CHAPTER 7 – DRAINAGE DESIGN REQUIREMENTS

[15.32.050; 16.16.010] City Engineer's Legislative Authority to Set Design Standards

701 GENERAL INFORMATION

701.1 Drainage, Storm Sewers, Drainage Channels and Retention Basins—General Requirements.

701.1.1 Storm Drainage Systems Required

701.1.1.1 It is the policy of the City of Casa Grande that all development within the city shall provide adequate provisions for the conveyance, disposal, or retention of stormwater. This requirement applies equally to private properties and to public streets. [15.32.130; 15.40.1000; 16.16.280;]

701.1.1.2 All developments within the City shall provide a stormwater management system that includes the construction of a stormwater conveyance system to direct the flows to either the retention/detention basins and/or to the ultimate outlet(s) for the site. [16.16.280.A]

701.1.1.3 The city will not recommend for approval any plat of a subdivision which does not make adequate provision for storm or floodwater runoff channels or basins. [16.16.280.A]

701.1.1.4 The stormwater drainage system shall be separate and independent of any sanitary sewer system. [16.16.280.A]

701.1.1.5 Changes or additions to sites which require approval of a site development plan will be required to address drainage on the entire site and meet storm drainage requirements as set forth in this chapter for the complete site. [15.40.1280.I]

701.1.2 Conformity to Previous Drainage Reports/Plans:

701.1.2.1 All proposed drainage systems shall conform to the City's Master Drainage Plan and to the approved drainage plans of adjacent developments up and downstream of the proposed project. If the proposed project is a part of a larger development for which a master drainage plan has been approved the proposed project shall conform to such master plan.

701.1.2.2 The applicant and their consultants shall review all previously approved drainage plans that impact the proposed project and shall acknowledge in their report/plans that, except as noted in their report/plans, they accept the assumptions/analysis/conclusions/recommendations of the prior report(s) and will use them as the basis for their report and design. [[15.32.050; 16.16.010]]

701.1.3 Offsite Drainage to be Considered:

701.1.3.1 The point or points at which a natural drainage way enters, flows through and leaves prior to development shall remain the same after the property

has been altered for the development unless the city engineer specifically approves rerouting of flows. Rainfall runoff from storms of all return frequencies should enter and depart from property after its development in substantially the same manner as under predevelopment conditions. [15.40.680; 15.40.1240.B; 15.40.680; 15.40.1290.B]

701.1.3.2 The construction of a channel crossing must not cause the diversion of drainage flows except when that diversion is part of an approved plan for modification of drainage patterns. [15.40.690]

701.1.3.3 If the storm runoff flows onto the property to be subdivided from adjacent properties, this must be included in detail in the report. Drainage area, calculated peak flows, and other pertinent runoff data must be presented. If the flow is in a defined channel, the channel must be improved to carry a one-hundred-year flow with a minimum freeboard of one foot. [15.40.1270.E]

701.1.3.4 If improvements in an adjacent subdivision have channeled runoff onto the developing property, this flow should be carried through the new subdivision. It will, however, be necessary to abide by all provisions in Section 15.40.1240. [15.40.1270.F]

701.1.4 Preservation of Natural Drainways

701.1.4.1 The applicant shall dedicate, either in fee or by drainage or conservation easement, land on both sides of existing watercourses to a distance to be determined by the city council. [16.16.300.D]

701.1.4.2 Low-lying lands along watercourses subject to flooding or overflowing during storm periods, whether or not included in areas for dedication, shall be preserved and retained in their natural state as drainage ways. A hydrology report and construction drawings which preserve the flow characteristics of the drainage way may allow construction within the low-lying land. [16.16.300.E]

701.1.5 Drainage – Streets

701.1.5.1 Storm drainage shall be accommodated in the streets, gutters or retention basins unless otherwise indicated by the city engineer. It is expected that streets will carry water from adjacent property and from local areas, but they are not to be used as major water carriers in lieu of natural washes or man-made channels. Streets may carry water from adjacent property and from local areas, but they are not to be used as major water carriers in lieu of natural washes or man-made channels. Street runoff may be allowed, at the discretion of the city engineer, in those circumstances where stormwater can be quickly conveyed to established drainage facilities. [15.40.700; 16.16.280.A; [15.40.1240.K; 15.40.700]

701.1.5.2 Subsurface drainage systems shall be discouraged, but where storm sewers are required, the cost shall be borne by the developer for storm sewers to a size of twenty-four inches; if over twenty-four inches in size and determined to be for benefit outside of the subdivision, the costs may be shared, as

determined by the city council, but only for that portion determined to be of benefit outside the subdivision. [16.16.280.A]

701.1.5.3 The design procedures and criteria to be used shall be in accordance with those prepared and published by the city. [15.40.710]

702 RETENTION/DETENTION

702.1 Retention Required

702.1.1 General. All water which falls within the development (including the respective one-half of all abutting streets to the development) from a one hundred-year storm of a one-hour duration (approximately 2.39 inches), as established by the Arizona Highway Department Hydrological Design and Revised Precipitation Maps, must be retained within the boundaries of the development unless street runoff is allowed. [15.40.1240.A; 15.40.1250.A]

702.1.2 Retention Required - Large Lot Single Family: On-lot retention is permissible only in single-family developments where each proposed residential lot contains not less than 1.25 net acres. Each proposed residential lot shall be depressed in the front yard, as defined in Chapter 17.12 of the city code, to contain the indicated design storm, including that of the proposed street runoff, unless approval for street runoff is approved by the city engineer. The deed of each lot shall have a restriction indicating on-lot retention shall be maintained in perpetuity. In addition, on-lot retention basins shall be shown as retention easements on the subdivision plat. [15.40.1240.E]

702.1.3 Retention Required - Commercial/industrial and single lot multifamily (duplex, triples, etc.) subdivisions may provide either community retention basins or on-site retention for each lot including street runoff. [15.40.1240.J]

702.1.4 Basin Drainage Easements - Retention basins shall be protected from further development by a recorded drainage easement and must be fully improved with landscaping, irrigation systems, lighting and such other aesthetic and recreational improvements as may be required by the city. [15.40.1240.D] Ownership of and operation and maintenance responsibilities for all basins shall remain with the property owner(s) unless specifically defined by the City as being otherwise. All drainage easements over retention basins shall grant the City, or it's designee(s), the right to enter easement for purposes of making periodic inspections and, when deemed necessary, to make repairs to the basin (cost of which shall be the responsibility of the basin owners(s) (see Section 702.1.5).

702.1.4.1 All provisions for stormwater retention and all retention requirements and retention basin capacity calculations shall comply with the regulations of the city storm drainage master plan and drainage policy, as it from time to time may be amended. [16.16.290.A]

702.1.4.2 Dedicated retention basins, when approved by the City Council, will be part of the city's park and open space system. Nondedicated retention basins shall be maintained by the owner. All nondedicated retention basin areas shall be designated as easement areas for retention purposes and shall have a recorded protective covenant requiring perpetual maintenance. [16.16.290.B]

702.1.4.3 Two or more developers may join together to provide a common retention facility. A letter of agreement signed by all developers participating in the common retention area must be presented to the city engineer, and the recorded plat shall indicate that the retention area is a joint facility. The joint recreation area must meet all criteria as a single area. [16.16.290.C]

702.1.5 Maintenance of Basins – It shall be the responsibility of the developer to establish a system acceptable to the city to provide perpetual operation, maintenance and replacement of all retention areas not dedicated to the city. This maintenance system may be the formation of a homeowner's association or some other type of financial guarantee acceptable to the city. [15.40.1240.D] It is unlawful for any person owning or controlling a retention basin to permit stormwater to stand therein longer than thirty-six hours. Upon failure of the developer/owner of the basin to properly maintain the basin such that stormwater remains in the basin greater that 36 hours the City may enter upon the property and take such actions as may necessary to ensure that the basins drains properly. Any costs associated with such work will be assessed to the owner of the basin. [Refer to Sections 15.40.1300 thru 15.40.1340 for further details.]

702.2 Retention Basin Design Criteria

702.2.1 Overflow and Ultimate Outfall: [15.32.050; 16.16.010]

702.2.1.1 The site shall be designed so that all runoff is routed to the site's *ultimate outlet(s) (the point(s) from which runoff exits the site).* [[15.32.050; 16.16.010]

702.2.1.2 Each basin shall be designed such that it has an overflow outlet capable of conveying the 100-year flow from the area directly tributary to the basin itself and to any basin that would, should they overflow, also flow into/through the basin in question. Any such overflows shall be directed to another basin or to the site's ultimate outfall. [15.32.050; 16.16.010]

702.2.1.3 The overflow outlet shall generally be an earthen swale (with appropriate landscaping) leading to the *ultimate outlet*, except that drives and roadways may, upon approval of the city engineer, be used as means of conveying overflows to the *ultimate outlet*. [15.32.050; 16.16.010] As roadways are not to be used as stormwater conveyance systems [15.40.700] the developer must indicate that there are no other reasonable means to route the overflow. See Section 703 for guidelines for design of stormwater conveyance systems.

702.2.1.4 The invert of the overflow channel shall coincide with the elevation of the maximum volume provided. The overflow channel shall be a minimum 1-foot deep and the maximum depth of flow shall be 0.5-feet. At least 0.5-foot freeboard shall be provided above the depth of the overflow channel.

702.2.1.5 First floor Elevations Tributary to Basins:

702.2.1.5.1 All buildings shall have first floors set at least 1-foot above the maximum freeboard elevation of the overflow outlet. [15.40.720, 15.40.730]

702.2.1.5.2 When in a development with multiple basins the outfall for each basin may be a grade break in the roadway or landscape system at an elevation higher than the top of the basin. In such cases the first floor elevations shall be set at the higher of the following:

702.2.1.5.2.1 The gutter elevation of the roadway/landscape grade break plus the depth of the flow over the grade break plus 0.5-feet, or;

702.2.1.5.2.2 The gutter elevation of the roadway/landscape grade break plus 1.0-feet.

702.2.2 Volume Required: [15.40.1290.A]

Each retention basin shall be sized as follows -

$Vr = [P*A*C_w] / 12$, where;
A = Area (square feet or acres)
V_r = Volume required to be retained (cubic feet or acre feet)
P = 100 year-one hour rainfall (inches) = 2.39
C_w = Weighted Runoff factor for tributary areas (multiple weighted factors may be required for multiple retention areas and/or special conditions as determined by the city engineer)

702.2.3 Runoff Factors [15.40.1290.A]

Runoff factors for the design of retention and, when approved for use by the city engineer, can be found in *Table 7.4: Runoff Coefficients*. Weighted runoff coefficients for lands within the proposed project shall established for each specific land use within the project. Calculations for weighted coefficients are to include the street section in front of the use. These weighted coefficients are to be for all drainage calculations for the project (retention and conveyance). The runoff coefficients for the *urban land uses* noted in Table 7.4 are only to be applied to when computing the weighted runoff factor for existing offsite sites areas or areas of future development.

702.2.4 Basin Geometric Design Criteria [15.40.1240]:

702.2.4.1 Maximum Depth:

Unless approved otherwise by the city engineer, all retention basins shall have a design capacity to preclude a water depth in excess of three feet resulting from a one-hundred-year, one-hour storm. The depth of retention shall be measured from nearest adjacent top of curb. Unless specially approved by the City Engineer otherwise, all retention basins shall have at least 1-foot of free board above the maximum water elevation. (See Section 702.2.1 for information on the design criteria of basin overflow systems.) [15.40.1240.C]

702.2.4.2 Side Slopes:

Side slopes shall conform to the following slope-depth ratio:

BASIN DEPTH (measured from top)	**STEEPEST SLOPE** (horizontal : vertical)
First 3 feet	4:1
From 3 to 6 feet	8:1
Freeboard area	6:1

Exceptions to minimum slope requirements will be considered by the city engineer, when innovative and aesthetically pleasing design features are presented and public safety is not compromised. [15.40.1240]

702.2.4.3 Retention within Road Right-of-Way:

Except when authorized by the city engineer, retention of stormwater within road rights-of-way is prohibited. The city engineer will consider the use of the road rights-of-way upon the determination that no additional rights-of-way will be required in the area(s) under consideration and that allowing the joint use of the right-of-way will not have an adverse impact on the operation, by the city or other utility providers, of any current or proposed utilities in or planned for the area. The city engineer will also consider the potential impact of the proposal on public safety. Under no circumstances will retention be allowed within the right-of way either of arterial streets or of major collector streets. When approved by the city engineer, the right-of-way area from one foot in back of sidewalk may be used for the retention basin [15.40.1240.C]. The maximum basin depth below the adjoining curb or sidewalk within any right-of-way shall not exceed 1-foot. [15.32.050; 16.16.010]

702.2.4.4 Commercial/Industrial Sites:

Commercial/industrial sites may retain a maximum of fifty percent of the required volume on asphalt, concrete or other hard surface, except in special

situations, and with permission of the city engineer. The maximum depth of water on said hard surface shall not exceed 8” (0.67’). [15.40.1250]

702.2.4.5 Lakes or ponds:

When used for stormwater collection lakes or ponds will be required to meet all retention basin requirements specified herein except for the water depth, drainage time and side slopes below the normal water level. [15.40.1240.I]

702.2.4.6 Offsite Drainage: thru Onsite Basins

No offsite flows greater than 3-cfs shall be routed through an on-site basin. [15.32.050; 16.16.010]

702.2.5 Draining of Basins

702.2.5.1 Draining Retention Basins:

702.2.5.1.1 In no event shall stormwater stand in the retention basins longer than thirty-six hours. [15.40.1240.A; 15.40.1300]

702.2.5.1.2 Small/Shallow Basins: Upon the approval of the City Engineer, basins with:

702.2.5.1.2.1 a depth of water less than 1-foot AND

702.2.5.1.2.2 a required volume of less than 1 AC-FT may be drained by direct percolation into the basin’s soil.

702.2.5.1.2.3 Approval will only be considered when the applicant has demonstrated, to the satisfaction of the city engineer via percolation test results, that the soils at the elevation of the basin bottom have adequate permeability to drain the basin within the prescribed 36-hours.

702.2.5.1.2.4 Soils percolation data shall be provided by a licensed geotechnical engineer.

702.2.5.1.2.5 For maximum design percolation shall not exceed 50% of the field measure rates.

702.2.5.1.2.6 Such test results must be accepted by the city engineer prior to approval of drainage plans.

702.2.5.1.2.7 Percolation tests may be required to be re-verified after construction of the site has been completed. [15.32.050; 16.16.010]

702.2.5.1.3 Basins with a depth of water greater than 1-foot and/or a required volume of 1 AC-FT or more shall have a positive means of dewatering within the 36 hour time frame:

702.2.5.1.3.1 Where possible, basins may be drained by pumping or controlled gravity flow into existing storm drainage lines or irrigation ditches, or streets when approved by the city engineer.

- In order for the city engineer to consider the use of existing drainage lines (pipes and/or channels) the developer shall provide the city engineer verification satisfactory to the city engineer, that the receiving drainage lines have capacity from the point of discharge to the ultimate outfall (generally the either the North Branch or the Main Branch of the Santa Cruz Wash).

- In order for the city engineer to consider the use of irrigation lines the developer shall provide the city engineer written approval from the appropriate irrigation district of their willingness and ability to accept the proposed retention basin discharge. [15.32.050; 16.16.010]

702.2.5.1.3.2 Dry wells are permitted to drain surface retention areas only when no other means of disposal is available. When the use of drywells are approved, percolation tests shall be performed in retention areas to determine natural percolation. Such test results shall be submitted to the city engineer prior to approval of drainage plans. [15.40.1290.C]

702.2.5.1.3.3 Infiltration into the dry well cannot be considered to reduce the size of the retention area. [15.40.1290.C]

702.2.5.1.3.4 Number of Drywells Required:

- When drywells are approved by the city engineer for stormwater disposal, the maximum volume of water that can considered as disposed per drywell for design purposes shall not exceed 12,600 CF (0.1 cfs for 36 hours). [15.32.050; 16.16.010; FCDMC]

- The estimated number of basins, for design purposes, is to be determined by dividing the required volume by 12,600. Plans should reflect that number of drywell. [15.32.050; 16.16.010]

- During construction the actual number of drywells may be adjusted upwards or downwards based on field testing of an installed drywell. At least one drywell will be tested for actual infiltration rates. [15.32.050; 16.16.010]

- If test results of the installed drywell indicates a higher rate is possible, a request may be made to the City Engineer to reduce the number of basins required. The maximum rate allowed for determining the number of basins shall not exceed 50% of the measured flow (provides for degradation of perform as the well matures and the soil pores become clogged with fine particles. Generally the city engineer will approve a reduction in the number of drywell if supported by field data. In like manner the number of drywells may need to be increased if the observed infiltration rates do not equal the anticipated design rates. [15.32.050; 16.16.010]

702.2.5.1.3.5 The developer shall be responsible for the design, performance, operation or maintenance of dry wells used with on-site retention. A percolation test must be carried out on the dry well before acceptance. The percolation test results are to be filed with the city engineer. [15.40.1290.C]

702.2.5.1.4 After completion of site construction the developer shall: [15.32.050; 16.16.010]

702.2.5.1.4.1 Prior to the installation any landscape improvements in the basin, the developer shall scarify the bottom of the basin.

702.2.5.1.4.2 During installation of the landscaping the developer shall not over compact the basin bottom.

702.2.5.1.4.3 Install appropriate soils erosion protection at all inlet points and around all drywells, if permitted, and other areas as necessary to protect the dewatering properties of the basin.

702.2.5.2 Detention Basins:

702.2.5.2.1 Detention basins are facilities intended to temporarily hold stormwater runoff and then discharge the stored stormwater back into the drainage conveyance system.

702.2.5.2.2 Retention basins permanently remove a specified volume of stormwater from the conveyance system.

702.2.5.2.3 Generally the City of Casa Grande prefers the use of retention basins and detention basins shall only be used upon the approval of the City Engineer and only when in the opinion of the City Engineer not doing so will result in an adverse impact to the proposed project. [15.32.050; 16.16.010]

702.2.5.2.4 When allowed, detention facilities shall be designed such that the post development flows shall not exceed the predevelopment flows from the proposed project area.

703 STORMWATER CONVEYANCE SYSTEMS

703.1 Hydrology

703.1.1 General

703.1.1.1 Hydrology calculations are necessary in the design of storm drainage facilities; when properly designed insure that surrounding structures and properties are safeguarded against storm waters due to the proposed development. Standards contained in this section of the design manual for Storm Drainage System Design are in accordance with the *Maricopa County Drainage Policies 2007* and *Drainage Design Manual for Maricopa County, Arizona, Volume I Hydrology 1995*, and is to be followed to provide design criteria necessary for engineers relating to hydrology, except where amended herein.

703.1.1.2 For watersheds (on and/or off site) that are less than 160 acres tributary to the design point(s), the design engineer shall perform their hydrologic calculations using the Rational Method to estimate runoff. For watersheds (on and/or off site) greater than 160 acres tributary to the design point(s) the design engineer shall perform their hydrologic calculations using a rainfall runoff model. Generally HEC-1, HEC-HMS, or DDMSW (FCDMC) are to be used. Alternative methods of a similar nature may be used when approved by the City Engineer.

703.1.2 Storm drainage systems within the City shall be developed within two classifications as follows:

703.1.2.1 Minor System: The runoff generated from the 10 year storm shall consist of “Minor System” storm water facilities necessary to collect and convey storm water runoff for more frequent rainfalls. The “Minor System” shall be designed to accommodate storms up to and including a ten year storm as defined in Section 1.2.

703.1.2.2 Major System: The runoff generated from the 100 year storm shall consist of “Major System” storm water facilities necessary to collect, convey, retain, and/or detain storm water runoff for less frequent rainfalls. The “Major System” shall be designed to accommodate storms up to and including a one hundred year storm as defined in Section 1.2. Design of the “Major System” includes the analysis of the overall drainage system insuring that there will always have positive drainage of the one hundred year flows, which can be retained or detained, and that all structures are above the WS100 elevation.

703.1.3 The design engineer may use more recent rainfall data from NOAA Atlas 14 Volume 1, Semi-arid Southwest study, relating to rainfall depths and intensities within the City of Casa Grande boundaries for hydrology
and hydraulic calculations.

703.2 Hydrologic Calculations

703.2.1 Watersheds 160 Acres or Less – Rational Method

703.2.1.1 Rational Method Runoff Equation:
Q = C*I*A
Q = the peak discharge (cubic feet per second) from a given area.
C = a coefficient relating the runoff to rainfall. (Table B3.1 or B3.2)
I = average rainfall intensity (inches/hour), lasting for a TC.
T_C = the time of concentration (hours).
A = drainage area (acres).

703.2.1.2 Time of Concentration: iterative process that calculates the interval of time from the beginning of the rainfall event of a specific drainage area; from the most hydraulically remote point to reach the point of concentration.

Time of Concentration (TC) is calculated by utilizing the formula developed by Papadakis & Kazan (1987):

T_C=11.4L0.5 * Kb0.52 * S-0.31 * I-0.38
T_C = time of concentration in hours
L = length of the longest flow path in miles
K_b = watershed resistance coefficient
S = watercourse slope in feet/mile
I = rainfall intensity in inches/hour

Engineers shall utilize Table 3.1, Figure 3.1, and Equation 3.3 of the Drainage Design Manual for Maricopa County Volume I Hydrology to estimate the resistance coefficient (K_b) and the adjusted Intensity for the T_C equation.

703.2.1.3 Time of concentration shall not be less than:

1) Ten (10) minutes for Residential developments
2) Five (5) minutes for Commercial developments

703.2.1.4 Runoff Coefficients:

Use the runoff coefficients found in Table 7.4. Also see section 702.2.3 Runoff Factors .

The weighted runoff coefficient will be estimated by:

$$Cw = \frac{A_1C_1+A_2C_2+\ldots +A_nC_n}{A_1+A_2+\ldots +A_n}$$

Where:

Cw = Weighted *C*
Cn = Runoff coefficient for sub-area "n",
A = Area for sub-area "n"

703.2.2 Watersheds Greater than 160 Acres - Rainfall Runoff Models

703.2.2.1 For watersheds (on and/or off site) greater than 160 acres (tributary to the design point(s))the design engineer shall perform their hydrologic calculations using HEC-1, HEC-HMS or, DDMSW (FCDMC). Alternative methods of a similar nature may be used when approved by the City Engineer.

703.2.2.2 Rainfall values shall be determined as follows:

703.2.2.2.1 Drainage areas less than 20 square miles: X-yr 6-hour storm

703.2.2.2.2 Drainage areas between 20 and 100 square miles: X-yr 6-hour and X-yr 24-hour storm

703.2.2.2.3 Drainage areas greater than 100 square miles: X-yr 24-hour storm

703.2.2.3 Rainfall Loss Rates:

Green & Ampt
Initial & Uniform

703.2.2.4 Time of Concentration: (per Chapter XX Drainage Design Manual for Maricopa County Volume I Hydrology)

703.2.2.5 Unit Hydrograph: Clark

703.2.2.6 Channel Routing:

703.2.2.6.1 Normal Depth: Kinematic wave within curb and gutter street sections may be used.

703.2.2.7 Storage Routing: Use of low-level outlet option (SL Record) only allowed if outlet-rating curve is substantiated by an external calculation.

703.2.2.8 Transmission Losses: Will only be considered for large watercourses with data substantiating the transmission loss. (e.g. stream gauge data, or other scientific instrumentation).

703.3 Rainfall Runoff Modeling (HEC-1 or HEC-HMS)

The City of Casa Grande encourages the use of a rainfall runoff model that provides estimates of peak rate of flow, volumes, and runoff hydrographs. The preferred modeling tools are the U.S. Army Corps of Engineers' hydrology models HEC-1 or HEC-HMS.

Other hydrologic models will be considered on a case-by-case basis by the City Engineer. Designers are encouraged to seek approval of these alternative methods before initiating design work. Full support documentation will be required for approval prior to gaining the City Engineer's approval.

Input data and parameters, and results must be clearly and concisely annotated on printout sheets attached to the drainage report. The methodology listed in the Highway Drainage Design Chapter–Hydrology Report Number FHWA-AZ93-281 is acceptable.

703.3.1 Strom Drainage Design for Streets

703.3.1.1 Flow of the stormwater shall always be confined to the road right-of-way or to drainage easements. [**15.40.700]**

703.3.1.2 Curbed streets shall be designed and constructed to carry the stormwater runoff from a ten-year storm between curbs. [15.40.1240.F]

703.3.1.3 The maximum depth for water flowing in any street shall be eight inches during the peak runoff from a one-hundred year frequency storm. The above requirements imply that in some cases water may flow deeper than normal vertical curb height and may flow for a short distance over a sidewalk or other back-of-curb areas. [**15.40.700]**

703.3.1.4 Catch basins, scuppers, or similar facilities, together with the necessary channels, must be provided at appropriate locations to remove water flowing in the streets so as not to exceed the above described depth limits. [**15.40.700]**

703.3.1.5 Particular care must be taken in street sag locations to ensure that these requirements are met. [**15.40.700]**

703.3.1.6 All storm drain pipe installed in alleys or streets shall be constructed of rubber gasket reinforced concrete pipe capable of withstanding H-22 highway loads or an alternate as approved by the city engineer. [15.40.1240.H]

703.3.1.7 Flows local streets across any parkway, arterial, or collector streets are not allowed for the 10 year frequency storm flows. However, cross street flows are acceptable on local streets and shall be limited 8.0 inches in depth ().

703.3.1.8 Inverted crowns within public streets and roads are not allowed.

703.3.1.9 Street drainage design shall not increase runoff onto adjacent properties. Parkway, Arterial, and Collector streets shall not direct surface runoff onto local roadways.

703.3.1.10 Acceptable street drainage facilities includes but are not limited to:

703.3.1.10.1 Curb opening catch basin constructed to MAG standard details or approved alternatives.

703.3.1.10.2 Grated inlets within the public rights of way require approval of the Public Works Department and shall be constructed in accordance to MAG standard construction detail 537. All grates must be rated H-20 traffic loading and for bicycle traffic.

703.3.1.10.3 Under sidewalk scupper constructed to MAG standard details or approved alternatives.

703.3.1.10.4 Curbs constructed to MAG standard detail 220 or approved alternatives.

703.3.1.10.5 Outflow pipe head walls with handrails constructed to MAG standard detail 501-3 or approved alternatives.

703.3.1.10.6 Culverts constructed to ADOT Highways Division Structures Section "B" standard details (31-002; June 1992).

703.3.1.11 Street drainage calculations:

703.3.1.11.1 Calculate street/gutter flow and velocity by using the modified Manning's equation in Section 3 of the Drainage Manual for Maricopa County, Volume II Hydraulics.

703.3.1.11.2 Calculate catch basin and scupper sizes according to Section 3 of the Drainage Manual for Maricopa County, Volume II Hydraulics, and/or FHWA HEC-12 or HEC-22.

703.4 Channels

703.4.1 Where the capacity of the street section has been exceeded the stormwater shall be diverted to a drainage channel that shall then route the runoff to either a retention basin or to the ultimate outlet for the drainage area or the project site. [15.32.050; 16.16.010]

703.4.2 In general drainage channels shall be constructed of natural materials and shall be integrated into the design of the projects. .[16.16.300.A]

703.4.3 If improvements in an adjacent subdivision have channeled runoff onto the developing property, this flow should be carried through the new development. [15.40.1270.F]

703.4.4 Channels shall be designed with adequate width and depth for maximum potential volume of flow. [16.16.300.A]

703.4.5 The maximum depth of flow in a channel shall not exceed 3-feet and at least 1-foot of freeboard shall be provided to all channels. [15.32.050; 16.16.010] [15.40.1270.E]

703.4.6 If the *upstream offsite* flow is in a defined channel, the channel must be improved to carry a one- hundred-year flow with a minimum freeboard of one foot. [15.40.1270.E]

703.4.7 Channels shall be designed so as to avoid erosion of the soils. The applicant shall provide information, prepared by a licensed geotechnical engineer, of the maximum

allowable velocity that can occur without the initiation of erosion in the channel(s). Drop structures shall be added as necessary to achieve the slopes required to maintain permissible velocities. [15.32.050; 16.16.010]

703.5 Street crossing at channel requirements.

703.5.1 The crossing structure requirements listed below will normally apply; however, the engineer may depart from these requirements if he can demonstrate to the floodplain administrator's satisfaction that they are inappropriate because of the type of development or the nature of the terrain or natural area development requirements would be violated. In extreme cases, it may be necessary to allow for the entire channel flow to pass over the road. [**15.40.690.A]**

703.5.2 Local and minor collector streets shall have a culvert or bridge which is capable of carrying all of the park flow of runoff from a two-year frequency storm beneath the roadway and which is also capable of carrying enough of the peak flow of runoff from a ten-year frequency storm beneath the roads so that the portion of the flow over the road is no more than six inches deep. [**15.40.690.A.1]**

703.5.3 Major collector and major or minor arterial streets shall have a culvert or bridge which is capable of carrying all of the peak flow of runoff from a ten-year frequency storm beneath the roadway and which is also capable of carrying enough of the peak flow of runoff from a twenty-five-year frequency storm so that the portion of the flow over the road is no more than six inches deep. [**15.40.690.A.2]**

703.5.4 Watercourse crossings for roads shall be designed so that all lots and structures within a development will be accessible from the boundary of that development by at least one route during the period of peak flow by runoff from a one-hundred-year frequency storm. The boundary shall include any adjacent street or streets. Accessibility will be considered to exist if it can be demonstrated by the engineer that at the time of the peak flow the depth of flow over the road will be no greater than one foot. [**15.40.690.A.3]**

703.5.5 Regardless of the size of the culvert or bridge, the street crossing should be designed to convey the one-hundred-year storm runoff flow under and/or over the road to the area downstream of the crossing to which the flow would have gone in the absence of the street crossing. The construction of a channel crossing must not cause the diversion of drainage flows except when that diversion is part of an approved plan for modification of drainage patterns. [**15.40.690.B]**

703.6 Drainage Easements

703.6.1 Dedication of drainage easements—Requirements.

703.6.1.1 Where a subdivision is traversed by a watercourse, drainageway, channel, or stream, a stormwater easement or drainage right-of-way shall be provided conforming substantially to the lines of the watercourse, and of the width and construction, or both, as will be adequate for the purpose. Whenever possible, it is desirable that the drainage be maintained by an open channel with landscaped banks and adequate width for maximum potential volume of flow.[16.16.300.A]

703.6.1.2 Where topography or other conditions are such as to make impractical the inclusion of drainage facilities within road rights-of-way, perpetual, unobstructed easements of at least fifteen feet in width for such drainage facilities shall be provided across property outside the road lines and with satisfactory access to the road. Easements shall be indicated on the plat. Drainage easements shall be carried from the road to a natural watercourse or to other drainage facilities. [16.16.300.B]

703.6.1.3 When a proposed drainage system will carry water across private land outside the subdivision, appropriate drainage rights must be secured and indicated on the plat. [16.16.300.C]

704 DRAINAGE REPORTS

704.1 A drainage report shall be submitted by an applicant requesting one of the following:

704.1.1 Approval of a subdivision plat or a horizontal regime;

704.1.2 A permit for grading, unless the requirement is waived by the floodplain administrator;

704.1.3 A permit to construct right-of-way improvements;

704.1.4 A permit to construct any structure. [15.40.670 Development permit application—Drainage reports required.]

704.2 When a drainage report is required, it must be prepared and sealed by a civil engineer registered as a professional engineer in the state of Arizona, and it must be prepared in accordance with the criteria established by the city. [15.40.670 Development permit application—Drainage reports required.]

704.3 The purpose of the report is to analyze the effect that a proposed development would have upon the rainfall runoff in the vicinity of the development, to provide data to ensure that the development is designed to be protected from flooding, and to provide data supporting the design of facilities to be constructed for the management of rainfall runoff.

704.4 Each drainage report must consider rainfall runoff from storms with a return frequency up to and including a one hundred-year storm. The complexity of the report depends upon the nature of the development and the site on which the development will occur. [15.40.670 Development permit application—Drainage reports required.]

704.5 A conceptual stormwater collection and retention plan shall be submitted with a preliminary plat or site development plan and approved prior to the approval of the plat or plan. **15.40.1230 Conceptual drainage plan]**

704.6 In the design of the development, every effort shall be made to utilize the natural slope of the land for the stormwater collection system.

704.6.1 The plan shall include but not be limited to the following:

704.6.1.1 Method of collection (surface and/or subsurface);

704.6.1.2 Depth, side slopes and area of retention;

704.6.1.3 Calculations of volume held and required;

704.6.1.4 High water elevation and invert of pipes;

704.6.1.5 Method of disposal of water within thirty-six hours;

704.6.1.6 Areas tributary to each retention basin;

704.6.1.7 Any other data to form a complete plan.

704.6.2 Detailed street flow calculations are to be made a part of the report. Where the flows exceed the street capacities, pipe flow calculations and sizing data shall be included. [15.40.1270.C]

705 Residential Projects Preliminary Hydrology Reports [15.40.1260]

705.1 A preliminary drainage report must be presented with the application for subdivision review. No review will be scheduled until this report is obtained.

705.2 A preliminary report shall discuss the general storm drainage problem and state the method of resolution proposed. Any obvious drainage problems such as existing waste ditches, natural drainage channels, runoff from existing adjacent subdivision, etc. must be discussed in detail.

705.3 If lot runoff will be retained on the lot, a sample plot plan must be included.

705.4 A preliminary retention basin design must be presented. This should include the size and depth of the basin and possible methods of draining it.

705.5 All calculations must be made a part of the report.

706 Residential Projects Final Drainage Report [15.40.1270]

706.1 A reduced (eight and one-half inches by eleven inches) copy of the subdivision plat must be included in the report. Drainage areas and peak street flows are to be shown on this plat as well as the location for the retention basin.

706.2 Detailed street flow calculations are to be made a part of the report. Where the flows exceed the street capacities, pipe flow calculations and sizing data shall be included.

706.3 Detailed drawings of the retention basin, inlet structures, outlet structures, etc. shall be submitted with the report.

706.4 If the storm runoff flows onto the property to be subdivided from adjacent properties, this must be included in detail in the report. Drainage area, calculated peak flows, and other pertinent runoff data must be presented. If the flow is in a defined channel, the channel must be improved to carry a one-hundred year flow with a minimum freeboard of one foot.

706.5 If improvements in an adjacent subdivision have channeled runoff onto the developing property, this flow should be carried through the new subdivision.

707 Commercial/Industrial Projects Drainage Report [15.40.1280]

707.1 Show all proposed buildings, asphalt areas, grass areas, concrete or desert landscape, and dimensions of same;

707.2 Show existing grades by a grid method or contour lines, especially at property lines and back of sidewalks;

707.3 Establish a bench mark (BM) of known or assumed elevation to which every other elevation is referenced;

707.4 Indicate direction that roof will drain and the finished floor elevation of all buildings;

707.5 Show enough finished grades that drainage direction of asphalt areas, etc., are clearly evident - how this direction with arrows. Show the finished grade of all parking and landscaped areas;

707.6 Show all items of construction that will affect drainage and retention;

707.7 Divide the lot into drainage areas and calculate runoff for each area;

707.8 Calculate the retention volume provided for each area. See Section 15.40.1290 for calculations of runoff and retention volume.

707.9 Changes or additions to sites which require approval of a site development plan will be required to address drainage on the entire site and meet storm drainage requirements as set forth in this chapter for the complete site.

1. **Table 7.1: Hydrology Design Criteria**

Approach	***Parameter***	***Method***	***Comment***
Rational Equation	Rainfall, Time of Concentration (TC), C value	Refer to ADOT Hydrology Chapter 2 for further details and clarification	ADOT Chapter 2 The Rational Equation is limited to drainage areas of no larger than 160 acres. City of Casa Grande is in ADOT Zone 8.
Rainfall Runoff Model (HEC-1/HEC-HMS)	Rainfall	X-yr, 6-hr Local Storm X-yr, 6-hr local storm and 24-hr general storm should be modeled. X-yr, 24-hr storm	Local storm used on watersheds smaller than 20 square miles. General storm used on watersheds between 20-100 square miles in size. For watersheds of 10-20 square miles, compare 6-hour and 24-hour results to ADOT Regression Curves. For watersheds of more than 100 square miles.
	Loss Rate	Green & Ampt Initial & Uniform	ADOT Chapter 3
	Time of Concentration	ADOT	ADOT 4-1,4-2,4-3
	Unit Hydrograph	Clark	ADOT Section 4.2.1
	Channel Routing	Normal Depth	ADOT Chapter 5. Kinematic wave within curb and gutter street sections may be used. Other routing methods will be considered by the City Engineer.
	Storage Routing	Handled in HEC Model	ADOT Chapter 6. Use of low-level outlet option (SL Record) only allowed if outlet-rating curve is substantiated by an external calculation.
	Transmission Losses	NA	Will only be considered for large watercourses with data substantiating the transmission loss. (e.g. stream gauge data, or other scientific instrumentation).

Table 7.2: Localized Intensity-Depth-Frequency (I-D-F)

Duration (minutes)	Frequency						
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr
5 min	4.32	5.28	6.00	6.96	7.80	8.64	10.44
10 min	3.24	4.02	4.56	5.34	6.00	6.60	8.04
15 min	2.60	3.32	3.84	4.52	5.08	5.64	6.92
30 min	1.72	2.22	2.58	3.06	3.44	3.82	4.70
1-Hr	1.05	1.37	1.60	1.91	2.15	2.39	2.95

Table 7.3: Rainfall Data for Casa Grande

Duration	Frequency						
	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	500-Yr
5 min	0.36	0.44	0.50	0.58	0.65	0.72	0.87
10 min	0.54	0.67	0.76	0.89	1.00	1.10	1.34
15 min	0.65	0.83	0.96	1.13	1.27	1.41	1.73
30 min	0.86	1.11	1.29	1.53	1.72	1.91	2.35
1-Hr	1.05	1.37	1.60	1.91	2.15	2.39	2.95
2-Hr	1.14	1.53	1.79	2.16	2.45	2.74	3.39
3-Hr	1.19	1.63	1.92	2.33	2.65	2.97	3.69
6-Hr	1.30	1.82	2.17	2.66	3.03	3.40	4.26
12-Hr	1.40	2.06	2.49	3.09	3.54	4.00	5.05
24-Hr	1.50	2.29	2.81	3.52	4.06	4.60	5.85

Table 7.4: Runoff Coefficients[1,2]

Land Use Category	2-10 Year		25 Year		50 Year		100 Year	
	Min	Max	Min	Max	Min	Max	Min	Max
Very low Density Residential [3]	0.33	0.42	0.36	0.46	0.40	0.50	0.41	0.53
Low Density Residential[3] (CCG: 0.45)	0.42	0.48	0.46	0.53	0.50	0.58	0.53	0.60
Medium Density Residential[3] (CCG: 0.50)	0.48	0.65	0.53	0.72	0.58	0.78	0.60	0.82
Multiple Family Residential[3] (CCG: 0.50 > 0.60)	0.65	0.75	0.72	0.83	0.78	0.90	0.82	0.94
Industrial 1[3] (CCG: 0.80)	0.60	0.70	0.66	0.77	0.72	0.84	0.75	0.88
Industrial 2[3]	0.70	0.80	0.77	0.88	0.84	0.95	0.88	0.95
Commercial 1[3] (CCG: 0.80)	0.55	0.65	0.61	0.72	0.66	0.78	0.69	0.81
Commercial 2[3]	0.75	0.85	0.83	0.94	0.90	0.95	0.94	0.95
Pavement and Rooftops (CCG: 0.95)	0.75	0.85	0.83	0.94	0.90	0.95	0.94	0.95
Gravel Roadways and Shoulders	0.60	0.70	0.66	0.77	0.72	0.84	0.75	0.88
Agricultural (CCG: 0.10)	0.10	0.20	0.11	0.22	0.12	0.24	0.13	0.25
Lawns/Parks/Cemeteries (CCG: 0.20 > 0.35)	0.10	0.25	0.11	0.28	0.12	0.30	0.13	0.31
Desert Landscaping 1 (CCG: 0.70)	0.55	0.85	0.61	0.94	0.66	0.95	0.69	0.95
Desert Landscaping 2	0.30	0.40	0.33	0.44	0.36	0.48	0.38	0.50
Undeveloped Desert Rangeland (CCG: 0.25)	0.30	0.40	0.33	0.44	0.36	0.48	0.38	0.50
Hillslopes, Sonoran Desert	0.40	0.55	0.44	0.61	0.48	0.66	0.50	0.69
Mountain Terrain	0.60	0.80	0.66	0.88	0.72	0.95	0.75	0.95
CCG: Bare Ground (Vacant Lots) (CCG: 0.40)								

[1] Runoff coefficients for 25, 50, and 100-year storm frequencies were derived using adjustment factors of 1.10, 1.20 and 1.25, respectively, applied to the 2-10 year values with an upper limit of 0.95.

[2] The ranges of runoff coefficients shown for urban land uses were derived from lot coverage standards specified in the zoning ordinances for Maricopa & Pinal Counties.

[3] Runoff coefficients for urban land uses are for lot coverage only and do not include the adjacent street and right of way, or alleys.