible velocities given in Tables 35-29C and 35-29D of this ordinance.

(g) If relocation of a stream channel is unavoidable, the cross-sectional shape, meander, pattern, roughness, sediment transport, and slope must conform to the existing conditions insofar as practicable. Energy dissipation is necessary when existing conditions cannot be duplicated.

(h) Streambank stabilization shall be provided, when appropriate, as a result of any stream disturbance, such as encroachment, and shall include both upstream and downstream banks as well as the local site.

(i) HEC-RAS, or similarly capable software approved by the City Engineer, shall be used to confirm the water surface profiles in open channels.

(j) The final design of artificial open channels shall be consistent with the velocity limitations for the selected channel lining. Maximum velocity values for selected lining categories are presented in Table 35-29C of this ordinance. Seeding and mulch shall only be used when the design value does not exceed the allowable value for bare soil. Table 35-29D of this ordinance shall be used for velocity limitations of vegetative linings. Vegetative lining calculations and stone riprap procedures must comply with Section 3.2 of the NCTCOG-iSWM Hydraulics Technical Manual.

(k) For gabions, design velocities may range from 10 fps for 6-inch mattresses up to 15 fps for 1-foot mattresses. Velocities of 20 fps are allowable for basket installations if indicated by the manufacturer. The design of stable rock riprap lining shall be determined on a case by case basis depending on the intersection of the velocity (local boundary shear) and the size and gradation of
the riprap material. Unless otherwise approved by the City Engineer, all acceptable riprap velocity limits shall comply with Section 3.2.7 of the NCTCOG-iSWM Hydraulics Technical Manual.
<table>
<thead>
<tr>
<th>Channel Description</th>
<th>Manning's n</th>
<th>Max. Permissible Channel Velocity (ft/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MINOR NATURAL STREAMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fairly regular section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Some grass and weeds, little, or no brush</td>
<td>0.030</td>
<td>3 to 6</td>
</tr>
<tr>
<td>2. Dense growth of weeds, depth of flow materially greater than weed height</td>
<td>0.035</td>
<td>3 to 6</td>
</tr>
<tr>
<td>3. Some weeds, light brush on banks</td>
<td>0.035</td>
<td>3 to 6</td>
</tr>
<tr>
<td>4. Some weeds, heavy brush on banks</td>
<td>0.050</td>
<td>3 to 6</td>
</tr>
<tr>
<td>5. Some weeds, dense willows on banks</td>
<td>0.060</td>
<td>3 to 6</td>
</tr>
<tr>
<td>For trees within channels with branches submerged at high stage, increase above values by</td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>Irregular section with pools, slight channel meander, increase above values by</td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>Floodplain – Pasture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Short grass</td>
<td>0.030</td>
<td>3 to 6</td>
</tr>
<tr>
<td>2. Tall grass</td>
<td>0.035</td>
<td>3 to 6</td>
</tr>
<tr>
<td>Floodplain - Cultivated Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. No crop</td>
<td>0.030</td>
<td>3 to 6</td>
</tr>
<tr>
<td>2. Mature row crops</td>
<td>0.035</td>
<td>3 to 6</td>
</tr>
<tr>
<td>3. Mature field crops</td>
<td>0.040</td>
<td>3 to 6</td>
</tr>
<tr>
<td>Floodplain - Uncleared</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Heavy weeds scattered brush</td>
<td>0.050</td>
<td>3 to 6</td>
</tr>
<tr>
<td>2. Wooded</td>
<td>0.120</td>
<td>3 to 6</td>
</tr>
<tr>
<td><strong>MAJOR NATURAL STREAMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roughness coefficient is usually less than for minor streams of similar description on account of less effective resistance offered by irregular banks or vegetation on banks. Values of &quot;n&quot; for larger streams of mostly regular sections, with no boulders or brush</td>
<td>Range from 0.028 to 0.060</td>
<td>3 to 6</td>
</tr>
<tr>
<td><strong>UNLINED VEGETATED CHANNELS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clays (Bermuda Grass)</td>
<td>0.035</td>
<td>5 to 6</td>
</tr>
<tr>
<td>Sandy and Silty Soils (Bermuda Grass)</td>
<td>0.035</td>
<td>3 to 5</td>
</tr>
<tr>
<td><strong>UNLINED NON-VEGETATED CHANNELS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy Soils</td>
<td>0.030</td>
<td>1.5 to 2.5</td>
</tr>
<tr>
<td>Silts</td>
<td>0.030</td>
<td>0.7 to 1.5</td>
</tr>
<tr>
<td>Sandy Silts</td>
<td>0.030</td>
<td>2.5 to 3.0</td>
</tr>
<tr>
<td>Clays (Bermuda Grass)</td>
<td>0.030</td>
<td>3.0 to 5.0</td>
</tr>
<tr>
<td>Coarse Gravels</td>
<td>0.030</td>
<td>5.0 to 6.0</td>
</tr>
<tr>
<td>Shale</td>
<td>0.030</td>
<td>6.0 to 10.0</td>
</tr>
<tr>
<td>Rock</td>
<td>0.025</td>
<td>15</td>
</tr>
</tbody>
</table>
### Table 35-29D - Maximum Velocities for Vegetative Channel Linings

<table>
<thead>
<tr>
<th>Vegetation Type</th>
<th>Slope Range (%)</th>
<th>Maximum Velocity (ft/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bermuda Grass</td>
<td>0-5</td>
<td>6</td>
</tr>
<tr>
<td>Bahia</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Tall fescue grass mixtures¹</td>
<td>0-10</td>
<td>4</td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>0-5</td>
<td>6</td>
</tr>
<tr>
<td>Buffalo Grass</td>
<td>5-10</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>4</td>
</tr>
<tr>
<td>Grass Mixture</td>
<td>0-5²</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5-10</td>
<td>3</td>
</tr>
<tr>
<td>Sericea lespedeza, Weeping lovegrass, Alfalfa</td>
<td>0-5³</td>
<td>3</td>
</tr>
<tr>
<td>Annuals⁴</td>
<td>0-5</td>
<td>3</td>
</tr>
<tr>
<td>Sod</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Lapped Sod</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

¹ Do not use on slopes steeper than 10% except for side-slope in combination channel.
² Use velocities exceeding 5 ft/s only where good stands can be made.
³ Mixtures of Tall Fescue, Bahia, and/or Bermuda
⁴ Do not use on slopes steeper than 5% except for side-slope in combination channel.
⁵ Annuals - used on mild slopes or as temporary protection until permanent covers are established.

### Sec. 35-29.4. - Streets and Stormwater Inlets

(a) Design Frequency

1. Streets and roadway gutters: conveyance storm event
2. Inlets on-grade: conveyance storm event
3. Parking lots: conveyance storm event
4. Storm drain pipe systems: conveyance storm event
5. Low points: flood mitigation storm event
6. Street ROW: flood mitigation storm event
7. Drainage and Floodplain easements: flood mitigation storm event

(b) Design Criteria

1. Streets and ROW
Depth in the street shall not exceed top of curb or maximum flow spread limits for the conveyance storm. The flood mitigation storm shall be contained on-site or within dedicated right-of-way and easements.

(2) Parking Lots

Parking lots shall be designed for the conveyance storm not to exceed top of curb with maximum ponding at low points of one (1) foot. The flood mitigation storm shall be contained on-site or within dedicated easements.

(3) Flow Spread Limits

Inlets shall be spaced so that the spread of flow in the street for the conveyance storm shall not exceed the guidelines listed in Table 35-29E, as measured from the gutter or face of the curb:

<table>
<thead>
<tr>
<th>Street Classification</th>
<th>Allowable Encroachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collectors, Arterial, and Thoroughfares (greater than 2-lanes)</td>
<td>- 8 feet or one travel lane, both sides for a divided roadway</td>
</tr>
<tr>
<td>Residential Streets</td>
<td>- curb depth or maximum 6 inches at gutter</td>
</tr>
</tbody>
</table>

(4) Storm Drain Pipe

a. For ordinary conditions, storm drain pipes shall be sized on the assumption that they will flow full or practically full under the design discharge, but will not be placed under pressure head. The Manning Equation is recommended for capacity calculations.

b. The maximum hydraulic gradient shall not produce a velocity that exceeds 15 feet per second (fps). Velocities for storm drainage design must comply with Table 35-29F, unless otherwise approved by the City Engineer. Storm drains shall be designed to have a minimum mean velocity flowing full at 2.5 fps.

<table>
<thead>
<tr>
<th>Table 35-29F Desirable Velocity in Storm Drains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Culverts (All types)</td>
</tr>
<tr>
<td>Storm Drains (Inlet laterals)</td>
</tr>
<tr>
<td>Storm Drains (Collectors)</td>
</tr>
<tr>
<td>Storm Drains (Mains)</td>
</tr>
</tbody>
</table>

c. The minimum desirable physical slope elevation exceeds 1 foot below ground elevation for the design flow, the top of the pipe, or the gutter flow line, whichever is lowest, adjustments are needed in the system to reduce the elevation of the hydraulic grade line.

d. Access manholes are required at intermediate points along straight runs of closed conduits in accordance with the maximum spacing criteria shown in Table 35-29G.
Table 35-29G Access Manhole Spacing Criteria

<table>
<thead>
<tr>
<th>Pipe Size (inches)</th>
<th>Spacing (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 and smaller</td>
<td>330 to 650 (MAY)</td>
</tr>
<tr>
<td>48 and larger</td>
<td>650 to 1150 (MAY)</td>
</tr>
</tbody>
</table>

e. Pipe hydraulic grade line (HGL) shall be below the throat of inlets.

(5) Manholes

a. The Owner shall provide a manhole at all locations where the diameter of the trunk line pipe changes or where the cross-sectional dimensions of the trunk line box changes.

b. The Owner shall provide a manhole at all locations where the spacing between two or more laterals intersecting the trunk line is equal to or less than 10 feet.

Sec. 35-29.5. - Hydrologic Methods

(a) The following methods may be used to support hydrologic site analysis for the design methods and procedures included in NCTCOG-iSWM:

(1) Rational Method
(2) SCS Unit Hydrograph Method
(3) Snyder’s Unit Hydrograph Method
(4) TxDOT Regression Equations
(5) USGS Regression Equations
(6) iSWM Water Quality Protection Volume Calculation
(7) Water Balance Calculations

(b) Table 35-29H lists the hydraulic methods and circumstances for their use in various analysis and design applications. Table 35-29H provides some limitations on the use of several methods. The Rational Method is acceptable for small, highly impervious drainage areas, such as parking lots and roadways draining into inlets and gutters.

(c) The U.S. Geological Survey (USGS) and Texas Department of Transportation (TxDOT) regression equations are acceptable for drainage areas with characteristics within the ranges given for the equations shown in Table 35-29H. These equations should not be used when there are significant storage areas within the drainage basin or where other drainage characteristics indicate general regression equations are not appropriate.
Table 35-29H Constraints on Using Recommended Hydrologic Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Size Limitations</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rational</td>
<td>0-100 acres</td>
<td>Method can be used for estimating peak flows and the design of small site or subdivision storm sewer systems</td>
</tr>
<tr>
<td>Modified Rational</td>
<td>0-200 acres</td>
<td>Method can be used for estimating runoff volumes for storage design</td>
</tr>
<tr>
<td>Unit Hydrograph (SCS)</td>
<td>Any Size</td>
<td>Method can be used for estimating peak flows and hydrographs for all design applications</td>
</tr>
<tr>
<td>Unit Hydrograph (Snyder's)</td>
<td>1 acre and larger</td>
<td>Method can be used for estimating peak flows and hydrographs for all design applications</td>
</tr>
<tr>
<td>TxDOT Regression Equations</td>
<td>10 to 100 mi²</td>
<td>Method can be used for estimating peak flows and hydrographs for rural design applications</td>
</tr>
<tr>
<td>USGS Regression Equations</td>
<td>3-40 mi²</td>
<td>Method can be used for estimating peak flows and hydrographs for urban design applications</td>
</tr>
<tr>
<td>ISWM Water Quality Protection Volume Calculation</td>
<td>Limits set for each Structural Control</td>
<td>Method can be used for calculating the Water Quality Protection Volume (WQv)</td>
</tr>
</tbody>
</table>

Sec. 35-29.6. - Streambank Protection

Streambank protection is the second design focus area as shown in 35-29B. There are three options by which an Owner may provide adequate streambank protection downstream of a proposed development. The first step is to perform the required downstream assessment as described in Section 35-29.7. If it is determined that the proposed project does not exceed acceptable downstream velocities or the downstream conditions are improved to adequately handle the increased velocity, then no additional streambank protection is required. If on-site or downstream improvements are required for streambank protection, easements or right-of-entry agreements will need to be obtained by the Owner. If the downstream assessment shows that the velocities are within acceptable limits as provided by this ordinance, then no streambank protection is required.

(a) Option 1: Reinforce/Stabilize Downstream Conditions

If the increased velocities are greater than the allowable velocity of the downstream receiving system, then the Owner must reinforce/stabilize the downstream conveyance system. The proposed modifications must be designed so that the downstream system is protected from post-development velocities. The Owner must provide supporting calculations and/or documentation that the downstream velocities do not exceed the allowable range once the downstream modifications are installed.

Allowable bank protection methods include riprap, gabions, and bio-engineered methods. Sections 3.2 and 4.0 of the NCTCOG-iSWM Hydraulics Technical Manual provide guidance for designing...
stone riprap for open channels, culvert, culvert outfall protection, riprap aprons for erosion protection at outfalls, and riprap basins for energy dissipation.

(b) Option 2: Install Stormwater Controls to Maintain Existing Downstream Conditions

The Owner must use on-site controls to keep downstream post-development discharges at or below allowable velocity limits. The Owner must provide supporting calculations and/or documentation that the on-site controls will be designed such that downstream velocities for the three storm events (Streambank Protection, Conveyance, and Flood Mitigation) are within an allowable range once the controls are installed.

(c) Option 3: Control the Release of the 1-yr, 24hour Storm Event

Twenty-four hours of extended detention shall be provided for on-site, post-developed runoff generated by the 1-year, 24-hour rainfall event to protect downstream channels. The required volume for extended detention is referred to as the Streambank Protection Volume (denoted SPv). The reduction in the frequency and duration of bankfull flows through the controlled release provided by extended detention of the SPv will reduce the bank scour rate and severity.

Sec. 35-29.7. - Acceptable Downstream Conditions

(a) As part of the development, the downstream impacts of developments must be carefully evaluated for the two design focus areas of Streambank Protection and Flood Mitigation, as provided in Table 35.29B. The purpose of the downstream assessment is to protect downstream properties from increased flooding and downstream channels from increased erosion potential due to upstream development. The importance of the downstream assessment is particularly evident for larger sites or developments that have the potential to dramatically impact downstream areas. The cumulative effect of smaller sites, however, can be just as dramatic and, as such, the NCTCOG-iSWM design focus area requirements must be followed for both small sites and large sites.

(b) The downstream assessment shall extend from the outfall of a proposed development to a point downstream where the discharge from a proposed development no longer has a significant impact, in terms of flooding increase or allowable velocities, on the receiving stream or storm drainage system. The City shall be consulted to obtain records and maps related to the National Flood Insurance Program and availability of Flood Insurance Studies and Flood Insurance Rate Maps (FIRMs) which will be helpful in this assessment. The downstream assessment shall be a part of the preliminary and final plans, and must include all of the following information and analyses:

(1) Hydrologic analysis of the pre- and post-development on-site conditions;

(2) Drainage path that defines extent of the analysis;

(3) Capacity analysis of all existing constraints points along the drainage path, such as existing floodplain developments, underground storm drainage systems culverts, bridges, tributary confluences, or channels;

(4) Offsite undeveloped areas considered as “full build-out” for both the pre- and post-development analyses;

(5) Evaluation of peak discharges and velocities for three 24-hour storm events, streambank protection storm; conveyance storm; and flood mitigation storm; and
(6) Separate analysis for each major outfall from the proposed development.

(c) Once the analysis is complete, the Owner must provide the City Engineer with answers to the following four questions at each determined junction downstream:

(1) Are the post-development discharges greater than the pre-development discharges?
(2) Are the post-development velocities greater than the pre-development velocities?
(3) Are the post-development velocities greater than the velocities allowed for the receiving system?
(4) What are the post-development flood heights compared to the predevelopment flood heights?

These questions shall be answered for each of the three storm events. The answers to these questions and if they negatively impact property or the public safety and welfare as determined by the City Engineer will determine the necessity, type, and size of non-structural and structural controls to be placed on-site or downstream of the proposed development.

Sec. 35-29.8. – Drainage channel adjacent to subdivision or lot

(a) In an area where a subdivision or lot is adjacent to a drainage channel, responsibility for drainage originating on-site and off-site, shall be identical to the requirements of Sections 35-29.1 and 35-29.2.

Sec. 35-30. - Channel Edge Wall

(a) All channels shall include an edge wall section within the channel sideslope. The purpose of the edge wall section is to help control the potential for future erosion. This edge wall section may be located at the top bank (or) the edge of the 100-year floodplain. The edge wall section shall meet the following minimum requirements:

(1) A vertical height of 2 feet above the grade of the channel sideslope at the wall location;
(2) A vertical depth of 2 feet below the grade of the channel sideslope at the wall location;
(3) The edge wall section must include aesthetic features. Plain concrete walls are not acceptable. Concrete walls with textured and stained face treatments, aesthetically textured walls, or similar features are permissible; and
(4) The edge wall section shall include the use of erosion protection material at the toe of the wall for a minimum distance of 5 feet.

Sec. 35-31. - Easements & Maintenance

(a) Easements for drainage purposes shall be provided and dedicated to the public in all subdivisions and plats as provided by City ordinance, including this Division 5 and Sec. 35-24.

(b) The Owner shall provide a Public Easement Area or Privately Maintained Easement Area and a required maintenance easement, which shall be dedicated to the City of Irving as a permanent drainage area and open space corridor in accordance with the following:
(1) Dedications of Easement Areas Required for Drainage and Floodplain Areas

Drainage and floodplain areas for all open channels, creeks, and flumes shall be dedicated to the City of Irving. Dedicated areas shall encompass all areas having a ground elevation below the higher of one foot above the base flood elevation, at or above the water surface elevation associated with the design flood, or the top of the high bank or channel edge. Residential lots shall not extend into easement and floodplain areas. No fences, buildings, or other structures which could impede flow shall be placed within these dedicated areas. In all cases, the dedicated area shall also include at least a 15-foot wide maintenance strip along both sides of the channel or, if the City Engineer so allows, at least a 20-foot wide maintenance strip along one side of the channel. Streets, alleys, bike paths, paved trails, and other pedestrian walkways, alongside the channel may serve as all or part of the maintenance easement. Drainage easements for flumes shall be located with sufficient width to permit future maintenance accessibility, and in no case shall be less than 15 feet wide.

(2) Maintenance Access

Maintenance access areas will be provided along channel improvements as provided in this ordinance. The improvements will also include maintenance access ramps in the channel improvements when the side slopes are steeper than 4 to 1. The location and number of the maintenance access ramps will be established by the City Engineer. Each reach of improvement must have facilities to allow access for maintenance equipment.

(3) Maintenance of Drainage and Floodplain Improvements and Facilities in Drainage and Floodplain Areas

All drainage and floodplain areas shall be dedicated to the City of Irving. The maintenance responsibility of the dedicated area shall be determined as follows:

a. Drainage and floodplain improvements constructed by the City of Irving shall be the maintenance responsibility of the City.

b. Public Easement Areas – Public Easement Areas shall be dedicated in fee simple to the City of Irving and shall be the City’s maintenance responsibility. Public Easement Areas shall include the following:

1. Drainage and floodplain improvements constructed in relation to single family residential developments (including duplexes), except for improvements under Section 35-32.

2. Drainage and floodplain improvements constructed in relation to land uses, other than single family residential, shall be dedicated as Public Easement Areas, unless otherwise directed by the City Engineer, and the Owner enters into a Maintenance Agreement with the City.

c. Privately Maintained Easement Areas – Drainage and floodplain improvements constructed in conjunction with land use improvements by a private development. Properties adjacent to the improvements or a property owners association shall be defined by plat or separate
instrument filed with the Dallas County Deed Records and the City of Irving City Secretary's Office as being responsible for the maintenance and repairs to said improvements.

(c) The City Engineer may require drainage and floodplain improvements to be dedicated as Privately Maintained Easement areas, regardless of land use type, for any of the following conditions:

(1) For channel and floodplain areas left in a natural state;

(2) For channel and floodplain improvements that utilize a channel sideslope that is steeper than 4:1; or

(3) For channel and floodplain improvements projects that utilize bio-engineering improvements as stabilization measures.

(d) Any area dedicated as a Privately Maintained Easement must meet all of the following requirements:

(1) Drainage and floodplain improvements dedicated as Privately Maintained Easement areas shall be the maintenance responsibility of the Owner.

(2) In situations where the City Engineer allows or requires the drainage or floodplain area to be dedicated as a Privately Maintained Easement area, the Owner shall enter into a perpetual maintenance agreement with the City. The perpetual maintenance shall be assured by either a private entity, trust fund, or other mechanism as approved by the City Council.

(3) In areas where the perpetual maintenance is assured by either a private entity, trust fund, or other mechanism, the City shall not be responsible for maintenance of the drainage improvements. If such improvements deteriorate in condition, the City Engineer shall notify the private entity, trust fund, other mechanism, Owner, or responsible maintenance entity of required corrections and/or maintenance to bring the drainage or floodplain area up to the standards as originally approved by the City and accordance with the original improvement design. If such maintenance is not accomplished within thirty (30) days after receipt of written notice by the City, the City or its contractors may perform the necessary work and attach a lien on the property for the reasonable costs incurred by the City or its contractors to perform the work.

Sec. 35-32. - Lakes and Dams

(a) In the event that an Owner desires to modify an existing pond or lake or desires to impound stormwater by filling or constructing an above-ground dam, thereby creating a lake, pond, lagoon, or basin as part of the planned development of that property, the criteria listed below shall be met before City approval of the impoundment can be given. Ponds or lakes created by excavation of a channel area without erecting a dam above natural ground elevation or instream, low water check dams are also subject to the criteria listed below, with the exception of spillway capacity requirements. The City Engineer has the final authority to determine the design criteria for a proposed dam, check dam, or excavated lake. The requirements of the State of Texas must also be met for the construction of dams, lakes, and other impoundments.

(b) The design criteria for a dam is dependent on the size and hazard classification of the dam. The size and hazard classification will be based on Chapter 12 of the Texas Water Code and will be
determined by the City Engineer based on information furnished by the Owner. The following criteria will be used to classify a dam:

(1) Size

The classification for size is based on the height of the dam and storage capacity, whichever gives the larger size category. Height is defined as the distance between the top of the dam (minus the freeboard) and the existing streambed at the downstream toe. Storage is defined as the maximum water volume impounded at the top of the dam (minus the freeboard). The following categories in table 35-32A must be used:

<table>
<thead>
<tr>
<th>Category</th>
<th>Storage (Acre-feet)</th>
<th>Height (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>&lt;100</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Small</td>
<td>≥100 and &lt;1,000</td>
<td>≥10 and &lt;40</td>
</tr>
<tr>
<td>Intermediate</td>
<td>≥1,000 and &lt;50,000</td>
<td>≥40 and &lt;100</td>
</tr>
<tr>
<td>Large</td>
<td>≥50,000</td>
<td>≥100</td>
</tr>
</tbody>
</table>

(2) Hazard Potential

The hazard potential for a dam is based on the potential for loss of human life and property damage downstream from a dam in the event of failure. The following categories in table 35-32B must be used:

<table>
<thead>
<tr>
<th>Category</th>
<th>Loss of Life</th>
<th>Economic Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extent of Development</td>
<td>Extent of Development</td>
</tr>
<tr>
<td>Low</td>
<td>None expected (no permanent structures for human habitation)</td>
<td>Minimal (undeveloped to occasional structures or agriculture)</td>
</tr>
<tr>
<td>Significant</td>
<td>Possible, but not expected (No urban developments and no more than a small number of inhabitable structures)</td>
<td>Appreciable (notable agriculture, industry, or commercial development)</td>
</tr>
<tr>
<td>High</td>
<td>Expected (urban development or large number of inhabitable structures)</td>
<td>Excessive (extensive public, industrial, or agricultural development)</td>
</tr>
</tbody>
</table>

(3) Spillway Design Flood

The classification of a dam based on the above criteria will be used to determine the Spillway Design Flood (SDF). The total capacity of a dam structure, including principal and emergency spillways, shall be adequate to pass the SDF without exceeding the top dam elevation at a minimum. The SDFs required for various dam classifications are shown in table 35-32C.
<table>
<thead>
<tr>
<th>Hazard</th>
<th>Size</th>
<th>SDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Minor</td>
<td>100 – year</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>1/4 PMF</td>
</tr>
<tr>
<td>Intermediate</td>
<td></td>
<td>1/4 PMF to 1/2 PMF</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>PMF</td>
</tr>
<tr>
<td>Significant</td>
<td>Minor</td>
<td>1/4 PMF to 1/2 PMF</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td>1/2 PMF TO PMF</td>
</tr>
<tr>
<td>Intermediate</td>
<td></td>
<td>PMF</td>
</tr>
<tr>
<td>High</td>
<td>Small</td>
<td>PMF</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>PMF</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>PMF</td>
</tr>
</tbody>
</table>

(c) In all cases, the minimum principal spillway design capacity is the 100-year design flood. In certain cases, a dam breach analysis may be required to determine the proper classification of the structure. For all structures requiring a spillway design flood equal to the PMF, a dam breach analysis is required to determine the downstream consequences of a failure. All dams designed for a SDF of 1/2 PMF or less shall be constructed with a minimum freeboard of two feet above the SDF elevation.

(1) Additional Design Requirements

a. An engineering plan for such construction, accompanied by complete drainage design information and sealed by a Registered Professional Engineer, shall be submitted to the City Engineer.

b. The spillway and any emergency overflow areas shall be located so that flood waters will not inundate any buildings, roadways, or other structures.

c. All Federal, State, and local laws and regulations pertaining to impoundment of surface water must be followed, including the design construction and safety of the impounding structure. Copies of any Federal, State, and local governmental or agency permits issued for the proposed impoundments shall be submitted to the City Engineer.

d. Any existing structure, which is included in the project area shall be improved to comply with the applicable Federal, State, and local governmental safety requirements for structures.

e. Before removing, enlarging, or altering any existing lake, the Owner will furnish a study of the effects of the alteration upon flooding conditions both upstream and downstream. The study shall be prepared by a Registered Professional Engineer and submitted to the City for approval prior to making the proposed alteration. Compensatory storage shall be provided in a manner such that equal or comparable flood retention capacity is maintained.
f. Any improvements to existing dams or lakes or construction of new impoundments shall be made at the expense of the Owner, prior to acceptance of the adjacent street, utilities, and drainage improvements under the City’s Subdivision Ordinance, as amended.

(2) Maintenance and Liability Criteria

a. The Owner shall agree to retain private ownership of the lake, pond, lagoon, or basin constructed and to assume full responsibility for the protection of the general public from any health or safety hazards related to the lake, pond, lagoon, or basin constructed. A private drainage easement shall be dedicated to the City for the improvement and shall meet the requirements of this ordinance.

b. The Owner shall agree to assume full responsibility for the maintenance of the lake, pond; lagoon, or basin constructed. The Owner shall keep the City Engineer advised of the current person responsible for this maintenance.

Sec. 35-33. - Levees

(a) The requirements established in this section for levee improvements apply to new levee systems. The requirements do not apply to existing levee systems or modifications to existing levee systems. In the event that an Owners desires to build new levees to protect an area from flooding, applicable FEMA and State of Texas guidelines and the all of the following criteria shall apply:

(1) Levees shall be designed to have a minimum of four feet of freeboard above the Standard Project Flood for the fully developed watershed flows.

(2) Levees shall be designed according to the Corps of Engineers design criteria whether or not they are federally authorized levees.

(3) Levee systems shall be designed with interior drainage systems to prevent flooding from local runoff contained within the system for the 100-year design flood.

(4) Levee systems shall have written operation procedures that address gate closure conditions and an emergency warning plan. A copy of these procedures shall be furnished to the City Engineer.

(5) Automated gate closure systems shall have power from two independent sources and shall be capable of being operated manually.

(6) Ring levees protecting individual structures proposed for construction after the enactment date of this ordinance shall not be permitted.

(7) All new levee systems shall have permanent positive closures to the required design elevation. Temporary closures involving sandbagging or other procedures requiring manual operations shall not be permitted.

(8) Provisions shall be made for ensuring the permanent maintenance of levees either by a flood control district or similar governmental organization or by the existing property owner and all future owners, heirs, or assigns.
(9) Additional plan requirements include water surface profiles for the design flood and SPF; top of levee profile, definition of interior drainage facilities, including pump station and ponding areas; location of gravity outlets, gatewells and closure structures; and elevation-duration data on the receiving system.

Sec. 35-34. - Culverts, Bridges, Flumes, and Detention Structures

(a) Culverts shall be designed for the flood mitigation storm or in accordance with TxDOT requirements, whichever is more stringent. Considerations when designing culverts include: roadway type, tailwater or depth of flow, structures, and property subject to flooding, emergency access, and road replacement costs. The flood mitigation storm shall be routed through all culverts to ensure structures are not flooded and damage does not occur to the highway or adjacent property for this design event.

(1) Velocity Limitations

a. The maximum velocity shall be consistent with channel stability requirements at the culvert outlet.

b. The maximum allowable velocity for corrugated metal pipe (CMP) is 15 feet per second. The use of corrugated metal pipe is not allowed in public right-of-way or easements unless approved by the City Engineer. There is no specified maximum allowable velocity for reinforced concrete pipe, but outlet protection shall be provided where discharge velocities will cause erosion conditions.

c. To ensure self-cleaning during partial depth flow, a minimum velocity of 2.5 feet per second is required for the streambank protection storm when the culvert is flowing partially full.

(2) Length and Slope

a. The maximum slope using concrete pipe is 10% and for CMP is 14% before pipe-restraining methods must be taken.

b. Maximum vertical distance from throat of intake to flowline in a drainage structure is 10 feet.

c. Drops greater than 4 feet will require additional structural design.

(3) Headwater Limitations

a. The allowable headwater is the depth of water that can be ponded at the upstream end of the culvert during the design flood, which will be limited by one of the following constraints or conditions:

1. Headwater must not damage upstream property.
2. Culvert headwater plus 12 inches of freeboard shall not exceed top of curb or pavement for low point of road over culvert, whichever is lower.
3. Ponding depth will be no longer than the elevation where flow diverts around the culvert.
4. Elevations will be established to delineate floodplain zoning.
b. The headwater shall be checked for the flood mitigation storm elevation to ensure compliance with flood plain management criteria and the culvert shall be sized to maintain flood-free conditions on major thoroughfares with 12-inch freeboard at the low point of the road.

c. Either the headwater shall be set to produce acceptable velocities or stabilizing/energy dissipation shall be provided where these velocities are exceeded.

d. In general, the constraint that gives the lowest allowable headwater elevation shall establish the criteria for the hydraulic calculations.

(4) Tailwater Considerations

a. If the culvert outlet is operating with a free outfall, the critical depth and equivalent hydraulic grade line shall be determined.

b. For culverts that discharge to an open channel, the stage-discharge curve for the channel must be determined in accordance with the methods provided by Section 2.1.4 of the NCTCOG-iSWM Hydraulics Technical Manual.

c. If an upstream culvert outlet is located near a downstream culvert inlet, the headwater elevation of the downstream culvert will establish the design tailwater depth for the upstream culvert.

d. If the culvert discharges to a lake, pond, or other major water body, the expected high water elevation of the particular water body will establish the culvert tailwater.

(5) Other Criteria

a. In designing debris control structures, the most current edition of the U.S. Department of Transportation Federal Highway Administration Hydraulic Engineering Circular No. 9 entitled “Debris Control Structures” or other approved reference is required to be used.

b. If storage is being assumed or will occur upstream of the culvert, then Section 2.0 of the NCTCOG-iSWM Hydraulics Technical Manual regarding storage routing shall be used in the culvert design.

c. Reinforced concrete pipe (RCP), pre-cast and cast in place concrete boxes are recommended for use (1) under a roadway; (2) when pipe slopes are less than 1%; or (3) for all flowing streams.

d. Culvert skews shall not exceed 45 degrees as measured from a line perpendicular to the roadway centerline without approval from the City Engineer.

e. The minimum allowable pipe diameter shall be 18 inches for laterals and 24 inches for the storm sewer main line.

f. Erosion, sediment control, and velocity dissipation shall be designed in accordance with Section 4.0 of the NCTCOG-iSWM Hydraulics Technical Manual.

(b) Bridges are cross drainage facilities with a span of 20 feet or larger.

(1) Design Frequency

a. Flood mitigation storm for all bridges.

(2) Design Criteria
a. A freeboard of two feet shall be maintained between the computed design water surface and the low chord of all bridges.

b. The contraction and expansion of water through the bridge opening creates hydraulic losses. These losses are accounted for through the use of loss coefficients. Table 35-34A gives recommended values for the Contraction (Kc) and Expansion (Ke) Coefficients.

| Table 35-34A - Recommended Loss Coefficients for Bridges |
|---------------------|---------|--------|
| Transition Type      | Contraction (Kc) | Expansion (Ke) |
| No losses computed   | 0       | 0      |
| Gradual transition   | 0.1     | 0.3    |
| Typical bridge       | 0.3     | 0.5    |
| Severe transition    | 0.6     | 0.8    |

(c) The use of flumes is not recommended for widespread use. Flumes shall not be permitted when the purpose of a permanent flume is to carry runoff down the sides of earthen channels, unless approved by the City Engineer. A flume may be used to direct overflow runoff along property lines until the runoff can be intercepted by streets or conduit flows. Flumes crossing sidewalks shall be covered or bridged such as to minimize danger to pedestrians.

d) Detention structures shall be designed for each of the three storm events (streambank protection, conveyance, and flood mitigation) for the critical storm duration that results in the maximum (or near maximum) peak flow in accordance with the following design criteria:

a. Dry detention basins shall be sized to temporarily store the volume of runoff required to provide flood protection up to the flood mitigation storm, if required by the City Engineer.

b. Extended detention dry basins shall be sized to provide extended detention of the streambank protection volume over 24 hours and may also provide additional storage volume for normal detention (peak flow reduction) of the flood mitigation storm event.

c. Routing calculation must be used to demonstrate that the storage volume and outlet structure configuration are adequate. Procedures on the design of detention storage shall be followed in accordance with Section 2.0 of the NCTCOG-iSWM Hydraulics Technical Manual.

d. Detention Basins shall be designed with an 8 foot side maintenance access.

e. No earthen (grassed) embankment slopes shall exceed 4:1.

f. A freeboard of 1 foot will be required for all detention ponds.

g. A calculation summary shall be provided on construction plans. For detailed calculations of unit hydrograph studies, a separate report shall be provided to the City Engineer for review and referenced on the construction plans. Stage-storage-discharge values shall be tabulated and flow calculations for discharge structures shall be shown on the construction plans.
h. An emergency spillway shall be provided at the flood mitigation maximum storage elevation with sufficient capacity to convey the flood mitigation storm assuming blockage of the outlet works with six inches freeboard. Spillway requirements must also meet all appropriate state and Federal criteria.

i. A landscape plan shall be provided for all detention ponds.

j. All detention basins shall be stabilized against significant erosion and include a maintenance plan.

k. Design calculations will be provided for all spillways and outlet structures.

l. Maintenance agreements shall be included for all detention structures.

m. Storage may be subject to the requirements of the Texas Dam Safety Program (see NCTCOG-iSWM Program Guidance: Dam Safety and Water Rights; see also Texas Water Code Ch. 12 and 30 TAC 299, as amended) based on the volume, dam height, and level of hazard.

n. Earthen embankments 6 feet in height or greater shall be designed per the Texas Commission on Environmental Quality guidelines for dam safety (see NCTCOG iSWM Program Guidance: Dam Safety and Water Rights; see also Texas Water Code Ch. 12 and 30 TAC 299, as amended).

o. Vegetated slopes shall be less than 20 feet in height and no steeper than 4:1 (horizontal to vertical). Rip-rap-protected slopes shall be no steeper than 2:1. Geotechnical slope stability analysis is recommended for slopes greater than 10 feet in height.

p. Areas above normal high water elevations of the detention facility should be sloped toward the basin to allow drainage and to prevent standing water. Finish grading shall be installed and maintained to avoid creation of upland surface depressions that may retain runoff. The bottom area of storage facilities should be graded toward the outlet to prevent standing water conditions. A low flow or pilot channel across the facility bottom from the inlet to the outlet (often constructed with riprap) is recommended to convey low flows and prevent standing water conditions.

q. Extended detention (ED) orifice sizing is required in design applications that provide extended detention for downstream streambank protection of the ED portion of the water quality protection volume. The release rate for both the WQv and SPv shall discharge the ED volume in a period of 24 hours or longer. In both cases, an extended detention orifice or reverse slope pipe must be used for the outlet. For a structural control facility providing both WQv extended detention and SPv control (wet ED pond, micropool ED pond, and shallow ED wetland), there will be a need to design two outlet orifices must be designed – one for the water quality control outlet and one for the streambank protection drawdown.

Sec. 35-35. - Erosion and Sedimentation Control

The Owner shall comply with the requirements of Article X, Chapter 41, of the Code of Civil and Criminal Ordinances of the City of Irving, Texas, and shall submit an erosion control plan for approval by the City Engineer prior to any earth disturbing activities. The Owner shall control erosion during and associated with the installation of subdivision improvements.

Sec. 35-36. - Operations & Maintenance
An Operations and Maintenance Plan shall be provided with the development submittal. The Operations and Maintenance Plan must clearly identify the person(s) responsible for operation and maintenance of temporary and permanent stormwater controls and drainage facilities to ensure proper and continuous function. The Operations and Maintenance Plan shall include, but is not limited to, the following:

(1) Identifying the person(s) responsible for all tasks in the plan;
(2) Inspections and maintenance requirements;
(3) Maintenance of permanent stormwater controls and drainage facilities during construction;
(4) Cleaning and repair of permanent stormwater controls and drainage facilities before transfer of ownership;
(5) Frequency of inspections for the life of any private permanent structures;
(6) Funding source for long-term maintenance of private structures;
(7) Description of maintenance tasks and frequency of maintenance of private structures;
(8) Property access and safety issues;
(9) Necessary maintenance easements;
(10) Copies of maintenance agreements;
(11) Requirements for testing and disposal of sediments; and
(12) Life span of structures and replacement as needed.

SECTION III. This ordinance shall be cumulative of all other ordinances of the City of Irving and shall not repeal any of the provisions of said ordinances except in those instances where provisions of those ordinances are in direct conflict with the provisions of this ordinance.

SECTION IV. That the terms and provisions of this ordinance shall be deemed to be severable and that if the validity of any section, subsection, sentence, clause, word, or phrase of this ordinance shall be declared to be invalid, the same shall not affect the validity of any other section, subsection, sentence, clause, word, or phrase of this ordinance.

SECTION V. That any person, firm, or corporation violating any of the terms or provisions of this ordinance shall be subject to the same penalties provided for in Section 35-1.1 of the Irving Land Development Code and/or Chapter 1, Section 1-6 “General Penalty: Continuing Violations” of the Code of Civil and Criminal Ordinances of the City of Irving, Texas, as amended.

SECTION VI. That nothing in this ordinance shall be construed to affect any prosecution currently pending, or any suit or proceeding currently proceeding in any Court, or any liability incurred, or any cause or causes of action acquired or existing, under any act or prior ordinance, nor shall any legal right or remedy of the City of any character be lost, impaired, or affected by this ordinance.

SECTION VII. That this ordinance shall be effective upon passage.

ORD-2017-10008

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PASSED AND APPROVED BY THE CITY COUNCIL OF THE CITY OF IRVING, TEXAS, on October 26, 2017.

[Signature]
RICHARD H. STOPPER
MAYOR

ATTEST:

Shanae Jennings
City Secretary

APPROVED AS TO FORM:

Kuruvilla Oommen
City Attorney