Drainage Criteria Manual Compliance Summary
(Online content updated on January 3rd, 2025)

Territory			Reference	Rule	Document Type				How and where the application meets requirement		Travis County Comments	Date
TC	COA ETJ	O ETJ			PP	FP	SP	CP	How	Where		
SECTION 1 - DRAINAGE POLICY												
1.2.0 - CITY OF AUSTIN DRAINAGE POLICY												
1.2.2 - General												
			DCM 1.2.2 (A)	Stormwater runoff peak flow rates for the two (2), ten (10), 25 and 100-year frequency storms shall not cause increased inundation of any building or roadway surface or create any additional adverse flooding impacts.								
			DCM 1.2.2 (B)	Street curbs, gutters, inlets and storm drains shall be designed to intercept, contain and transport all runoff from the 25-year frequency storm.								
			DCM 1.2.2 (C)	In addition to B. above, the public drainage system shall be designed to convey those flows from greater than 25-year frequency storm up to and including the 100-year frequency storm within defined public rights of way or drainage easements.								
			DCM 1.2.2 (D)	Stormwater runoff peak flow rates shall not be increased at any point of discharge from a site for the two (2), ten (10), 25 and 100-year storm frequency events.								
			DCM 1.2.2 (E)	Regulation of peak flows to allowable levels, as determined by the provisions of this policy, shall be achieved by storage on-site or off-site or by participation in an approved Regional Stormwater Management Program (RSMP requires approval by Travis County TNR). The Stormwater Management Section of this manual provides a guide to acceptable methods, but does not limit the designer to the methods presented therein.								
			DCM 1.2.2 (F)	For those developments which are immediately adjacent and discharge directly into Lake Travis, Lake Austin, Lady Bird Lake and the Colorado River, on-site detention is not required.								
			DCM 1.2.2 (G)	NA in unincorporated Travis County								
			DCM 1.2.2 (H)	H.For site plans or subdivisions that are part of a phased development where prior phases of the development have been permitted or constructed using rainfall criteria pre-dating Atlas 14, the following drainage criteria shall apply: 1. The current rainfall criteria shall be used to design the storm drain system (including gutters, inlets, pipes, spread requirements, etc.) within the current phase; 2. The 100-year runoff generated from the current phase using the current rainfall criteria must be conveyed to the detention pond or designed outfall location via a storm drain system, including pipes, channels, and streets. This analysis must use the current rainfall criteria for the entire drainage area to the pond or outfall. For this analysis, the drainage system is not required to satisfy the minimum clear width requirements for the 25-year event in Table 3-1; and 3. The 100-year runoff generated using the current rainfall criteria for the entire drainage area to the detention pond must not cause the peak water surface elevation of the pond to overtop the dam/embankment outside the controlled weir/overflow structure. The development will not be required to match the peak flow rates to pre-development conditions using the current rainfall criteria. 4. If the development cannot satisfy these conditions, the design of the current phase must satisfy one or a combination of the following until the above conditions are satisfied: (a) Modify the existing detention pond or the intervening storm drain system; and/or (b) Provide on-site detention within the current phase until the above conditions are satisfied or the peak flows from the current phase are not increased.								
			DCM 1.2.3 (A)	No lowering of the standard height of street crown shall be allowed for the purposes of obtaining additional hydraulic capacity.								
			DCM 1.2.3 (B)	For non-curbed streets all flows for the 100-year frequency storm shall be contained within paralleling roadside ditches, medians, drainage channels or other drainage facilities located within public rights-of-way or drainage easements.								

			DCM 1.2.3 (C)	Except as allowed by this Section or otherwise approved by the Watershed Protection Department, all discharges shall be conveyed by a closed conduit to the nearest existing storm drain. No outlet structures from stormwater management facilities, groundwater collection, parking detention, or other improvements discharging concentrated flows shall be designed to discharge concentrated flow directly onto arterial or collector streets. For local streets, no concentrated discharge from sites with a development site acreage larger than 0.25 acres shall be permitted. If a development is located within 550 feet of an existing storm drain system, the developer shall provide all the necessary infrastructure designed in accordance with the criteria in this manual to connect appropriately to the storm drain system. If the proposed connection is located more than 550 feet from an existing storm drain system, the developer shall work with the Watershed Protection department to determine the best plan to achieve an appropriate connection or convey storm water to a downstream system after confirming capacity and condition of the receiving system.								
			DCM 1.2.3 (D)	Concentrated discharge across a sidewalk area will not be allowed. A channel section can be used under the sidewalk area, provided the outlet device utilizes sheet flow methods, maintains a minimum three (3) foot horizontal separation from all utility infrastructure, and it is covered by a method approved by the Public Works Department.								
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			DCM 1.2.4 (A)	All drainage system components that are within public right of way or public drainage easements shall be manufactured and installed in compliance with the City of Austin Standard Specifications and Standards and shall comply with all applicable portions of the City of Austin's Transportation Criteria Manual published by the Department of Transportation, unless: 1. Those components receive stormwater runoff solely from private property, 2. That property consists solely of the property being developed, and 3. Those components are privately maintained.								
			DCM 1.2.4 (B)	Construction plans for proposed reinforced concrete box culverts, bridges and related structures may be adaptations of the Texas Department of Transportation (TxDOT) Standards.								
			DCM 1.2.4 (C)	For bridges and culverts crossing local streets, runoff from the fully developed 100-year frequency storm shall not produce a headwater elevation at the roadway greater than either twelve (12) inches above the roadway crown elevation or any top of upstream curb elevation, whichever is lower.								
			DCM 1.2.4 (D)	For bridges and culverts crossing streets other than a local street, runoff from the fully developed 100-year frequency storm shall not produce a headwater elevation at the roadway greater than six (6) inches above the roadway crown elevation or six (6) inches above any top of upstream curb elevation, whichever is lower.								
			DCM 1.2.4 (E)	Introduction. Drainage facilities, referred to as stormwater control measures (SCMs) throughout this section, include but are not limited to headwalls, open channels, storm drains, area inlets, easements, detention ponds, retention ponds, water quality controls, and their appurtenances. In addition to this section all SCMs shall comply with the following requirements in; DCM Section 8.3, Stormwater Management Ponds, ECM Section 1.6.3, Maintenance and Construction Requirements, and applicable City of Austin Standard Specifications and Standards manuals. The following table lists which requirements apply to residential development (single family/duplex) and which requirements apply to commercial development. Throughout this section residential development is defined as single family and duplex development and commercial development is defined as all development other than open space and residential development (pursuant to the definition in LDC Section 25-8-1). The requirements below shall apply to all City maintained SCMs and all SCMs for residential development regardless of whether they are publicly or privately maintained. The requirements of this section do not apply to rainwater harvesting, porous pavement, and subsurface ponds, unless otherwise stated in ECM 1.6.2.E, Subsurface Ponds. The requirements of subsections 1-Access, 2-Staging Area, 6-Gates (a only), and 10-Signage do not apply if the combined total storage volume of all ponds is less than or equal to 5,000 cubic feet and the maximum ponding depth is less than or equal to three (3) feet. The requirements below are organized by the typical phase of permitting (preliminary plan, final plat, subdivision construction plan, and site plan) when these items will need to be addressed.								

			DCM 1.2.4 (E)(1)	**Access**. This section provides the minimum requirements for reasonable access into SCMs for maintenance and inspection activities for both residential and commercial developments. a. Maintenance access drives and ramps shall be cleared, graded and stabilized with rock and comply with Standard Detail 662S-2 (Pond Maintenance Road Typical Cross Section). b. For residential development, access from the right-of-way (ROW) to the SCM shall comply with Standard Detail 433S-2 (Type II Driveway) approach and curb cut on the abutting street. c. Residential development shall provide a maintenance access drive around the perimeter of the SCM. The Director of the Watershed Protection Department may approve a maintenance access drive that does not follow the entire perimeter of the SCM if the applicant demonstrates that access is provided to all key components, including but not limited to basins, inlets, and outlets. d. Maintenance access drives shall also be provided for facilities that will be maintained by the City when access is proposed between single family lots or when access from any other location exceeds a grade of twenty percent (20%). e. Maintenance access drives shall meet the following requirements: i. A minimum horizontal width of twelve (12) feet, ii. A minimum vertical clearance of fourteen (14) feet from existing and proposed vegetation and all other objects, iii. Be located outside the toe of any fill slope and the top of any cut slope, iv. An inside turning radius of no less than thirty-six (36) feet, v. A means for equipment to turn around when located more than 200 feet from the public ROW, vi. A maximum longitudinal slope of fifteen (15) percent, vii. A maximum transverse slope of five (5) percent, viii.A maximum vertical grade break of twelve percent (12%), and ix. A maximum vertical curve grade change of one percent (1%) per horizontal foot. f. Both residential and commercial developments shall provide maintenance access ramps into each basin of a SCM and shall meet the following requirements: i. Have a longitudinal slope no steeper than 4:1, and ii. Have a clear distance of fifteen (15) feet from the bottom of the ramp to any interior slope.								
			DCM 1.2.4 (E)(2)	**Staging Area**. A staging area is required in order to allow for storage of materials and equipment during inspection and maintenance operations. The staging area must meet the following requirements: a.Be at least 800 square feet in area with no dimension less than twenty (20) feet, b. Be located within 100 feet of the SCM basin, c. Be adjacent to the access drive and within an access or drainage easement, d. No portion can be located within any ponding area, interior slope of the facility, or access drive, e. Have a vertical clearance from existing and proposed vegetation and all other objects of no less than fourteen (14) feet, and f. Have no finished slope greater than ten (10) percent.								
			DCM 1.2.4 (E)(3)	**Drainage Easements.** a. Drainage or drainage access easements are required per LDC 25-7-151 and 25-7-152. b. Drainage or drainage access easements that are required along property lines shall be located adjacent to a property line and shall not be centered on a property line.								
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			DCM 1.2.4 (E)(4)	**Setbacks.** a. For any new development, the SCM basin shall have a minimum fifteen (15) foot setback from any property line adjacent to a residential development. This requirement does not apply to rain gardens that use no concrete per LDC 25-2-1062.								

			DCM 1.2.4 (E)(5)	**Fencing**. This section applies to all residential and commercial development. a. A six (6) foot high fence is required when: i. A portion of the SCM basin has an interior slope or wall steeper than three (3) feet horizontal to one (1) foot vertical with a height exceeding one (1) foot, or, ii. An exterior slope or wall steeper than three (3) feet horizontal to one (1) foot vertical with a height exceeding three (3) feet above adjacent ground, b. Fence Location. i. Fencing is allowed on top of vertical walls to achieve the six (6) foot minimum requirement. The total combined height of the wall and fence must be a minimum of six (6) feet above the exterior finished grade, or ii. If the fence is not placed on top of the vertical walls, the fence shall be located no less than twenty (20) feet past the toe of the embankment or to the edge of the property line. c. Materials. Allowable fence materials include, but are not limited to, chain link, solid wood, masonry, stone or wrought iron. i. Metal components of the fence shall be corrosion resistant and wood components of the fence shall be weather resistant. ii. Any fence posts used shall be galvanized steel with a concrete footing of at least twelve (12) inches in diameter and at least eighteen (18) inches in depth (see Standard Specification No. 701). d. Handrail option. SCMs with a total ponding depth less than or equal to three (3) feet and that require fencing per subsection (a) above may provide a pedestrian handrail in lieu of the six (6) foot high fence. The design must meet the requirements in Standard Details 707S-1 or 707S-2 (Pedestrian Handrail).								
			DCM 1.2.4 (E)(6)	**Gates.** a.For residential development, a pipe gate is required at the end of the driveway at the ROW. The design must meet the requirements in Standard Detail 662S-1 (Pond Pipe Gate at Ramp Detail). i. No pipe gate is required if an access gate for a fully fenced pond or SCM is located within twenty-five (25) feet of the ROW. b. All fences shall have at least one gate, which shall open fully inward and outward and shall be at least twelve (12) feet in width. c. The first gate shall provide access to the SCM from either the easement or ROW. Access to the outfall structures is required for inspection and maintenance. d. If the fencing prohibits access to the outfall structure, then a second gate shall be provided allowing access to the outfall structure.								
			DCM 1.2.4 (E)(7)	**Outfalls.** Discharge from storm drain outfalls shall not cause channel, bluff, or stream bank erosion. If the storm drains discharge to an open channel system; creeks, channels, or ditches that convey stormwater (as determined by the City), the applicant shall show: a.Acceptable nonerosive conveyance from the SCM per section 5.8.0, b.That the angle of intersection between the outfall flow path and the channel flow path is not greater than 45-degrees, c.That storm drains that discharge into open channels conform to the design guidelines in Standards 508S-13 or 508S-16 through 508S-20, as appropriate for site specific conditions, and d.Appropriately designed outfalls including adequate energy dissipation, which may include stream stabilization.								
			DCM 1.2.4 (E)(8)	**Slopes.** a.All side slopes, earthen embankments, and pond bottoms, shall be compacted to ninety-five (95) percent of maximum density in accordance with established embankment construction requirements (Standard Specification 132S). i.The bottom of the SCM is not required to meet the compaction requirements above if the design proposes a SCM that is fully reliant on infiltration to meet water quality standards. b.Side slopes for earthen embankments shall not exceed three (3) horizontal to one (1) vertical. c.Rock slopes may exceed these limits if a geotechnical report warrants a deviation. Actual field conditions may override the geotechnical report. d.Detention ponds with earthen berms shall have a minimum bottom slope of two (2) percent. e.Detention ponds with full concrete bottoms shall have a minimum slope of one-half (0.5) percent. property line.								
			DCM 1.2.4 (E)(9)	**Pilot Channels.** a.The pilot channel shall be at least four (4) feet wide and two (2) inches deep. Refer to DCM Section 6.4.1.C. b.Pilot channels are not permitted in water quality SCMs due to short-circuiting and standing water problems.								
			DCM 1.2.4 (E)(10)	**Signage.** Signs are required on each side of a residential or City-maintained stormwater control measure. The design must meet the requirements shown in Storm Water Facility Sign (Standard Detail 662S-3).								

			DCM 1.2.4 (E)(11)	**Mechanical SCMs.** Mechanical SCMs include, but are not limited to, detention, rainwater harvesting, and retention irrigation SCMs that utilize pump systems to redistribute stormwater to meet a required discharge rate. a.All mechanical SCMs to be maintained by the City shall meet City of Austin Water and Wastewater criteria as stated in the Utilities Criteria Manual, Section 2. b.OSHA confined space requirements must be met for any facility determined to be a confined space or that is subsurface. For subsurface SCMs, refer to ECM Section 1.6.2.E, Subsurface Ponds, for specific design standards.							
			DCM 1.2.4 (E)(12)	**Landscaping.** a.The landscaping requirements of ECM Section 2.9.1 apply to SCMs for residential development or for such facilities that will be maintained by the City. This requirement may only be provided via screening types B or C. b.Landscaping and other vegetation shall not encroach into or impede use of any access drive or access strip, based upon the size of the landscaping or vegetation at maturity.							
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			DCM 1.2.4 (F)	Any concentrated flow necessitates the dedication of a drainage easement to the larger of following: the limits of the fully developed 100-year storm water surface elevation, or minimum easements widths as required in this Drainage Criteria Manual.								
			DCM 1.2.4 (G)	An easement or right-of-way as required in this Drainage Criteria Manual must be of sufficient width to provide continuous access for the operation, maintenance, or repair of a drainage facility or conveyance of stormwater. (1) A minimum of 25 feet in width for an open drainage system; or (2) See DCM Table in this section for enclosed drainage system.							
			DCM 1.2.5	Computations to support all drainage designs shall be submitted to the appropriate City departments for review. The computations should be in such form as to allow for timely and consistent review and also to be made a part of the permanent City record for future reference. All computations submitted shall be certified by a professional engineer registered in the State of Texas.							
			DCM 1.2.6 (A)(1)	For purposes of this Drainage Criteria Manual, a drainage area of 64 acres or greater is required within a contributing watershed to create a "floodplain". For areas of flow with less than 64 acres of contributing area, no floodplain shall be defined unless the City or FEMA currently indicates the area as a floodplain. In all cases where a floodplain delineation is required, its determination shall be based on the projected full development of all properties contributing to the point of consideration. It is the responsibility of the design engineer to determine, based on the most accurate information available, what the floodplain delineation is.							
			DCM 1.2.6 (A)(2)	The design engineer may elect to utilize a floodplain delineation previously approved by the Director of the Watershed Protection Department, assuming the same is still applicable under present requirements and criteria. In so doing the engineer does not remove himself from the responsibility for the delineation's accuracy.								
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			DCM 1.2.6 (B)(3)	FEMA reviews the impact of proposed site developments and offers or denies conditional assurance that a FIRM may be changed by the proposed development. FEMA offers this assurance by a Conditional Letter of Map Change (CLOMC). The CLOMC is a conditional statement that the FIRM may be changed if (1) the development is constructed as proposed in the CLOMC application, and if (2) a complete LOMC is submitted after construction of the proposed development.							
			DCM 1.2.6 (C)(2)	If the floodplain depicted on the FIRM is required to be changed, pursuant to C.1. above, due to updated analysis of the floodplain under existing conditions, then the following requirements are applicable:							
			DCM 1.2.6 (C)(2)(a)	Prior to approval of a preliminary plan, the applicant must provide to the City a letter of acknowledgement by FEMA of receipt of a complete application for a LOMC.	×							

			DCM 1.2.6 (C)(2)(b)	Prior to approval of a final plat, the applicant must provide to the City evidence of approval by FEMA of the LOMC submitted under C.2.(a). If the final plat is approved before it is determined that a LOMC is necessary or desired, prior to release of a subdivision construction permit or site plan permit, the applicant must provide to the City a letter of acknowledgement by FEMA of receipt of a complete application for a LOMC.		×							
			DCM 1.2.6 (C)(2)(c)	Prior to final acceptance of the construction of the subdivision or issuance of building permits for buildings that are within the floodplain at the time of application, the applicant must provide to the City evidence of final acceptance by FEMA of the LOMC submitted under C.2.(a) above.			×	×					
			DCM 1.2.6 (C)(3)	If the floodplain depicted on the FIRM is required to be changed, pursuant to C.1. above, due to land development activities that alter existing conditions, then the following requirements are applicable:									
			DCM 1.2.6 (C)(3)(a)	Prior to approval of a preliminary plan, the applicant must provide to the City either: evidence that the proposed land development activities do not increase the level of the FEMA floodplain; or a letter of acknowledgement by FEMA of receipt of a complete application for a CLOMC.	×								
			DCM 1.2.6 (C)(3)(b)	Prior to approval of a final plat, the applicant must provide to the City either: evidence that the proposed land development activities do not increase the level of the FEMA floodplain; or evidence of approval by FEMA of the CLOMC.		×							
			DCM 1.2.6 (C)(3)(c)	If the final plat is approved before it is determined that a CLOMC is necessary or desired, then prior to approval of a subdivision construction permit or site plan permit, the applicant must provide to the City either: evidence that the proposed land development activities do not increase the level of the FEMA floodplain; or a letter of acknowledgement by FEMA of receipt of a complete application for a CLOMC.			×	×					
			DCM 1.2.6 (C)(3)(d)	Prior to final acceptance of the subdivision construction or site plan improvements or issuance of building permits for buildings that are within the portion of the FEMA floodplain affected by a required LOMC, the applicant must provide to the City evidence of final acceptance by FEMA of the CLOMC if required under C.3 above, and a letter of acknowledgement by FEMA of a complete application for a LOMC.			×	×					
			DCM 1.2.6 (C)(3)(e)	Prior to issuance of a certificate of occupancy for buildings within the portion of the FEMA floodplain affected by a required LOMC, the applicant must provide to the City evidence of final acceptance by FEMA of the LOMC.									
			DCM 1.2.6 (C)(4)	The applicant shall bear the cost of engineering services required to develop the application, respond to review comments, and obtain final approval of LOMCs and CLOMCs. The applicant shall bear the cost of any fees associated with review and disposition of LOMCs and CLOMCs that are established by FEMA.									

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SECTION 2 - DETERMINATION OF STORM RUNOFF											
2.2.0 - EFFECTS OF URBANIZATION											
2.2.1 - Design Assumptions for Storm Runoff Analysis											
			DCM 2.2.1 (A)	When analyzing an area for channel or storm drain design purposes, urbanization of the full watershed without stormwater detention facilities shall be assumed (except as noted in (D.) below). Zoning maps, future land use maps, and master plans should be used as aids in establishing the anticipated surface character of the ultimate development. The selection of design runoff coefficients and/or percent impervious cover factors are explained in the following discussions of runoff calculation.							
			DCM 2.2.1 (B)	An exception to (A.) above may be granted if the channel is immediately downstream of a City maintained regional detention facility and written approval is obtained from the Director of the Watershed Protection Department.							
			DCM 2.2.1 (C)	In designing a storm drain system, full development of adjoining and interior tracts without detention shall be assumed.							
			DCM 2.2.1 (D)	In the event the engineer desires to incorporate the flow reduction benefits of existing upstream detention facilities, the following field investigations and hydrologic analysis will be required: (Please note that under no circumstances will the previously approved construction plans of the upstream detention facilities suffice as an adequate analysis. While the responsibility of the individual site or subdivision plans rests with the engineer of record, any subsequent engineering analysis must ensure that all the incorporated detention facilities work collectively.)							
			DCM 2.2.1 (D)(1)	A field survey of the existing physical characteristics of both the outlet structure and ponding volume. Any departure from the original engineer's design must be accounted for. If a dual use for the detention facility exists, (e.g., storage of equipment) then this too should be accounted for.							

			DCM 2.2.1 (D)(2)	A comprehensive hydrologic analysis which simulates the flow attenuation produced by the existing detention facility in the upstream contributing area. This should not be limited to a linear additive analysis but rather a network of hydrographs which considers incremental timing of discharge and potential coincidence of outlet peaks.								
2.3.0 - DESIGN RAINFALL												
			DCM 2.3.0	Rainfall frequency design criteria must be selected before applying any hydrologic method. In September 2018, the National Weather Service published NOAA Atlas 14 - Precipitation - Frequency Atlas of the United States, Volume 11 Version 2.0: Texas. This volume of Atlas 14 provides updated precipitation frequency estimates for Texas and replaces previous precipitation frequency studies. It is based on rainfall records at thousands of stations with a period of historic record through December 2017, with a few stations updated through June 2018. The Atlas 14 precipitation-frequency estimates vary across the Austin area with the highest values in the southern portions of the area decreasing to lower values in the northern portion of the area. Because of this variation, separate depth-duration-frequency tables are provided for the areas of Austin south (Zone 1) and north (Zone 2) of the Colorado River. This division ensures that Atlas 14 rainfall amounts across the two regions vary by less than 0.5 inches from the mean failfallrainfall in each region. The depth-duration-frequency data is provided in Tables 2-1A and 2-1B. These depths were claculatedcalculated by averaging each Atlas 14 precipitation-frequency grid over the Zone 1 and Zone 2 jurisdictional areas. The Zone 1 and Zone 2 areas are defined by splitting the City of Austin's full purpose jurisdiction and ETJ at the Colorado River, with one exception as described below and shown in Figure 2-2. Zone 1 includes all portions of the City's jurisdiction and 2- and 5-mile ETJ located south of the Colorado River except for the area located between Murfin Road and Lake Travis. Zone 2 includes all portions of the City's jurisdiction and 2- and 5-mile ETJ located north of the Colorado River and the area located between Murfin Road and Lake Travis. The depth-duration frequency (DDF) values and intensity-duration-frequency (IDF) parameters suitable for use in the City of Austin are provided in								
2.4.0 - RATIONAL METHOD												
2.4.1 - Runoff Coefficient (C)												
			DCM 2.4.1	The proportion of the total rainfall that will reach the drainage system depends on the surface vegetation condition, soil type, imperviousness of the surface, land slope and ponding characteristics of the area. Impervious surfaces, such as asphalt pavements and roofs of buildings, will be subject to approximately 100 percent runoff (regardless of the slope). On-site inspections and aerial photographs may prove valuable in estimating the nature of the surfaces within the drainage area. It should be noted that the runoff coefficient "C" is the Rational Method variable which is least amenable to precise determination. A reasonable coefficient must be chosen to represent the integrated effects of infiltration, surface ponding, evaporation, flow routing and interception, all of which affect the time distribution and peak rate of runoff. It is often desirable to develop a composite runoff coefficient based upon the percentages of different types of surfaces in the drainage area. This procedure is often applied to typical "sample blocks" as a guide to selection of reasonable values of the coefficient for an entire area. Suggested coefficients with respect to specific surface types are given in Table 2-1. "C" values for developed conditions should be based on maximum allowable impervious cover as listed in the City's zoning and watershed ordinances.								
2.4.2 - Time of Concentration												
			DCM 2.4.2	The time of concentration is the time for surface runoff to flow from the most remote point in the watershed to the point of interest. This applies to the most remote point in time, not necessarily the most remote point in distance. Runoff from a drainage area usually reaches a peak at the time when the entire area is contributing. However, runoff may reach a peak prior to the time the entire drainage area is contributing if the area is irregularly shaped or if land use characteristics differ significantly within the area. Sound engineering judgment should be used to determine a flow path representative of the drainage area and in the subsequent calculation of the time of concentration. The time of concentration to any point in a storm drainage system is a combination of the sheet flow (overland), the shallow concentrated flow and the channel flow, which may include storm drains. The minimum time of concentration for any drainage area shall be 5 minutes. Additionally, the minimum slope used for calculation of sheet and shallow flow travel time components should be 0.005 feet per foot (0.5%). The preferred procedure for estimating time of concentration is the NRCS method as described in NRCS's Technical Release 55 (TR-55).								
2.4.3 - Rainfall Intensity (i)												
			DCM 2.4.3	The rainfall intensity used in the Rational Method shall be calculated with the best-fit IDF curve (Equation 2-1 discussed in Section 2.3.2) based on the Tc value calculated for the entire drainage area of interest.								
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2.4.4 - Drainage Area (A)												

			DCM 2.4.4	The size (acres) of the watershed needs to be determined for application of the Rational Method. The area may be determined through the use of topographic maps, supplemented by field surveys where topographic data has changed or where the contour interval is too great to distinguish the direction of flow. The drainage divide lines are determined based on topography, street layout, lot grading, building structure configuration and orientation, drainage system layout and other features that are created by the urbanization process.							
2.5.0 - THE SOIL CONSERVATION SERVICE METHOD FOR CALCULATION OF PEAK FLOWS												
			DCM 2.5.0	The SCS method can be applied to urban drainage areas of any size. The HEC-HMS programs can be downloaded from the US Army Corps of Engineers website at http://www.hec.usace.army.mil/. Refer to Section 8.2.3 for information regarding watershed hydrologic models that are maintained by the City. These models may be requested by the public and used as the basis for drainage analysis where applicable. Any results based on models obtained from the City must be certified by a Texas Licensed Professional Engineer.							
2.5.1 - Austin Twenty-Four (24) Hour Storm Rainfall Distributions												
			DCM 2.5.1	The City of Austin has adopted the use of an SCS 24-hour storm duration with a Type III distribution for use with the SCS method. The DDF and IDF values to be used for the Austin area are shown in Table 2-3 and 2-4 above. For use in spreadsheet calculations, Table 2-6 below provides the Type III distribution ordinates in 5-minute increments as derived from the HEC-HMS program. The ordinates should be multiplied by the total 24 hour precipitation depth to produce the design rainfall distribution. When using the HEC-HMS model, the computational time interval should be selected based on criteria for the minimum lag time. The maximum computational time interval used in a HEC-HMS model should be 6 minutes.							
2.5.2 - Natural Resources Conservation Service Runoff Curve Numbers												
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
			DCM 2.5.2	The National Resources Conservation Service has developed an index, the runoff curve number, to represent the combined hydrologic effect of soil type, land use, agricultural land treatment class, hydrologic condition, and antecedent soil moisture. These watershed factors have the most significant impact in estimating the volume of runoff, and can be assessed from soil surveys, site investigations and land use maps. The curve number is an indication of the potential runoff for a given antecedent soil moisture condition, and it ranges in value from zero to 100. The National Resources Conservation Service runoff curve numbers are grouped into three (3) antecedent soil moisture conditions — Antecedent Runoff Condition (ARC) I, ARC II and ARC III. Values of runoff curve numbers for all three (3) conditions may be computed following guidelines in Part 630, Chapter 10 of the National Engineering Handbook . ARC I is the dry soil condition and ARC III is the wet soil condition. ARC II is normally considered to be the average condition. The Antecedent Runoff Condition (ARC) was previously referred to as the Antecedent Moisture Condition (AMC) in older NRCS publications. However, studies of hydrologic data indicate that ARC II is not necessarily representative of the average condition throughout Texas. Instead, investigations have shown that the average condition ranges from ARC I in west Texas to between ARC II and ARC III in east Texas. The NRCS curve number values provided in Table 2-7 are for an ARC II. If it is desired to change to an ARC I or III condition, the adjustments given in Part 630, Chapter 10 of the National Engineering Handbook should be used. Justification must be provided for the selection of an ARC other than condition II. The National Resources Conservation Service has classified more than 4,000 soils into four (4) hydrologic groups, identified by the letters A, B, C, and D, to represent watershed characteristics. Group A: (Low runoff potential). Soils having a high infiltration rate even when thoroughly wetted and consisting chiefly of deep, well-drained to excessively drained sands or gravels. Group B: Soils having a moderate infiltration rate when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse texture. Group C: Soils having a slow infiltration rate when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water or soil with moderately fine to fine texture. Group D: (High runoff potential). Soils having a very slow infiltration rate when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material. Table 2-7 lists the curve numbers for the four (4) soil groups under various land uses, land treatment and hydrologic conditions. Curve numbers for fully developed conditions should be based on maximum allowable impervious cover listed in Austin zoning and watershed ordinances. When calculating fully developed peak runoff rates it is recommended that the undeveloped curve number and the maximum allowable impervious cover be used as input parameters. In order to determine the soil classifications in the Austin area, the Natural Resource Conservation Service Soil Survey of Travis, Williamson or Hays County, Texas should be used. Digital versions of these soil datasets are available online at http://soildatamart.nrcs.usda.gov (accessed 12/18/2012).							
2.5.3 - Time of Concentration												

			DCM 2.5.3	The procedures for estimating time of concentration for the NRCS method are described in the SCS Technical Release 55 (TR-55) and in Section 2.4.2 of this manual. Three (3) types of flow (sheet flow, shallow concentrated flow and channel flow) are considered. Note that Table 2-2 shall be used for determination of sheet flow Manning's roughness coefficients rather than the table included in TR-55. In hydrograph analysis, the time of concentration can be defined as the time from the end of excess rainfall to the point of inflection on the falling limb of the hydrograph. The time of concentration determines the shape of the runoff hydrograph. Times of concentration are required for the existing and developed conditions to adequately model the impact of the development on stormwater runoff. The methodology presented in TR-55 provides a reasonable approach for the estimation of time of concentration. The lag time, defined as the time between the center of mass of excess rainfall to the runoff peak, is typically used in the HEC-HMS implementation of the SCS methodology. The lag time can be estimated with equation 2-9. $T_{lag} = 0.6\ T_c$ (Eq. 2-9) In general, times of concentration for the developed condition should be calculated based on conservative assumptions that consider the increased hydraulic efficiency expected with an ultimate developed condition. Times of concentration should be representative of the overall drainage area, not simply based on the longest (in either distance or time) flow path. Sheet flow for both existing and proposed conditions should be limited to 100 feet. This length should be considered a maximum; sheet flow lengths should be measured and justified for all conditions. Additionally, the minimum slope used for calculation of sheet and shall flow travel time components should be 0.005 feet per foot (0.5%).							
2.6.0 - PROBABLE MAXIMUM STORM/FLOOD DEVELOPMENT												
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
			DCM 2.6.0	<u>The purpose of this section is to describe a method for developing the Probable Maximum Flood (PMF) within the City of Austin jurisdiction. The PMF is calculated by obtaining the Probable Maximum Precipitation (PMP) for a specific storm duration and drainage area. Typically, a PMF runoff model requires both a temporal and spatial distribution of the PMP. However, if the drainage area is less than 10 square miles, the spatial distribution is not required (i.e. the drainage area is considered small enough that the PMP values can reasonably be considered point rainfall values).</u> <u>The State of Texas has the primary regulatory authority for dams in Texas. The State's Dam Safety Program is under the purview of the TCEQ and Title 30, Chapter 299 of the Texas Administrative Code contains applicable rules. The primary guidance for the analysis of dam performance during a PMF event can be found in the Hydrologic and Hydraulic Guidelines for Dams in Texas. This manual and other dam safety and maintenance manuals are available on the TCEQ's web site at https://www.tceq.texas.gov/ .</u>							
2.6.1 - Probable Maximum Precipitation (PMP)												
			DCM 2.6.1	The probable maximum precipitation (PMP) is defined by the National Weather Service as "theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographical location at a certain time of the year." The TCEQ has completed a statewide PMP Study for Texas to determine appropriate PMP values throughout the state. The study has a spatial resolution of approximately 2.5 square miles and considers variations in topography, climate, and storm types. This study replaces data formerly obtained from Hydrometeorological Reports (HMRs) 51 and 52. The TCEQ web site (above) provides guidance for using an online geoprocessing service to calculate PMP depths for a given drainage basin.							
2.6.2 - Probable Maximum Flood (PMF)												
			DCM 2.6.2	The PMF is calculated by obtaining the PMP for a specific storm duration and a specific drainage area. To determine the PMF, each of the possible storm durations (1, 2, 3, 6, 12, 24, 48, and 72 hour storms) needs to be analyzed in order to determine the critical duration. The critical duration is the storm duration that produces the highest water surface elevation behind the dam. The PMF for each storm duration is derived using the PMP depths from the TCEQ PMP tool (see 2.6.1) and using a rainfall-runoff model (i.e. HEC-HMS, TR-20). The Soil Conservation Service (SCS) Type III distribution must not be used for PMP analyses. Instead, the rainfall-runoff model should use the temporal distribution as provided in the Hydrologic and Hydraulic Guidelines for Dams in Texas. The temporal distribution for each storm duration has been reproduced in Figure 2-4, Appendix D. Figure 2-4 provides the temporal distribution ordinates to be multiplied by the associated storm depths for use in the various rainfall-runoff models. The runoff parameters used in the PMF model are the same as those used for runoff analyses of the more frequent storm events, with the exception of curve numbers and the temporal distribution of rainfall. Runoff curve numbers for the PMF need to reflect the assumption that the soils will be saturated. Therefore the runoff curve number should be based on ARC III. The appropriate curve number should be chosen using the tables provided in the DCM Section 2.5.2. These are ARC II values which can be converted to ARC III values using Table 10.1 in Part 630, Chapter 10 of the National Engineering Handbook. Note that the ARC was previously referred to as the Antecedent Moisture Condition (AMC) in older NRCS publications.							
Territory			**Reference**	**Rule**	**Document Type**							

TC	COA ETJ	O ETJ			PP	FP	SP	CP		Where	
SECTION 3 - STREET FLOW											
3.1.0 - GENERAL											
			DCM 3.1.0	The location of inlets and permissible flow of water in streets should be related to the extent and frequency of interference to traffic and the likelihood of flood damage to surrounding property for the 25 and 100 year frequency storms. Interference to traffic is regulated by design limits of the spread of water into traffic lanes, especially in regard to arterials. Flooding of surrounding property from streets is controlled by limiting curb buildup to the top of curb for a 25 year storm which is designated as the design storm. Conveyance provisions for the 100 year storm must also be made within defined right of way and easements.							
3.1.3 - Street Cross Flow											
			DCM 3.1.3	Whenever storm runoff, other than limited sheet flow, moves across a traffic lane, a serious and dangerous impediment to traffic flow occurs. Cross-flow is allowed only in case of superelevation of a curve or overflow from the higher gutter on a street with cross fall. No more than three (3) cubic feet per second for the 25 year storm shall be allowed to cross flow from the higher elevation to the lower elevation.							
3.1.4 - Allowable Flow of Water Through Intersections											
			DCM 3.1.4	As the stormwater flow approaches a street or tee intersection (except alleys), an inlet is required if more than three (3) cubic feet per second for the 25-year storm shall flow across the intersection. No more than three (3) cfs for the 25-year storm shall be allowed to enter the bulb of a cul-de-sac or corner bubble. In both situations, the inlet cannot be placed inside the curb return.							
3.1.5 - Valley Gutter											
			DCM 3.1.5	Valley gutters can be useful in diminishing the deterioration of pavements, particularly at intersections where flows tend to concentrate. At the intersection of two (2) arterial streets, a valley gutter cannot be used. At the intersection of two (2) collector streets or local streets, the valley gutter may be used. At an intersection of two (2) different types of streets, the valley gutter may be used across the smaller street only.							
3.2.0 - PERMISSIBLE SPREAD OF WATER											
			DCM 3.2.0	The flow of water in gutters of typical streets during the 25-year storm shall be contained below the top of curb and shall maintain the clear width requirements listed in Table 3-1. The flow of water shall be limited to a maximum of 6″ above the top of crown during the 100-year storm event and must be contained within the defined right-of-way and easements. These clear widths at the crown of the roadway or at the high point on a divided roadway are necessary to provide access for vehicles in the event of an emergency. Equation 3-1 (from equations presented in HEC-22, FHWA-NHI-10-009, modified to solve for depth rather than flow or spread) may be used to determine the depth of gutter flow for a specific street width and flow spread. y = 4H(S/W) - 4H(S2/W2) (Eq. 3-1) Where, y = Water depth in the gutter (feet) (limited to 0.5ft) W = Street width (feet) H = Crown height (feet) S = Spread on one side of street (feet)							
3.3.0 - DESIGN METHOD											
3.3.1 - Gutter Flow Velocities											
			DCM 3.3.1	To ensure scouring velocities for low flows, the gutter shall have a minimum slope of 0.004 feet per foot.							
3.3.2 - Straight Crowns											
			DCM 3.3.2	Flow in gutters on straight crown pavements is normally assumed to be uniform, with Manning's Equation being used to determine the flow. However, because the hydraulic radius assumption in the Manning's Equation is not able to adequately describe the hydraulic characteristics of the gutter cross section, modification of the equation is necessary to accurately compute the flow. The modified Manning's Equation is (HEC-22 Manual, FHWA-NHI-10-009): $Q_o = 0.56\ (z/n)\ S_o^{1/2} Y_o^{8/3}$ (Eq. 3-2) Where, Q_o = Gutter discharge, cfs z = Reciprocal of the crown slope, ft/ft S_o = Street or gutter slope, ft/ft n = Roughness coefficient Y_o = Depth of flow in gutter, feet The nomograph in Figure 3-1 in Appendix D of this manual provides a direct solution for flow conditions in triangular channels. For a concrete pavement gutter, an n value equal to 0.016 is recommended. For gutters with small slope (less than one (1) percent) where sediment may accumulate, an n value of 0.02 is recommended.							
3.3.3 - Parabolic Crowns											

Territory			Reference	Rule	Document Type						
TC	COA ETJ	O ETJ			PP	FP	SP	CP		Where	
			DCM 3.3.3	Flows in the gutter of a parabolically crowned pavement are calculated from a variation of Manning's Equation, which assumes steady flow in a prismatic open channel. However, this equation is complicated and difficult to solve for each design case. To provide a means of determining the flow in the gutter, generalized gutter flow equations for combinations of parabolic crown heights, curb splits and street grades of different street widths have been prepared. All of these equations have a logarithmic form. A. Streets Without Curb Split B. Streets With Curb Split - Higher Gutter C. Streets with Curb Split - Lower Gutter D. Parabolic Crown Location							
SECTION 4 - INLETS											
4.1.0 - GENERAL											
			DCM 4.1.0	The most common location for inlets is at the curb line of streets where surface flow collects. Inlets must be designed to avoid conflicting with the movement of vehicular traffic and to provide travel space free of surface flow in accordance with Section 3 of this manual. The following guidelines shall be used in the design of inlets to be located in streets:							
			DCM 4.1.0 (A)	Curb inlets shall be used to intercept surface runoff for curb and gutter streets unless the use of an alternative type inlet has been approved in writing by the Director of the Watershed Protection Department. The use of an alternative type inlet also needs to be approved in writing by the Director of Public Works for any effect that the layout of the inlet might have on the remainder of the right of way.							
			DCM 4.1.0 (B)	All curb inlets, whether in a sump or on grade, shall be a minimum of five (5) feet in length and be designed and constructed in accordance with the City's standard details for curb inlets. In all cases, the size and layout of inlets shall be such that all applicable requirements of the City street drainage criteria will be met.							
			DCM 4.1.0 (C)	Curb inlets in excess of ten feet in length shall be designed and constructed with a modified top in accordance with the City's standard details for curb inlets.							
			DCM 4.1.0 (D)	The standard curb inlet transition length is 9’-8” as shown in the standard details. Transition lengths may be reduced to a minimum of 7’-6” for curb inlets having a standard depth of depression only when the inlet is located on the outside lane of a street where the outside lane is clearly designated for parking only.							
			DCM 4.1.0 (E)	The use of a reduced throat inlet may be considered on travel lanes where a proposed inlet is less than ten feet from an existing driveway or street corner. Hydraulic requirements must be satisfied. All reduced throat inlets must be designed and constructed in accordance with the City's standard details. Approval in writing by the Director of the Watershed Protection Department is required in all cases where a reduced throat inlet is proposed.							
			DCM 4.1.0 (F)	The use of recessed inlets is encouraged on any street where space is available and subsurface utility lines can be accommodated. The advantage of recessed inlets is that they minimize the dip in the travel lane; the disadvantage is that they can make subsurface utility placement more difficult due to the increased potential for location conflicts. The width of the sidewalk shall not be decreased whenever a recessed inlet is used.							
			DCM 4.1.0 (G)	Grate inlets, combination inlets and slotted drains are discouraged from use due to the tendency of grates and slotted drains to clog, the increased maintenance needed to keep them free of debris, the hazards caused by broken or missing grates, and the difficulties associated with replacing broken or missing grates. When the use of a grate inlet, combination inlet or slotted drain is being considered, a written request to allow the proposed grate inlet, combination inlet or slotted drain may be made when accompanied by supporting information that clearly demonstrates that the proposed grate inlet, combination inlet or slotted drain is the only feasible solution. If approved in writing by the Director of the Watershed Protection Department, the selection and use of a grate inlet, combination inlet or slotted drain shall be in strict accordance with the manufacturer's design guidelines.							
			DCM 4.1.0 (H)	Trench drains with grates, when approved for use in writing by the Director of the Watershed Protection Department, shall be designed and constructed in accordance with the City's standard details for trench drains with grates. All trench drains with grates shall be designed for HS-20 loading. For all trench drains with grates located within City right-of-way, two additional sets of the full grate length shall be provided at the time of construction for City maintenance crews to have on hand for emergency replacement of the grate.							
			DCM 4.1.0 (I)	Inlet design and location must be in accordance with the criteria established in Section 3 of this manual.							
			DCM 4.1.0 (J)	The selection, use and maintenance of water treatment systems at inlets to improve water quality shall be in accordance with the manufacturer's recommendations. Inlet structures shall be sized so that the peak rate of flow entering the inlet from the surface will pass over or around the treatment device when the device is fully clogged. Flow that enters the inlet from the surface and flow in the storm drain system that is passing through the inlet structure shall not be hindered by the presence of a treatment device. The designer of the storm drain system must account for all increased headlosses due to the presence of a fully-clogged treatment device.							
4.3.0 - STORM INLET HYDRAULICS											

4.3.1 - Inlets In Sumps												
			DCM 4.3.1	Inlets in sumps are inlets at low points with gutter flow contributing from two (2) or more sides. The capacity of inlets in sumps must be known in order to determine the depth and width of ponding for a given discharge. The following requirements should be met: A. Curb Opening Inlets (Type S-1) and Area Inlet Without Grate (Type S-4) B. Grate Inlets (Type S-2) C. Combination Inlets (Type S-3) D. Recessed Inlets in Sumps. (Type S-1(R), Type S-3(R))							
4.3.2 - Inlets On Grade With Gutter Depression												
			DCM 4.3.2	The following requirements should be met: A. Curb Opening Inlets on Grade (Type G-1) B. Grate Inlets on Grade (Type G-2) C. Combination Inlets on Grade (Type G-3) D. Recessed Inlets on Grade (Type G-1R, G-3R)							
4.4.0 - INLET SYSTEM LAYOUT												
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
			DCM 4.4.0	The following is a general step-by-step procedure for designing the layout of an inlet system using information provided in Sections 3 and 4. The procedure is not a precise requirement for design, and is provided solely as a guideline for the designer. 4.4.1 - Preliminary Design Considerations 4.4.2 - Inlet System Design 4.4.3 - Inlet Flow Calculation Table							
SECTION 5 - STORM DRAINS												
5.1.0 - GENERAL												
			DCM 5.1.0	Enclosed conduits may be either reinforced concrete pipe or reinforced concrete box culverts meeting the City Standard Specifications for these products.								
				The design storm shall be the 25-year storm with provisions made for the 100-year storm as noted in Section 3.								
5.2.0 - DESIGN GUIDELINES												
			DCM 5.2.0	The following rules shall be observed in the design of storm drain systems located in public right of way or public drainage easements to promote proper operation of these systems and to minimize maintenance requirements:								
			DCM 5.2.0 (A)	Select pipe size and slope so that the velocity of flow will increase progressively or at least will not appreciably decrease at inlets, bends or other changes in geometry or configuration.								
			DCM 5.2.0 (B)	Do not discharge the contents of a larger pipe into a smaller one even though the capacity of the smaller pipe may be greater due to a steeper slope. For projects where a proposed storm drain system associated with the project has greater capacity than an in-place receiving system, and an upgrade to the receiving system is not imminent, a temporary exception may be allowed. For this exception to be allowed, the design of the system must incorporate temporary features as needed to prevent any increase in flooding due to the improved conveyance of the proposed upstream system. The proposed system with interim features shall prevent (a) the capacity of the existing in- place system from being exceeded during the design storm at any location or (b) the exacerbation of existing flooding during the design storm at all points along the receiving system, including the tie-in point. The more stringent of these two requirements shall apply. Supporting calculations, signed and sealed, shall be submitted by the design engineer to demonstrate that there will be no adverse flooding impacts due to the proposed storm drain improvements during the interim condition while the receiving system remains undersized and proposed temporary features are in place to prevent any increase in flooding.								
			DCM 5.2.0 (C)	Where there is a connection of different conduit sizes on the trunk line, the soffit elevations, rather than the flow line elevations, shall be approximately the same. The soffit elevation of the incoming pipe may be offset (increased) by an amount equal to the headloss at the structure where the conduits meet.								
			DCM 5.2.0 (D)	For design purposes, wherever two or more incoming conduits intersect at a single location, the incoming conduit having the greatest cross-sectional area shall be considered to be the "trunk line." If more than one incoming conduit has the same cross-sectional area, then the conduit having both the greatest cross-sectional area and the highest peak flow rate for the design storm shall be the "trunk line." All other incoming conduits at this location shall be considered to be "lateral conduits" or "laterals."								

			DCM 5.2.0 (E)	Where a lateral conduit intersects the trunk line at a manhole, the soffit elevation of the incoming lateral conduit shall be at approximately the same elevation as the soffit of the trunk line conduit. Exceptions may be made when the lateral does not need to be constructed to the depth of the trunk line or when the presence of existing utilities prevents the soffit elevation of the lateral from matching the soffit elevation of the trunk line. Where the soffit elevations of the trunk line and lateral are nearly the same, an offset in the soffit elevations may be provided in an amount equal to the headloss at the junction.								
			DCM 5.2.0 (F)	Where a lateral conduit intersects the trunk line at a wye junction, the soffit elevation of the incoming lateral conduit shall match the approximate soffit elevation of the trunk line conduit. If the soffit elevations are not proposed to be approximately the same, a request for a waiver will be required. Special consideration may be given in cases where there are design constraints such as the presence of existing major utilities which prevent the matching of soffit elevations without extensive utility relocations. In the case of a lateral pipe intersecting a box culvert, allowances shall be made to allow the wall of the pipe to penetrate the wall of the box without having to notch either the pipe wall or the top slab of the box.								
			DCM 5.2.0 (G)	For all pipe junctions other than a manhole, the angle of intersection between any two flow paths shall not be greater than 45 degrees. This includes discharges into box culverts and channels.								
			DCM 5.2.0 (H)	No storm drain system shall discharge into or through an inlet box. Instead the inlet shall discharge to the trunk line through a lateral line. A single connection from a one-lot or two-lot commercial subdivision or an irrigation system may discharge to an existing inlet if it does not impede the function of the inlet, and if the receiving storm drain system has the capacity to convey the additional flows. The inlet shall then be considered a junction box.								
			DCM 5.2.0 (I)	No proposed conduit having a diameter or height greater than 50 percent of the minimum dimension of an existing box culvert shall be allowed to discharge into that box culvert. Exceptions must be justified by structural engineering analysis demonstrating a sound structural design.								
			DCM 5.2.0 (J)	Conduit shall be reinforced concrete. Conduit shall be manufactured and installed in compliance with the City's standard specifications.								
			DCM 5.2.0 (K)	Plastic pipe (schedule 40 PVC or greater strength, 6" minimum diameter) shall be used inside water quality ponds (where the size of pipe required dictates its use) and for retention/re-irrigation systems and may be used within 50 feet of a water quality pond filtration bed (if the pipe is not subject to any type of vehicular loading). End treatment is required for outfall pipe in accordance with City standard specifications. Threaded cleanouts are required within 50 feet of every portion of lateral and collector drain lines and at every bend. Junctions between PVC and RCP shall occur at a manhole or cleanout, as determined by the City.								
			DCM 5.2.0 (L)	The 25-year hydraulic grade line shall remain a minimum of six (6) inches below the theoretical gutter flow line of inlets.								
5.3.0 - DESIGN PARAMETERS												
5.3.1 - Minimum Grades												
			DCM 5.3.1	Storm drains should operate with velocities of flow sufficient to prevent deposition of solid material. The controlling velocity is near the bottom of the conduit and is considerably less than the mean velocity. Storm drains should be designed to have a minimum velocity of two and one-half (2.5) feet per second during the 25-year design storm. When backwater conditions prevent one or more portions of the system from attaining the minimum velocity during the design storm, the portion(s) of the system that fail to meet the criteria shall be checked to ensure that the minimum velocity is attained during a lesser and more frequent storm event. If the minimum velocity is still not achieved, then the storm drain shall be redesigned so that the minimum velocity is attained or a request for waiver submitted explaining why it is not feasible to meet the design criterion.								
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
5.3.2 Maximum Velocities												
			DCM 5.3.2	Maximum velocities in conduits are important because of the possibility of excessive erosion of the storm drain pipe material. Table 5-1 lists the maximum velocities allowed at the peak rate flow during the 25-year event.								
5.3.3 - Minimum Diameter												
			DCM 5.3.3	Pipes that are to become an integral part of the public storm drain system shall have a minimum diameter of 18 inches.								
5.3.4 - Roughness Coefficients												
			DCM 5.3.4	The coefficients of roughness listed in Table 5-2 are for use in Manning's Equation.								
5.4.0 - FLOW IN STORM DRAINS												
			DCM 5.4.0	All storm drains shall be designed by direct solution of the Continuity Equation and Manning's Equation as follows:								
5.5.0 - HYDRAULIC GRADIENT												
			DCM 5.5.0	The hydraulic gradient line shall be computed and plotted for all sections of a storm drain system flowing full or under pressure flow..								

				When computing the hydraulic grade line, the tailwater elevation of the system shall be established after careful consideration of the flow elevation and timing in the receiving stream. When detailed hydrologic and hydraulic studies are available for the receiving stream, the modeling results from these studies must be used to estimate the tailwater elevation. If detailed studies are not available, the design engineer must use his professional judgment in calculating the appropriate tailwater elevation. The use of coincident frequencies is not encouraged, and will only be considered for use on a case-by-case basis when an appropriate means for estimating or calculating the tailwater elevation is not feasible. In no case shall the tailwater elevation of the system be considered to be below the top of pipe (overt elevation).							
				Storm drain profile drawings submitted for review and final profile drawings for construction shall show directly on the drawing the 25- year and 100-year hydraulic gradeline, flow rates and flow velocities for each segment of the storm drain system.							
5.6.0 - MANHOLES												
			DCM 5.6.0	Manholes provide a very important access point for maintenance purposes.								
5.6.1 - Spacing												
			DCM 5.6.1	Due to equipment constraints, every point within the storm drain must be a maximum of 250 feet from an access point for drains 30 inches in diameter or smaller. For storm drains greater than 30 inches in diameter, manholes shall be placed so that there is a maximum distance of 300 feet to an access point. Storm drain outfalls may be considered as access points for maintenance purposes. Access points must be accessible in accordance with the requirements of Section 1.2.4.E of this Manual and must provide a maintenance path within the storm drain that has no more than one horizontal bend between access points, with that bend having a deflection of no more than forty-five (45) degrees in the direction of flow, and no vertical bend with a deflection of greater than five (5) degrees. Storm drain slope adjustments of less than five (5) degrees are not subject to this requirement. An inlet may be considered as an access point for maintenance purposes if that inlet is: (1) the upstream terminus of the storm drain system, (2) located less							
				Manholes shall also be located where two or more laterals intersect the main line within five (5) feet of each other (See Figure 5-3 in Appendix D of this manual for examples of possible manhole locations). Manholes shall also be placed at locations where changes in pipe size occur.							
5.7.0 - DEPTH OF COVER												
			DCM 5.7.0	The design of storm drains for areas that will or could receive vehicular traffic or that will be subject to other loading must be supported by structural engineering calculations or references to structural engineering standards. The minimum depth of cover shall be two and a half feet (2.5 ft) over the storm drain outer edge except at the connection to a storm drain inlet. Depth of cover is measured from the ground elevation to the top outer edge of the storm drain.							
5.8.0 - STORM DRAIN OUTFALLS INTO OPEN CHANNELS												
			DCM 5.8.0	Storm drain outfalls into open channels shall conform to the design guidelines in Standards 508S-13 or 508S-16 through 508S-20, as appropriate for site specific conditions.								
5.8.0 (A) - End Treatment												
			DCM 5.8.0 (A)	As appropriate for site conditions based on engineering judgment, outfalls into natural channels shall utilize flexible armor, such as rock riprap (508S-16 through 508S-20), to allow for adjustment of the receiving channel due to normal creek erosion. Rock riprap shall be sized in accordance with ECM 1.4.6(D) and meet the requirements of Standard Specification 591S. Use of standard concrete headwalls (508S-13) and other rigid end treatments shall be limited to outfalls into non-erosive or armored channels. Where rigid end treatments are used in natural channels, the design shall account for future erosion and channel adjustment such that the structure will not become an obstruction to channel flow as adjustments occur. This may include using flexible armor to stabilize the surrounding channel banks and/or setting the structure into the bank such that future erosion will not expose the structure. For both flexible and rigid end treatments, the transition between natural channel banks and the outfall shall be smooth and stable such that erosion at the interface is minimized. The angle of intersection between the outfall flow path and the channel flow path shall not be greater than 45-degrees.							
5.8.0 (B) - Drop Height												
			DCM 5.8.0 (B)	The outfall drop height shall be minimized to the extent feasible and shall not exceed six feet, as measured vertically from the flowline of the outfall to the toe of the channel bank. The recommended outfall drop height is one foot to allow for potential sedimentation at the outfall. A manhole(s) may be used to limit the outfall drop height, per 508S-18. In all cases, non-erosive conveyance shall be provided from the outfall to the flowline (lowest elevation) of the receiving channel. Concentrated discharges on steep embankments, ravine slopes, or high bluffs shall be avoided.							
5.8.0 (C) - Stabilization												

			DCM 5.8.0 (C)	Where possible, the outfall should be located away from existing eroded banks in the most stable location available. The surrounding banks and bed shall be appropriately armored or made geotechnically stable, so as to sufficiently resist erosive forces. As outlined in Standards 508S-16 through 508S-20, armor below the outfall shall extend from the toe of the bank into the channel equal to a length ten times the pipe diameter. For channel bottom widths less than ten times the pipe diameter, armoring shall extend up the opposite bank to an elevation equal to that of the top of pipe. Flexible armor, such as rock riprap, shall be utilized for bed and bank stabilization in erodible channels. The location of the outfall, armoring, and channel stabilization must consider the location of existing infrastructure and utilities and provide adequate horizontal and vertical separation so as not to obstruct access or maintenance, nor adversely impact the infrastructure.							
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
SECTION 6 - OPEN CHANNELS												
6.1.3 - Section 404 Permit												
			DCM 6.1.3	When a project to modify a natural channel is proposed, the design engineer should check the requirements of Section 404 of the Clean Water Act. If required, a permit should be obtained from the U.S. Army Corps of Engineers by the design engineer. The application procedures and detailed information on nationwide permits are described in Appendix C.								
6.4.0 - DESIGN REQUIREMENTS												
6.4.1 - Grass-Lined Channels and Waterways												
			DCM 6.4.1	The grass species selected shall conform to the City of Austin Standards and Standard Specifications and the Environmental Criteria Manual, as appropriate, and must be suitable for permanent application based upon the anticipated operation and maintenance of the channel or waterway.								
			DCM 6.4.1 (A)	**Velocity.** The maximum permissible velocity for the one hundred (100) year storm is six (6) feet per second and includes all transitions to or from channels and waterways with similar or different materials. In all cases, the velocity for the one hundred (100) year storm must be non-erosive. The minimum permissible velocity for the two (2) year storm is two (2) feet per second.								
			DCM 6.4.1 (B)	**Roughness Coefficient.** The roughness coefficients selected shall be based on the degree of retardance of vegetation. Table 6-2 provides minimum Manning's Coefficients for channel design. The roughness coefficient shall be adjusted to reflect the relationship between the depth of flow and the typical height of the design vegetation, especially for shallow depths of flow, as well as other factors affecting channel conveyance.								
			DCM 6.4.1 (C)	**Slope.** The flow line slope of the channel shall be a minimum of two (2) percent unless the velocity for the two (2) year storm flow is greater than two (2) feet per second, in which case the channel slope may be a minimum of one (1) percent. Compliance with this requirement must take into account the variation in channel flow due to distributed inflows to the channel. A reinforced concrete pilot channel must be used if the channel slope is less than one (1) percent. The pilot channel must be at least four (4) feet wide, two (2) inches deep, and be capable of withstanding vehicular loading. Any grass-lined portion of the channel bottom must have a slope of at least two (2) percent from that portion to the concrete-lined pilot channel. However, no open channel flow line slope may be less than one-half (0.5) percent.								
			DCM 6.4.1 (D)	**Side Slopes.** Side slopes shall be three (3) to one (1) or flatter.								
			DCM 6.4.1 (E)	**Curvature.** The center line curvature shall have a minimum radius of twice the top width of the one hundred (100) year storm flow.								
			DCM 6.4.1 (F)	**Bottom Width.** The minimum flat bottom width of the channel is three (3) feet.								
			DCM 6.4.1 (G)	**Freeboard.** All grass-lined channels shall be designed to convey the one hundred (100) year storm event. The freeboard for the channel shall be the velocity head for the one hundred (100) year storm.								
6.4.2 - Concrete-Lined Channels												
			DCM 6.4.2	Concrete-lined channels may be needed in channel reaches where the velocities are excessive (See Section 6.4.1.A) or where the channel characteristics require such use.								
			DCM 6.4.2 (A)	**Velocity.** In concrete-lined channels the probability of achieving supercritical flow is greatly increased. The designer must take care to insure against the possibility of unanticipated hydraulic jumps forming in the channel in considering the 25 and 100 year storms. Flow with a Froude number equal to one (1) is unstable and should be avoided. If supercritical flow does occur, then freeboard and superelevation must be determined. In addition, all channels carrying supercritical flow shall be continuously lined with reinforced concrete.								
			DCM 6.4.2 (B)	**Roughness Coefficient.** Table 6-2 provides the Manning's Coefficients for concrete-lined channels.								
			DCM 6.4.2 (C)	**Freeboard.** Adequate channel freeboard shall be provided for the 100 year storm in reaches where supercritical flow occurs by Equation 6-3 or using the energy grade line, whichever is less.								
			DCM 6.4.2 (D)	**Superelevation.** Superelevation of the water surface shall be determined at all horizontal curves which deviate more than 45 degrees off the projected centerline. An approximation of the superelevation at a channel bend can be obtained from Equation 6-4.								
			DCM 6.4.2 (E)	**Side Slopes.** Since concrete lined channels do not require slope maintenance, the side slopes may be as steep as vertical with appropriate structural methods applied.								

			DCM 6.4.2 (F)	**Slope.** The flow line slope of the channel shall be no less than one-half (0.5) percent and must also be sufficient to produce a velocity for the two (2) year storm flow of at least two (2) feet per second. Compliance with this requirement must take into account the variation in channel flow due to distributed inflows to the channel.								
6.4.3 - Other Channels												
			DCM 6.4.3	Channels composed of materials other than vegetation or concrete shall be designed so that sediment deposition does not occur for the two (2) year storm (except for channel drop structures and energy dissipators as approved by the City) and velocities for the one hundred (100) year storm are not erosive, using methods as approved by the Director of the Watershed Protection and Development Review Department.								
6.5.0 - CHANNEL DROP STRUCTURES												
6.5.1 - Sloping Channel Drop												
			DCM 6.5.1 (A)	**Approach Apron.** A minimum ten (10) foot long riprap apron should be constructed immediately upstream of the drop to protect against the increasing velocities and turbulence which result as the water approaches the sloping portion of the drop structure. The same riprap and bedding design should be used as specified for the portion of the drop structure immediately downstream of the drop.								
			DCM 6.5.1 (B)	**Chute.** The chute shall have roughened faces and shall be no steeper than 2:1. The length, L, of the chute depends upon the hydraulic characteristics of the channel and drop. For a unit discharge, q, of 30 cubic feet per second per foot, L would be about 15 feet, that is, about ½ of the q value. The L should not be less than ten (10) feet, even for low q values.								
			DCM 6.5.1 (C)	**Downstream Apron.** The length of the downstream apron shall be sized according to Table 6-3 and shall be constructed of reinforced concrete or riprap depending on structural requirements.								
6.5.2 - Vertical Channel Drops												
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
			DCM 6.5.2	The design criteria for the vertical channel drop is based upon the height of the drop and the normal depth and velocity of the approach and exit channels. The channel must be prismatic throughout, from the upstream channel through the drop to the downstream channel. The steepest allowable sideslope for the riprap stilling basin is 4:1. The riprap should extend up the side slopes to a depth equal to one (1) foot above the normal depth projected upstream from the downstream channel. The maximum fall allowed at any one drop structure is four (4) feet from the upper channel bottom to the lower channel bottom.								
			DCM 6.5.2 (A)	**Approach Channel:** The upstream and downstream channels will normally be grass-lined trapezoidal channels.								
			DCM 6.5.2 (B)	**Approach Apron:** A minimum ten (10) foot long riprap apron is provided upstream of the drop to protect against the increasing velocities and turbulence which result as the water approaches the vertical drop.								
			DCM 6.5.2 (C)	**Downstream Apron:** The riprap stilling basin is designed to force the hydraulic jump to occur within the basin and is designed for essentially zero scour.								
6.6.0 - ENERGY DISSIPATORS												
6.6.1 - Baffled Apron (U.S. Bureau of Reclamation Type IX)												
			DCM 6.6.1 (A)	**Design Discharge.** The chute should be designed for the full capacity expected to be passed through the structure. The maximum unit discharge may be as high as 60 cfs per foot for the 100 year storm.								
			DCM 6.6.1 (B)	**Chute Entrance.** The flow entering into the chute should be well distributed laterally across the width of the chute. The velocity should be well below the critical velocity, preferably the value shown in the curve D of Figure 6-3 in Appendix E of this manual. The curve C in Figure 6-3 in Appendix E of this manual is the critical velocity in a rectangular channel, Vc=(gq)1/3.								
			DCM 6.6.1 (C)	**Chute Design.** The chute is usually constructed on a 2:1 slope. The upstream end of the chute floor should be joined to the horizontal floor by a curve to prevent excessive vertical contraction of the flow. The upstream face of the first row should be no more than one (1) foot (vertically) below the high point of the chute. Based on the results of U.S. Bureau of Reclamation experiments, the greatest tendency to overtop the training walls occurs in the vicinity of the second and third rows of baffles. To prevent this overtopping, a partial baffle (1/3 to 2/3 of the width of a full baffle) should be placed against the training walls in the first row. This will place a space of the same width adjacent to the walls in the second row. Alternate rows are then made identical (i.e., rows 1, 3, 5, 7, etc., are identical; Rows 2, 4, 6, 8, etc., are identical). Four (4) rows of baffles are necessary to establish the expected flow pattern at the base of the chute. The height of the training walls on the chute should be three (3) or more times the baffle height, measured normal to the chute floor. Several rows of baffle piers are usually constructed below the channel grade to establish full control of the flow. At least one (1) row of baffles should be buried in the backfill which is used to restore the original bottom topography.								

			DCM 6.6.1 (D)	**Heights and Spacing of Baffle Pier.** Baffle pier height, H, should be about 0.8 Dc to 0.9 Dc, as shown in Curve B in Figure 6-3 in Appendix E of this manual. Dc is the critical depth in a rectangular channel and determined by Equation 6-5. Baffle pier widths and spaces should be equal, up to 1.5 H but no less than H. The slope distance between rows of baffle piers should be 2H, twice the baffle height.							
6.6.2 - Baffled Outlet												
			DCM 6.6.2	Baffled outlets are used to dissipate the discharge energy from flow in a pipe. They are normally used at outlets from detention ponds or storm drainage systems. The baffles are intended to decrease the discharge velocities and subsequent erosion of the receiving system. The design detail for a baffled outlet can be found in the City of Austin Standards (see Reference 6-3).							
6.7.0 - STRUCTURE AESTHETICS												
			DCM 6.7.0	**Parks.** Hydraulic structures should not detract from the pleasures enjoyed in an urban park. Furthermore, parks and green belts may later be developed in an urban area in which the structure will play a dominant environmental role.								
				Play Areas. An important consideration is that drainage structures often are an attraction for neighborhood children. It is almost impossible to make drainage works inaccessible to children, and therefore what is constructed should be made as safe as is reasonably possible. Hazards to children's safety should be avoided whenever possible.							
				Concrete Surface Treatment. The use of textured concrete presents a pleasing appearance and removes form marks. Exposed aggregate concrete is also attractive but may require special control of the aggregate used in the concrete.							
				Rails and Fences. The use of rails and fences along concrete walls provides a pleasing topping to an otherwise stark wall, yet provides a safety measure against the hazard of falling from an unprotected wall.							
6.8.0 - SUPPLEMENTAL SECTION												
6.8.1 - Alternative New Channel Design												
			DCM 6.8.1	The following is a description of the cross-sectional characteristics of an alternative channel design to be applied at the engineer's discretion but is in no way a requirement.								
			DCM 6.8.1 (A)	A pilot channel designed to carry the ten (10) year storm shall be calculated with Manning's "n" values in accordance with Tables 6-2 and 6-3. This channel is designed to separate the more frequent ten (10) year storm via an unobstructed pilot channel. Side slopes of the pilot channel shall not exceed 3:1 slope gradient and shall have a bottom width of no less than six (6) feet. The remaining cross-sectional area is designed to convey the additional storm flows up to the 100 year storm. This upper platform will accommodate vegetation with minimal maintenance requirements.							
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
			DCM 6.8.1 (B)	The 100 year floodplain shall be contained within overbanks on each side of the pilot channel. These overbanks shall be a minimum width of ten (10) feet and have a slope gradient not to exceed 6:1. The overbanks shall be stabilized with the seeds of grasses, native wildflowers and native woody species appropriate to riparian habitat and with blanket products as described in the City of Austin Erosion and Sedimentation Control Manual. In calculating Manning's "n" values for the overbanks, reference must be made to Tables 6-2 and 6-3 with the following assumptions: 1. Heavily wooded and brushy overbanks and 2. Bank irregularities, which can be reasonably expected from occasional, moderate erosion. Figure 6-4 in Appendix E of this manual depicts the conceptual idea of the alternative channel design.							
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
SECTION 7 - CULVERTS												
7.1.0 - GENERAL												
			DCM 7.1.0	The design storm flow shall be determined by the hydrologic methods as set forth in Section 2 of this manual.								
				The system shall accommodate the runoff from 25-year and 100-year frequency storms meeting the limitations for overflows at bridges and culverts set forth in Section 1.2.4.C and 1.2.4.D.								
				The rules for manhole spacing described in Section 5.6.0 also apply to culverts.								
7.2.0 - CULVERT HEADWALLS & ENDWALLS												
7.2.2 - Conditions at Entrance												

			DCM 7.2.2	The operating characteristics of a culvert may be completely changed by the shape or condition at the inlet or entrance. Therefore, design of culverts must involve consideration of energy headlosses that may occur at the entrance. Entrance headlosses may be determined by the Equation 7-1.								
7.2.4 - Debris Fins.												
			DCM 7.2.4	For conditions where more than one (1) box culvert is required, the upstream face of the structure shall incorporate debris deflector fins to prevent debris buildup. For multiple-pipe situations installations of debris fins may be used but are not required.								
				The debris fin is an extension of the interior walls of a multiple-box culvert. The wall thickness shall be designed to satisfy structural requirements and reduce impact and turbulence to the flow.								
				A debris fin is constructed to the height of the culvert. A fin length of one and one-half (1.5) times the height of the box culvert is required. Since the debris fins are subject to the same erosive forces as bridge piers, care must be taken in the design of the footing. A toewall at the upstream end of the debris fin and the apron is recommended. Figure 7-2 in Appendix D of this manual depicts the conceptual design for debris deflector fins. It should be noted that alternate types of wingwalls can be used other than the parallel shown in Figure 7-2 in Appendix D of this manual.								
7.2.5 - Trashracks & Safety End Treatments.												
			DCM 7.2.5	If trashracks or safety end treatments are to be used, appropriate clogging factors must be applied. TxDOT provides some guidance for the selection of clogging factors. "Design of Small Dams" by US Bureau of Reclamation (1987) suggests a trashrack clogging factor of 50%.								
7.3.0 - CULVERT DISCHARGE VELOCITIES												
			DCM 7.3.0	Whenever possible, the culvert axis should match the natural channel alignment upstream and downstream. Matching the channel alignment with the culvert axis prevents a bend in the channel that would be subject to erosion.								
				Depressed entrances should be avoided. If capacity or depth of cover forces the use of a depressed entrance, the upstream apron should be designed to prevent progressive degradation of the upstream channel. Additionally, the potential for deposition should be considered.								
				The local conditions within the channel reach should be evaluated to determine if there is degradation present. In a degrading channel, headcuts can migrate upstream and compromise the integrity of the culvert. If channel degradation is anticipated, the design should accommodate for future erosion.								
				At a culvert outlet, exit velocities should be minimized to the greatest extent practical. Channel erodibility and local scour potential should be evaluated and taken into account. Due to the dynamic nature of alluvial channels, a flexible armoring system is preferred in streams subject to erosion. The City of Austin Standard 508S-20 (Stormdrain Outfall Protection, Culvert Under Roadway/Inline) may be used for protection of the receiving channel from erosive forces. Where degradation is expected, the volume of riprap should be increased to account for loss of base level downstream of the culvert outlet. The rock riprap used in this standard detail must be designed by the engineer for the specific hydraulic conditions present based on ECM 1.4.6(D). Where energy dissipation is needed at a culvert outlet, a rock riprap basin is preferred over rigid structures (see HEC-14 for design guidelines).								
				If multiple boxes or culverts are necessary, different flowline elevations for each structure should be evaluated. The culverts in the center of the channel should be lower to match with the existing natural channel with the outlying culverts raised up to more closely coincide with the natural channel "terrace" elevation. This will help to minimize sedimentation in the outlying culverts, help preserve the integrity of the channel system, and reduce maintenance costs. A culvert may be depressed below the channel flowline, such that a natural channel bottom is maintained, as long as n-values and cross-sectional area are adjusted appropriately when modeling conveyance. Riprap armoring is preferred; however, if site conditions necessitate a concrete apron, the minimum apron length which provides transition from a culvert outlet to an open channel shall be calculated from Equation 7-2.								
7.4.0 - SELECTION OF CULVERT SIZE AND FLOW CLASSIFICATION												
7.4.2 - Design Procedures												
			DCM 7.4.2	The Federal Highway Administration has published guidance for the hydraulic design of culverts. Their guidance includes design methodology, check lists, design charts, and tables which shall be used to perform culvert designs that meet the City's performance criteria.								
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
SECTION 8 - STORMWATER MANAGEMENT												
8.2.0 - REGIONAL STORMWATER MANAGEMENT PROGRAM												
8.2.2 - Participation Guidelines												

			DCM 8.2.2 (A)	**General.** General. The following guidelines are provided for those developments that desire to participate in the RSMP. Participation is available in all watersheds that drain into or through the City of Austin full purpose jurisdiction. A list of participating watersheds is available on the Austin Watersheds List, at https://www.austintexas.gov/sites/default/files/files/Watershed/rsmp/Austin_Watersheds.pdf. Participation may also be available within the City's Extra Territorial Jurisdiction with the concurrence of the stormwater management program of the relevant county or other entity. Participation may be through payment, construction of off-site drainage improvements, or verification that a previous agreement covers the proposed development. Developers who choose to provide off-site SWM should refer to Section 8.3.0 for design criteria. Participation may be granted upon determination of the applicant's ability to satisfy the requirements below. It should be understood, however, that this policy cannot cover all situations and that final determination of eligibility shall be made by the Watershed Protection Department.							
			DCM 8.2.2 (B)	**Order of Preference for Participation.** The goal of the RSMP is to provide control of increased runoff due to development both in the watershed as a whole and in the immediate vicinity of the proposed development. Options that achieve such local benefits are generally preferred. As such, preference for RSMP participation is as follows: 1.Improvement of a portion of the downstream drainage system or of SCMs in the immediate vicinity of the project; 2.Off-site detention; 3.Dedication of easements or donation of land for regional improvements; or 4.Payment in lieu of detention.							
			DCM 8.2.2 (C)	**Participation requirements.** Each RSMP applicant shall submit a completed feasibility determination request form and attend a required feasibility meeting. Each RSMP applicant shall submit a complete participation application form and engineering submittal to the Watershed Protection Department at the time of preliminary plan submittal or site plan submittal. To view the request form and information about the engineering submittal, please refer to the RSMP program link in the Watershed Protection Programs page of the City of Austin's website at www.austintexas.gov. In order to participate in the program, the applicant must satisfy all of the following conditions: 1.The intervening drainage system from the site to the tributary or main branch of the downstream mapped floodplain must have the capacity to provide for the fully developed 100-year storm from the entire drainage area (refer to Section 1.2.2 for capacity requirements). If the downstream systems are undersized or downstream flooding conditions exist, RSMP participation may be approved if it can be verified there will be no additional adverse flooding impact to downstream properties for storm events up to and including the 100-year storm. 2.The submitted engineering analysis must include a certified statement by a licensed engineer in the State of Texas that no additional adverse flooding impacts to other property will occur as a result of the proposed improvements. 3.An easement for unconditional conveyance of the fully-developed 100-year flood event from the site to the main branch or tributary of the watershed must be either in place, or acquired before participation is allowed.							
			DCM 8.2.2 (D)	**Special Conditions.** In addition to the specific criteria given above the engineer should note the following conditions which could arise: 1.Should a regional detention facility or the intervening public drainage system be committed to its maximum capacity, an applicant may (at the City's discretion), increase the capacity of the regional facility or drainage system through approved modifications. The funding of any such modifications will be the responsibility of the applicant, and may take the place of the required participation payment:a.if the improvements provide a public benefit; andb.if the cost of the improvements is equal to or greater than the required payment; or if the cost of the improvements is less than the required payment, the cost of the improvements will be credited towards the total payment amount and the difference will be paid. 2.If the subject tract desires to participate but intends to develop prior to construction of the regional facility or conveyance improvements, provisions must be made by the applicant for temporary on-site detention. 3.Existing on-site ponds may be removed if the development is approved as a participant in the RSMP and the Watershed Protection Department reviews and approves such removal.							

			DCM 8.2.2 (E)	**Participation Payments.** Payment calculations are finalized at the time of RSMP application approval and issuance of formal agreement for owner signature. RSMP application reviews are completed during the site plan or subdivision review process and will not be approved out of cycle. The participation payments shall be based on the total site area of the development, less any dedicated floodplain easements, drainage easements containing the 100-year floodplain, permanent retention or detention facilities, and other areas undevelopable under applicable City of Austin code. These areas may be deducted from the total site area to reduce the land cost area in the payment calculation. Deductible areas will be finalized by City staff at the time of payment calculation based on supporting documentation provided with the RSMP application. After a development is accepted for participation, payments shall be made in accordance with the following: 1.Single Family and Duplex Subdivisions.a.For single-family subdivisions that require the construction of streets or drainage facilities, a letter of credit must be posted with the Watershed Protection Department in an amount equal to the total participation payment prior to final plat approval. This letter of credit must be replaced by cash prior to construction plan approval.b.For single-family subdivisions that do not require the construction of streets, payment must be made prior to final plat approval.c.For single-family subdivisions the payment amount shall be based on the maximum allowable impervious cover (by zoning or watershed ordinance, whichever is more restrictive) unless the developer records a restrictive covenant and includes a plat note to limit the allowable impervious cover. The plat note must reference the restrictive covenant and the maximum allowable impervious cover per the restrictive covenant. 2.Commercial and Multi-Family Site Development. For commercial and multi-family site development (including triplexes, fourplexes, apartments and condominiums), payment must be made prior to issuance of a development permit. 3.Multi-Family, Commercial and Industrial Subdivisions. For multi-family, commercial and industrial subdivisions, payment for the rights-of-way shall be made prior to final plat approval. In addition, the applicant shall assign, by plat note, the responsibility for payment of the participation amount by the individual lot developer prior to their development permit approval. Upon payment, the participation agreement, available via the RSMP link on the Watershed Protection Department Programs page on the City of Austin's website, www.austintexas.gov, shall be signed and act as a binding agreement between the developer and the City.							
8.2.3 - Watershed Floodplain Models												
			DCM 8.2.3	A licensed engineer in the State of Texas must certify any results based on these models or modified versions thereof that are submitted to the City as part of the land development review and permit approval process.								
8.3.0 - STORMWATER MANAGEMENT PONDS												
8.3.2 - Performance Criteria for SWM Ponds												
			DCM 8.3.2 (A)	Detention ponds shall be designed to reduce post-development peak rates of discharge to existing pre-development peak rates of discharge for the 2-, 10-, 25- and 100-year storm events at each point of discharge from the project or development site. For the post-development hydrologic design of the SWM pond, any off-site areas which drain to the pond shall be assumed to remain in the existing condition. If off- site flows are conveyed through the SWM pond, the SWM pond outlet structure must be designed to safely pass 100-year fully developed off-site flows in accordance with the Safety Criteria set forth in Section 8.3.3.							
			DCM 8.3.2 (B)	For design purposes, any pond with a drainage area larger than 64 acres shall be classified as a regional pond. Performance criteria for regional ponds shall be reviewed and approved by the Watershed Protection Department on a project-by-project basis. The determination shall be based on a preliminary engineering study prepared by a licensed engineer in the State of Texas.							
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
			DCM 8.3.2 (C)	Maximum retention or "draw-down" time for flood detention ponds shall not exceed 24 hours from the time of peak storage to the time of complete emptying of the pond, as determined by hydrograph routing or other calculations acceptable to the City. This requirement does not apply to facilities in which retention or "draw-down" time is required to be greater than 24 hours. However, only the portion of the volume within a water quality control available after 24 hours of drawdown time may be used or credited towards detention requirements.							
8.3.3 - Safety Criteria For SWM Ponds												
			DCM 8.3.3	All ponds shall meet or exceed all specified safety criteria. Use of these criteria shall in no way relieve the engineer of the responsibility for the adequacy and safety of all aspects of the design of the SWM pond.								
			DCM 8.3.3 (A)	The spillway, outfall, embankment, and appurtenant structures shall be designed to safely pass the design storm hydrograph with the freeboard shown in the table below. All contributing on-site drainage areas, and off-site areas which are routed through the SWM pond, shall be assumed to be fully developed in order to properly size the spillway, outfall, embankment and appurtenant structures. Any orifice with a dimension smaller than or equal to 12 inches shall be assumed to be fully developed in order to properly size the spillway, outfall, embankment and appurtenant structures. For all spillways (especially enclosed conduits), the ability to adequately convey the design flows must take into account any submergence of the outlet, any existing or potential obstructions in the system and the capacity of the downstream system.							

			DCM 8.3.3 (B)	Any hydraulic structure designed to impound storm water that has a height greater than or equal to six (6) feet at any point along the perimeter of the SWM pond is a dam and must be designed to safely pass the minimum design flood hydrograph expressed as a percentage of the probable maximum flood (PMF) as described in DCM 8.3.3.B.3 and as evidenced by certification using the statement provided in DCM 8.3.3.B.3 by an engineer licensed in the State of Texas. The certification statement may be divided into the four disciplines of hydrology, hydraulics, structural and geotechnical and independently certified.							
			DCM 8.3.3 (B)(1)	1. The height of the hydraulic structure (dam) is measured from the top of the structure to the downstream intersection of the structure and the natural or excavated ground, whichever is lower.								
			DCM 8.3.3 (B)(2)	2. The PMF is computed by using the probable maximum precipitation (PMP) values as described in Section 2-6 of the Drainage Criteria Manual.								
			DCM 8.3.3 (B)(3)	3. A dam as defined in DCM 8.3.3.B must be designed to pass the minimum design flood hydrograph which is the greater of: a. 75 percent of the PMF. b. The percentage of the PMF as defined in Texas Administrative Code Chapter 299 Dams and Reservoirs. (Figure: 30 TAC § 299.15(a)(1)(A))							
			DCM 8.3.3 (B)(4)	4. Dam Safety Certification Statement: I [name of professional engineer] Texas license number [number] certify that the design of the dam in this set of plans can safely pass the minimum design flood hydrograph as required by the City of Austin and the State of Texas based on the hydrologic, hydraulic, structural and geotechnical analysis using standard accepted engineering practices.							
			DCM 8.3.3 (B)(5)	5. SWM ponds that are considered dams as defined in this section of the Drainage Criteria Manual may not be designed or constructed with any trees or other woody vegetation on the dam structure or within 20-feet of the upstream or downstream toe of the dam. This 20-foot clear zone must be called out on the site plan and for City maintained facilities must be part of the drainage easement dedicated for the dam facility. The toe of the dam is the junction of the constructed dam structure with the natural ground.							
			DCM 8.3.3 (B)(6)	6. SWM ponds that are considered dams as defined in this section of the Drainage Criteria Manual may not have permanent irrigation systems installed on the dam.								
			DCM 8.3.3 (B)(7)	7. SWM ponds that are considered dams as defined in this section of the Drainage Criteria Manual must be vegetated with grasses that do not exceed 12-inches in height and can be mowed as frequently as weekly. Examples include Bermuda grass and buffalo grass.								
			DCM 8.3.3 (B)(8)	8. SWM ponds that are considered dams as defined in this section of the Drainage Criteria Manual shall provide a fixed vertical marker on or near the emergency spillway indicating the water surface elevation relative to the top of the main embankment. The markings should be in half foot increments, viewable from the furthest point of access, and must be retroreflective as defined by the Texas Manual on Uniform Traffic Control Devices (TMUTCD).							
			DCM 8.3.3 (C)	All SWM ponds shall be designed using a hydrograph routing methodology. The appropriate City of Austin rainfall distribution shall be used to determine all runoff hydrographs.								
			DCM 8.3.3 (D)	The minimum embankment top width of earthen embankments shall be as follows: **HEIGHT OF EMBANKMENT, FT.** / **MINIMUM TOP WIDTH, FT.** 0-6 / 4 6-10 / 6 10-15 / 8 15-20 / 10 20-25 / 12 25-35 / 15							
			DCM 8.3.3 (E)	The constructed height of an earthen embankment shall be equal to the design height plus the amount necessary to ensure that the design height will be maintained once all settlement has taken place. This amount shall in no case be less than 5% of the total fill height. All earthen embankments shall be compacted to 95% of maximum density in accordance with COA standard specifications.							
			DCM 8.3.3 (F)	Earthen embankment side slopes shall be no steeper than 3 horizontal to 1 vertical. Slopes must be designed to resist erosion to be stable in all conditions, and to be easily maintained. Earthen side slopes for regional facilities shall be designed on the basis of appropriate geotechnical analyses.							
Territory			**Reference**	**Rule**	**Document Type**							
TC	**COA ETJ**	**O ETJ**			**PP**	**FP**	**SP**	**CP**		**Where**		
			DCM 8.3.3 (G)	Detailed hydraulic design calculations shall be provided for all SWM ponds. Stage-discharge rating data shall be presented in tabular form with all discharge components, such as orifice, weir, and outlet conduit flows, clearly indicated. A stage-storage table shall also be provided. In all cases the effects of tailwater or other outlet control considerations should be included in the rating table calculations.							

			DCM 8.3.3 (H)	When designing ponds in series (i.e., when the discharge of one becomes the inflow of another), a licensed engineer in the State of Texas engineer must submit a hydrologic analysis, which demonstrates the system's adequacy. This analysis must incorporate the construction of hydrographs for all inflow and outflow components.								
			DCM 8.3.3 (I)	Storm runoff may be detained within parking lots. However, the engineer should be aware of the inconvenience to both pedestrians and traffic. The location of ponding areas in a parking lot should be planned so that this condition is minimized. Stormwater ponding depths (for the 100 year storm) in parking lots are limited to an average of eight (8) inches with a maximum of twelve (12 inches).								
			DCM 8.3.3 (J)	All pipes discharging into a public storm drain system shall have a minimum diameter of 18 inches and shall be constructed of reinforced concrete. In all cases, ease of maintenance and/or repair must be assured.								
			DCM 8.3.3 (K)	All concentrated flows into a SWM pond shall be collected and conveyed into the pond in such a way as to prevent erosion of the side slopes. All outfalls into the pond shall be designed to be stable and non-erosive.								
8.4.0 - DETENTION POND STORAGE DETERMINATION												
			DCM 8.4.0	A flow routing analysis using detailed hydrographs must be applied for all detention pond designs. The Soil Conservation Service hydrologic methods (TR-20) and the Hydrologic Engineering Center (HEC) hydrologic methods (HEC-HMS) may be used. The engineer may use other methods but must have their acceptability approved by the Director.								
8.5.0 - DETENTION BASIN MAINTENANCE AND EQUIPMENT ACCESS REQUIREMENTS												
				Refer to Section 1.2.4. for subsurface ponds see Environmental Criteria Manual Section 1.6.2(E).								

Table Legend		
Territory	TC	Travis County
	COA ETJ	City of Austin Extraterritorial Jurisdiction
	O ETJ	ETJ of a municipality other than the City of Austin
Reference	TC 482	Chapter 482.Travis County Development Regulations
	TC 464	Chapter 464. Regulations for Floodplain Management and Guidelines and Procedures for Development Permits
	TCM	City of Austin Transportation Criteria Manual
	DCM	City of Austin Drainage Criteria Manual
Document Type	PP	Preliminary Plan
	FP	Final Plat
	SP	Site Plan
	CP	Construction Plan