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**Town of Cave Creek
Technical Design Guidelines - Grading and Drainage**





SECTION 1 - INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide guidance on grading and drainage issues and design for development within the Town of Cave Creek ("TOCC"). The main objectives of the manual are to:

- ✓ Provide guidelines that reflect the requirements of the Town ordinances, as well as other applicable County, State or Federal regulations.
- ✓ Provide guidelines on the use, availability and appropriateness of data.
- ✓ Provide guidelines on the recommended hydrologic and hydraulic methodologies and the preparation of the drainage reports.
- ✓ Provide assistance in the prediction of runoff which might result from a designated storm of a given time interval.
- ✓ Provide guidelines related to land development issues such as floodplain management, watercourse sedimentation and lateral movement, and stormwater management.

1.2 GENERAL INFORMATION

This document should be used in conjunction with the most recently adopted Ordinances, Plans and Guidelines as listed below:

- TOCC Zoning and Subdivision Ordinances
- TOCC General Plan
- TOCC Infrastructure Improvements Plan
- TOCC Technical Design Guideline No. 2 – Transportation
- TOCC Technical Design Guideline No. 3 – Utilities
- TOCC Technical Design Guideline No. 4 – Landscaping
- TOCC Technical Design Guideline No. 5 - Trails
- Maricopa Association of Governments (MAG) Standard Specifications and Details
- The latest versions of the Drainage Design Manual for Maricopa County, Arizona, Volume I-Hydrology, Volume-II Hydraulics, and Volume III-Erosion Control, as distributed by the Flood Control District of Maricopa County (FCDMC)



- Erosion Hazard Zone Delineation and Development Guidelines for Maricopa County (EHZ Guidelines).
- State Standard Attachment SSA5-96; Watercourse System Sediment Balance

The Drainage Design Manual for Maricopa County, Arizona, Volume I - Hydrology (County Hydrology Manual) and Volume II – Hydraulics (County Hydraulics Manual), and the EHZ Guidelines are adopted by the Town as a basis for drainage and sedimentation design guidance and criteria, except as amended herein.

Accordingly, wherever details presented herein differ from the County Hydrology and Hydraulics Manuals and/or the EHZ Guidelines, the more restrictive shall take precedent.

1.3 DISCLAIMER

Drainage reports and construction plans for development and/or improvement of properties within the Town of Cave Creek are reviewed and approved by the Town for general conformance with the Town's Ordinances, policies and standards. The Town does not, however, assume responsibility or liability for insufficient design and/or improper construction. Review and approval by the Town does not absolve the owner, developer, design engineer, or contractor of liability for inadequate design or poor construction. The design engineer has the responsibility to design graded improvements and drainage facilities that meet the standards of practice for the industry and promote public safety. Compliance with the regulatory elements, policies, and design standards documented herein, does not imply a guarantee that properties will be free from flood, geologic, and geotechnical related damage and failures. The Town and its officials, employees, and contract reviewers, assume no liability for information, data, or conclusions prepared by private engineers and makes no warranty expressed or implied in its review/approval of grading and drainage projects.

The data and information provided herein are offered as guidelines to development regarding grading and drainage design. With the exception of requirements mandated by Town Codes and Ordinances, all guidelines provided are subject to change or variation at the discretion of the Town Engineer and/or Town Manager.



1.4 DEFINITIONS

10-YEAR FLOOD: A flood with a ten percent chance of being equaled or exceeded in any given year.

50-YEAR FLOOD: A flood that has a two percent (2%) statistical probability of being equaled or exceeded during any year.

100-YEAR FLOOD: A flood with a one percent chance of being equaled or exceeded in any given year. This flood is also referred to as a base flood or regulatory flood.

ACCESS ROAD: A road within one mile of the grading site, designed on the approved grading plan, and used, during grading, for the transport of grading equipment, hauling of fill and other equivalent vehicular traffic to and from the grading site.

ADJACENT GRADE: The elevation of the ground, sidewalk, patio, deck support, or basement entryway immediately next to the structure.

APPROVAL: Written notice by the Town of Cave Creek staff approving the design, progress or completion of work. A copy of which will be filed in the office of the Town Building Official.

APPROVED PLAN: The most current grading plan which bears the authorized signature of approval of the Town of Cave Creek staff.

BALANCED BASIN/WATERSHED: A drainage basin or watershed which contains floodwater channels, natural or man-made, and/or flood control structures that are adequate to contain existing runoff from the base flood produced by the basin or watershed; but in which additional runoff cannot be safely contained by said channels or structures.

BASE FLOOD ELEVATION: The calculated water-surface elevation of the base flood.

BASE FLOOD: The base flood (Q100) shall mean the peak discharge of a 100-year flood. The base flood has a one percent probability of being equaled or exceeded in any given year.

BEDROCK: The solid, undisturbed bedrock in place either at the ground surface or beneath surficial deposits of gravel, sand or soil.

BORROW: Earth material acquired from an offsite location for use in grading on a site.

BRUSHING: The selective removal of vegetation from proposed development site or other piece of property.

BUILDING OFFICIAL: The Building Official of the Town of Cave Creek.



CLEARING OR GRUBBING: Removal, relocation or demolition of any plant, bush, tree, cacti, earth or rock from a property as preparation for subsequent development and construction.

COMPACTION: The process whereby the in-place density of any earth material is increased by mechanical equipment, hydraulic means or other approved method.

CRITICAL BASIN/WATERSHED: A drainage basin or watershed which contains natural or man-made floodwater channels and/or flood control structures that cannot contain existing runoff produced by the base flood within the basin or watershed, and which has a documented history of severe flooding hazards.

DETENTION SYSTEM (STORMWATER): A system which attenuates runoff in a controlled manner through the use of temporary storage facilities and an outlet structures.

DEVELOPMENT: Any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, fencing, excavating or drilling.

DRAINAGE BASIN: The limits of a geographic area that in its total drains to a single point of concentration, expressed in units of area. Also called catchment area, watershed, and river basin.

DRAINAGE: Runoff which flows above the ground surface as a result of precipitation events.

DRYWELL: A well constructed in such a manner as to augment natural percolation by allowing retained surface water to be directly introduced into an underlying porous stratum.

DWELLING UNIT: Any building or portion thereof which contains living facilities, including provisions for sleeping, eating, cooking and sanitation, as required by this ordinance, for not more than one (1) family, or a congregate residence for six (6) or fewer individuals.

EARTH MATERIAL: Any rock, natural soil or fill, and/or any combination thereof.

ENCROACHMENT (FLOODPLAIN): Encroachment is the advancement or infringement of uses, fill, or structures into any floodplain in a manner that impedes the flow capacity of the watercourse. An equal degree of encroachment is a standard applied to the evaluation of the effects of encroachment by measuring/estimating increases in flood heights. It assumes that an encroachment, if permitted, may confer on all property owners on both sides of the watercourse an equal right to encroach to the same degree within that reach. Since the factors affecting hydraulic efficiency are usually not uniform within a reach, this standard will usually not result in equal measured distances between floodway limit lines and the regulatory flood plain boundaries of the watercourse.



ENGINEERING PLANS: Plans, profiles, cross-sections, and other required details for the construction of improvements which shall be prepared and bear the seal of a professional engineer, currently registered in the State of Arizona under the appropriate discipline for the type of project which has been designed.

ENVELOPE, BUILDING: For residential application, a building envelope shall be considered to include a dwelling unit and all attached roofed structures including carports, covered patios, or armadas. For non-residential development, the building envelope shall be the main building and all attached roofed structures.

ENVELOPE, DEVELOPMENT: The delineated boundary inside the property limits within which all development and disturbance of ground must be contained. No disturbance of any kind for any purpose is allowed outside of the development envelope except for driveway access.

ENVIRONMENTALLY SENSITIVE AREAS: Areas that are:

1. **WASH AREAS:** The area within twenty feet (20') from and including the designated FEMA floodway, which has the presence of a channeled drainage way evidenced by a drainage path with or without vegetation.
2. **RIDGE LINE AREAS:** The ridgeline is formed by opposing slopes on a mountain or hill. The ridgeline area to be preserved is that area from the ridgeline to a distance of fifty feet (50') from the ridgeline.
3. **PEAK AREAS:** The peak is the top point of a mountain or hill formed by opposing slopes from all sides. The peak area to be preserved is that area from the peak to a distance of one hundred feet (100') from the peak.
4. **STEEP SLOPES:** Any land that has a slope of twenty percent (20%) or more.

EROSION: The wearing away of the ground surface as a result of the movement of wind, water or ice.

EROSION HAZARD AREA: Land adjoining a watercourse regulated by Town Ordinance which is deemed by the Town or Town Engineer to be subject to flood-related erosion losses.

EROSION SETBACK: The minimum horizontal distance between a structure and a channel bank necessary to protect the structure from flood related erosion damage.

EXCAVATION: Any act, by which earth, sand, gravel, rock, or other earthen material is cut into, dug, uncovered, displaced or relocated, and shall include the conditions resulting therefrom. In other words, the artificial (e.g. mechanical, manual, blasting, etc.) removal of earth materials.



EXISTING GRADE: The original grade or elevation of the existing ground surface prior to excavating, filling, stockpiling, and/or storage.

FCDMC: Flood Control District of Maricopa County

FEMA: Federal Emergency Management Agency

FILL: Deposits of soil, rock, or other materials placed by artificial or mechanical means.

FINAL INSPECTION: Field inspection conducted by the Town of Cave Creek prior to project acceptance or release of assurances (if required).

FINISH GRADE: The final grade or elevation of the improved or altered surface after grading and construction is completed.

FIRST FLUSH: The first or initial half-inch of runoff generated by a precipitation event.

FLOOD: A temporary rise in water level, including groundwater overflow of water onto lands not normally covered by water.

FLOOD HAZARD ZONE: Any land area located partially or wholly within a delineated floodplain susceptible to flood related damage as designated on the Flood Management Maps. Such flood hazard zones may include but not be limited to areas highly susceptible to erosion, stream meander sensitivity, moveable bed, scour, wave action, and subsidence.

FLOOD INSURANCE RATE MAP (FIRM): An official map on which the Federal Insurance Administration has delineated both the 100-year flood special flood hazard areas and the risk premium zones applicable to a community.

FLOOD INSURANCE STUDY: The official report provided by the Federal Insurance Administration. The report includes flood profiles and base flood elevations.

FLOOD MANAGEMENT MAP: An official map for Cave Creek on which the Floodplain Administrator has delineated floodplains and other flood related flood hazard zones for the purpose of floodplain administration.

FLOODPLAIN: The area susceptible to inundation by a base flood including areas where drainage is or may be restricted by man-made structures which have been or may be covered partially or wholly by flood water from the one hundred-year flood.

FLOODPLAIN ADMINISTRATOR: The individual appointed by the Maricopa County Board of Supervisors to administer and enforce the Maricopa County Flood Regulations.



FLOODPLAIN REGULATIONS: This Regulation and other codes, ordinances and regulations adopted pursuant to the authority granted in A.R.S §§48-3603 through 48-3628 relating to the use of land and construction within a delineated floodplain or other delineated flood related hazard area.

FLOODPLAIN USE PERMIT: A permit which must be obtained from the Floodplain Administrator prior to commencement or continuance of any non-exempt use within the jurisdictional floodplains.

FLOOD PROOFING: Any combination of structural and non-structural additions, changes or adjustments to structures which reduce or eliminate flood damage to real estate or improved property, water and sanitary facilities, structures and their contents.

FLOODWAY: The channel of a river or other watercourse and the adjacent land areas necessary in order to discharge the one hundred-year flood without cumulatively increasing the water surface elevation more than one foot.

FLOODWAY FRINGE: The areas of a delineated floodplain adjacent to the Floodway where encroachment may be permitted.

FLOOD, REGULATORY: see definition for Base Flood.

GEOLOGIC FLOODPLAIN: That portion of the land that has, in the geologic past, been subject to fluvial processes. The geologic floodplain may be different than the regulatory floodplain.

GRADE, ROUGH: The stage at which grading substantially conforms to the approved grading plan.

GRADING: Any excavating or filling to level land or create a slope or combination thereof.

GRADING PERMIT: An official document issued by the Town of Cave Creek staff authorizing the grading and related site work activity specified by the permit conditions.

GRUBBING: The clearing of a majority of the vegetative matter within a certain area.

HILLSIDE: All lands where the natural desert terrain of any lot or parcel has a slope of fifteen percent (15%) or greater.

LAND DISTURBANCE: Any human caused alteration of the land surface or indigenous vegetation including all clearing, grubbing, grading, and mining activities.

LEVEE: Man-made structures (usually an earthen embankment) designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding.



LOW OUTFALL ELEVATION: Lowest lot, sub-area and/or regional elevation outfall for the ultimate design of the street/development. A development's low flow outfall elevation may be in the street.

LOWEST FLOOR: The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of this Regulation.

MANUFACTURED/MOBILE HOME: A structure transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For floodplain management purposes, the term "Manufactured/Mobile Home" also includes park trailers, travel trailers and other similar vehicles placed on a site for greater than 180 consecutive days.

For flood insurance purposes the term "Manufactured/Mobile Home" does not include park trailers, travel trailers, and other similar vehicles.

MAJOR WASH: is defined as the area that has been designated a Federal Floodplain by the Federal Emergency Management Agency (**FEMA**) or any wash having a one-hundred (100) - year peak flow of fifty cubic feet per second (50 cfs) or greater.

MINOR WASH: is defined as a wash or constructed drainage feature having a one hundred (100) - year peak flow of less than fifty cubic feet per second (50 cfs).

NPDES PROGRAM: National Pollution Discharge Elimination System is federal law requiring a developer, public or private, to control or eliminate erosion and other forms of water pollution from a site.

NUISANCE WATER: The ponding or drainage of water whether from precipitation or other water source in areas other than designated retention basins, detention basins or drainage ways which causes an inconvenience or health and safety hazard to the general public.

OFF-SITE FLOWS: Stormwater flows reaching a development or site from outside the area of the development, including sheet flow from vacant lands and along roadways, or overflows from canals and retention basins.

ON-SITE FLOWS: Stormwater flows generated within a specific property boundary.

REACH: A hydraulic engineering term used to describe longitudinal segments of a stream or watercourse. In an urban area an example of a reach would be the segment of a watercourse between two consecutive bridge crossings.



REGULATORY FLOOD ELEVATION: The elevation which is one foot above the base flood elevation for a watercourse. Where a floodway has been delineated, the base flood elevation is the higher of either the natural or encroached water surface elevation of the 100-year flow.

RETAINING WALL: A wall or terraced combination of walls used to retain earth but not supporting a wall of a building.

RETENTION SYSTEM (STORMWATER): A system which contains and disposes of runoff in a controlled manner through the use of storage and disposal facilities. Storage facilities may include excavated basins and below grade containers such as pipes, boxes or grid chambers. Disposal facilities may include drywells and gated gravity outfalls with sufficient capacity to drain the retained runoff within a thirty-six hour (36 hr.) period.

REVEGETATION: Establishing native plants at a density similar to existing conditions in disturbed or denuded areas.

RIDGE OR RIDGELINE is a relatively narrow landform that is prominent because of the steep angle at which it rises; an elongated crest, or series of crests, with or without individual peaks, significantly higher than the adjoining round.

SHEET FLOODING: Areas of flooding with depths of one-half foot (0.5') or greater during the regulatory flood where a clearly defined channel does not exist and the path of the flooding is often unpredictable and indeterminate.

SITE: Any lot or parcel of land, or contiguous combination of lots and parcels under the same ownership, or unified control, where grading or related site work is to be performed.

STABILIZED SLOPE: A slope treated with revegetation or other mitigation measures approved by the Town of Cave Creek that resist erosion or augment the structural integrity of the slope.

STRUCTURE: That which is built or constructed, an edifice or building of any kind, or any piece of work artificially built up or composed of parts joined together in some definite manner, which requires location on the ground or is attached to something having location on the ground.

WATERCOURSE: Any lake, river, stream, creek, wash, arroyo, or other body of water or channel having banks and bed through which waters flow at least periodically and any depression serving to give direction to a current of storm water.

WATERSHED: The drainage area above a point on a watercourse.

ZONING ADMINISTRATOR: The Zoning Administrator shall be Planning Department Director or his/her designee.



1.5 STANDARD SPECIFICATIONS AND DETAILS

The latest *MAG Standard Specifications and Standard Details* have been adopted by the Town of Cave Creek. All design and construction must be in accordance with the *Uniform Standard Specifications and Details* published by the Maricopa Association of Governments and as amended by the Town of Cave Creek. Alternate details and specifications may be submitted for review and acceptance by the Town Engineering Department. If accepted, alternate details will be shown as part of the approved engineering plans.



SECTION 2 - POLICIES AND CRITERIA

2.1 GENERAL

This manual contains recommended procedures, equations, data and design standards which the engineer, planner and/or designer is generally required to use. The engineering plans and drainage reports should be prepared in adherence to the guidelines presented herein.

The design standards are intended to be used in conjunction with the governing specifications of the appropriate ordinances of the Town of Cave Creek, Maricopa County, State of Arizona and Federal agencies.

The design concepts, procedures and technical data are presented herein only as guidelines and are not intended to replace sound engineering judgment. Investigations of Hydrology, Hydraulics and Erosion control requires technical competence as well as experience and good judgment.

The Town does not guarantee the accuracy and applicability of the procedures presented in this manual. The user shall be entirely responsible for verification of reasonability of the predicted parameter values and shall apply alternative methods and other appropriate checks to validate the results.

2.2 PERMITTING REQUIREMENTS

2.2.1 Town of Cave Creek

No grading, grubbing or permanent improvement work shall be commenced until all engineering plans and required drainage reports have been approved by the Town Engineer or consultant as provided by the Town Council. A *Building Permit* shall be required and conspicuously posted on the property a minimum of ninety-six hours (96 hrs.) prior to the commencement of any grading or grubbing.

No temporary or permanent structure shall be constructed without first obtaining a *Building Permit*.

See Section 2.2.5 for additional requirements pertaining to the acquisition of Town issued permits for *FEMA* delineated floodplain properties.

2.2.2 Maricopa County

Development or improvement work within any *FEMA* delineated floodplain area shall require acquisition of a *Floodplain Use Permit* from Maricopa County. Application and review processes for floodplain use permits are administered by the FCDMC.



Before issuing a *Floodplain Use Permit*, the FCDMC undertakes a detailed review of the hydrologic conditions that affect the subject property, and then checks to make sure that any proposed improvements conform to the County's Floodplain Regulations.

2.2.3 State of Arizona

National Pollution Discharge Elimination System (NPDES) – Any construction activity resulting in the disturbance of one or more acres of ground will require a permit under the NPDES Program.

The Arizona Department of Environmental Quality (ADEQ) has obtained a *Construction General Permit (AZG2003-001)* to cover all construction activities within the State (except on Indian Lands). To obtain authorization for discharges of stormwater associated with construction activity, the operator/owner must comply with all the requirements of the General Permit and submit a *Notice of Intent (NOI)* in accordance with Part III of the General Permit to ADEQ.

The operator/owner must also develop and implement a *Storm Water Pollution Prevention Plan (SWPPP)* that satisfies the conditions of the permit.

If the project site is located within one-quarter mile ($\frac{1}{4}$ mi.) of unique or impaired water, the SWPPP must be submitted with your NOI.

Section 401 Permitting – While the Corps issues the Section 404 permit, Section 401 of the CWA requires ADEQ to certify, possibly with additional permit conditions, that the draft permit complies with effluent limits, state water quality standards, and any other appropriate requirements of state law. The goal of the program is that no discharge of dredged or fill material will be permitted if either a practicable alternative exists that is less damaging to the aquatic environment, or, if the nation's waters would be significantly degraded. ADEQ has authority under Section 401 of the CWA to grant, deny, or waive water quality certification for both individual and nationwide Section 404 permits. The Corps cannot issue a permit, individual or general, where ADEQ hasn't approved or waived certification or where ADEQ has denied certification. For more information, contact ADEQ or visit www.azdeq.gov/environ/water/permits/dredge.html.

2.2.4 U.S. Army Corps of Engineers

The Town of Cave Creek is a participant in the *National Flood Insurance Program (NFIP)*. The *Code of Federal Regulations* requires that if a community chooses to participate in the National Flood Insurance Program, it must assure that developments within its boundaries comply with Sections 401 and 404 of the *Federal Clean Water Act (CWA)*.



Section 404 Permitting – The US Army Corps of Engineers (Corps) and the US Environmental Protection Agency (EPA) jointly administer Section 404 of the CWA. The CWA regulates the discharge of dredged or fill material into jurisdictional washes, rivers, streams, lakes, certain man-made canals, and other “waters of the United States,” including wetlands. Examples of activities likely to incur regulation under Section 404 of the CWA within the Town may include:

- Roadway crossings of watercourses
- Dam construction and flow regulation
- Streambed modification and/or stabilization
- Grading activities associated with commercial sites, subdivisions, master planned communities, highways, and airports.

In addition, the US Fish and Wildlife Service, Arizona Department of Environmental Quality (ADEQ), Arizona Game & Fish Department, and Arizona Department of Water Resources have important advisory roles. In order to allow time for permit processing and coordinating with their timeframes, contact the Corps early in the project planning stage for information about permits and submittal and notification requirements.

See <http://www.spl.usace.army.mil/> and click on Regulatory, then Permit Process within Arizona State, for specific information.

In general, all construction activities involving excavation or fill placement that disturbs more than 0.10 acres of Clean Water Act Section 404 jurisdictional areas will require a permit that must be obtained from the U.S. Army Corps of Engineers. Individual permits may be required for projects with potentially significant impacts (normally those exceeding 0.5 acres of impacted jurisdictional watercourse area) and require an extensive permitting and public notice process. Nationwide permits (currently 44 activity-specific permits) may be authorized for activities with minimal environmental impact and undergo a streamlined process.

2.2.5 FEMA

As a participating community within the NFIP, the Town of Cave Creek has several of the major watercourses within the Town currently delineated with *Special Flood Hazard Areas (SFHA)*, as depicted on the effective *Flood Insurance Rate Maps (FIRM)* for the community. Any proposed changes to those delineations, or proposed removal of structures from the SFHA, will require a *Letter of Map Change (LOMC)* issued by FEMA. The following are definitions of the various LOMC processes:

Letter of Map Amendment (LOMA) - A LOMA is a determination made by FEMA for an existing property as to whether it is located within the SFHA on the effective Flood Insurance Rate Map (FIRM).



LOMA's are used to correct for anomalies or errors in SFHA delineations that errantly included a property within the current SFHA. FEMA's determination is based on evidence provided by the applicant that the property in question is not in the SFHA by reason of either location or elevation above the base flood. A LOMA usually requires the preparation and submittal of a *FEMA Elevation Certificate* as a part of the application.

Letter of Map Revision (LOMR) – A LOMR is an official revision to the currently effective FEMA map. It is used to change flood zones, floodplain and floodway delineations, flood elevations, and planimetric features.

The application/determination process usually includes the submittal of technical hydrology, hydraulic, and sedimentation analysis and data, and any supporting survey or topographical mapping.

Letter of Map Revision based on Fill (LOMR-F) – A LOMR-F is submitted for properties on which fill has been placed to raise the structure or lot to or above the base flood elevation. *National Flood Insurance Program (NFIP)* regulations require that the lowest adjacent grade of the structure be at or above the base flood elevation for a LOMR-F to be issued removing the structure from the SFHA.

The participating community must also determine that the land and any existing or proposed structures to be removed from the SFHA are "reasonably safe from flooding". To remove the entire lot and structure, both the lowest point on the lot and the lowest floor of the structure must be at or above the base flood elevation. Also, a LOMR-F is not applicable for use in certain SFHA areas such as floodways, approximate A Zones, and no-rise floodplains. A LOMR-F usually requires the preparation and submittal of a FEMA Elevation Certificate as a part of the application.

Conditional Letter of Map Revision (CLOMR) – A CLOMR is the same as a LOMR, only the applicant is requesting that FEMA make a "conditional" determination based on proposed design concepts which are prior to any actual grading or construction. Issuance of a CLOMR does not remove a property from the SFHA.

Conditional Letter of Map Revision based on Fill (CLOMR-F) – A CLOMR-F is the same as a LOMR-F, only the applicant is requesting that FEMA make a "conditional" determination based on proposed design concepts which are prior to any actual grading or construction. Issuance of a CLOMR-F does not remove a property from the SFHA.

At the discretion of the Town Engineer, any development proposing significant changes to a SFHA may be required to obtain a LOMC. In this circumstance, the following criteria are established for obtaining certain Town permits for development of SFHA properties where a significant change is proposed:



- ✓ *Grading Permit* – Prior to issuance of a grading permit, a LOMA, CLOMR, or CLOMR-F must be obtained from FEMA.
- ✓ *Certificate of Occupancy* – No Certificate of Occupancy will be issued by the Town until the LOMA, LOMR, or LOMR-F is obtained from FEMA.

2.3 CODES, ORDINANCES, AND REGULATIONS

2.3.1 Town of Cave Creek

The Town of Cave Creek, as part of its regulatory function, has established Zoning ordinances and Subdivision ordinances.

The *Zoning and Subdivision Ordinances* regulate the development and use of private and public land. The long range planning is guided through the *General Plan*. The Planning Department is responsible for current planning, long range planning and zoning enforcement and administers the Zoning and Subdivision Ordinances. All planning and design activities must comply with the Zoning and Subdivision Ordinances of the Town of Cave Creek. Copies of these ordinances may be obtained from the Town of Cave Creek and are electronically available at www.cavecreek.org.

2.3.2 Maricopa County

The Town of Cave Creek requires that the *Drainage Design Manual for Maricopa County, Arizona, Volume I - Hydrology and Volume II - Hydraulics by the Flood Control District of Maricopa County (FCDMC)* be used for drainage design purposes. The design guidelines contained in these manuals must be used for all purposes unless otherwise specified in this manual. All development within FEMA delineated floodplains must also adhere to the most current Floodplain Regulations for Maricopa County. Erosion Hazard analyses and determinations are to be accomplished using EHZ Guidelines

2.3.3 State and Federal

Grading and drainage related state and federal regulations that may be applicable to development within the Town include:

- *NPDES Program (regulated by ADEQ)*
- *Drywell Registration (regulated by ADEQ)*
- *Clean Water Act – Section 404 (regulated by U.S. Army Corps of Engineers)*
- *Clean Water Act – Section 401 (regulated by ADEQ)*
- *National Flood Insurance Program – LOMC processes (regulated by FEMA and FCDMC)*



2.4 GENERAL GRADING

The design and implementation of all grading and related site work should:

- Minimize scars and other adverse visual impacts resulting from cut and fill.
- Blend with the natural contours of the land.
- Conserve the natural scenic beauty and vegetation of the site.
- Restrict the area and volumes to the minimum necessary to implement the planned development.
- For any grading, which impacts natural drainage patterns on the property, the historical drainage must be maintained at the property boundary. This includes drainage location, volume, velocity, sediment yield and the direction of flow off the property.
- Ensure that graded hillside, slopes, or other areas subject to erosion are stabilized
- Minimize dust pollution and surface water drainage from graded areas during grading and development
- Ensure that development activity is designated and implemented to minimize adverse impacts and include appropriate restorative measures.

Detailed grading policies and design guidelines are presented in Section 3 of this document.

2.5 GENERAL DRAINAGE

In general, no person or entity shall alter any natural drainage course or existing drainage facility in such a way as to damage or endanger by flooding, erosion, nuisance water or any other means, any public or private property or improvements. This includes altering surface sheet flow by the erection of fences, berms, curbs, or any other excavation, fill or structure, if such alteration will increase flow in any existing drainage course or facility without specific approval of the Town Engineer. Detailed *Drainage Policies and Guidelines* are summarized in Section 4 of this document, including details for the preparation of drainage reports.



SECTION 3 - GRADING DESIGN GUIDELINES

3.1 CUT AND FILL SLOPES

The maximum allowable cut and fill slopes are respectively 3H:1V and 4H:1V. Steeper slopes may be allowed with proper compaction and stabilization measures with certification of stability by an Arizona Registered Geotechnical Engineer. In no case will fill slopes be allowed to exceed 2H:1V.

The height of driveway cut and fill is limited to four feet (4') but may not exceed eight feet (8'), provided the combination does not exceed twelve feet (12'). A maximum of one-third of the cross sectional width of the driveway at any point may be on fill materials and a minimum of two-thirds (2/3) of the cross sectional width shall be on cut material or natural grade.

Cuts and fills shall be setback from property lines and buildings shall be setback from cut or fill slopes in accordance with; 1) the currently adopted edition of the International Building Code, and/or 2) the recommendation or design sealed by an Arizona registered geotechnical engineer. Retaining walls may be used to reduce the required setback when approved by the Town Engineer.

All cut and fill slopes for the roadway shall be within the roadway right-of-way or roadway easement. Slope maintenance easements for roadway cuts and fills shall be required by the Town Engineer.

The total area of cuts and fills shall not exceed the disturbed area requirements provided in the Town's Zoning Ordinance.

3.2 HILLSIDE DEVELOPMENT AREAS

3.2.1 Definition

The hillside and desert terrain within the Town of Cave Creek contains significant ridgelines and drainage-ways. As a result, special considerations are necessary to protect these natural features. The factors to be considered are the intensity of land disturbance, density, and including but not limited to, the natural characteristics of high desert terrain, such as: steepness of slope, difficulties in providing public services, limitations on vehicular travel, significant vegetation, landforms, soil and rock stability, and existing drainage patterns. These factors will allow for responsible development in hillside areas while maintaining significant ridgelines and minimizing the physical and visual impact of such development.

The guidelines presented below apply to all lands, heretofore referred to as Hillside Development Areas, where the natural desert terrain of the building site on any lot or parcel has a slope of fifteen percent (15%) or steeper. Figure 3-1 illustrates the determination of a fifteen percent (15%) slope:

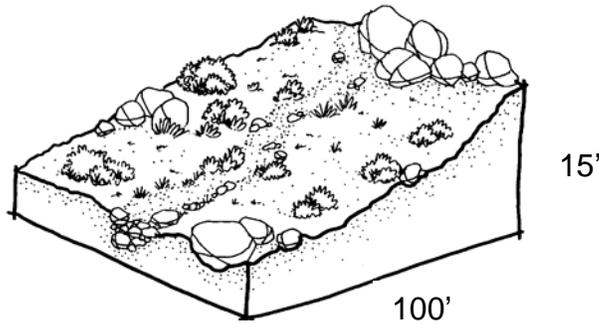


Figure 3-1
Illustration of a 15% Slope

3.2.2 Land Disturbance Guidelines

Allowable land disturbance within a Hillside Development Area shall be limited to the disturbance limitation percentage as set forth in the Town Zoning Ordinance. Where land within a lot falls within multiple slope categories, the overall disturbance limitation for that lot shall be the aggregate of the square footage of each individual disturbance limitation for the various slope category areas within that lot. All land required to be left undisturbed according to Zoning Ordinance shall be retained in its natural, undisturbed condition.

The following are additional guidelines concerning land disturbance:

- All buildings, structures, roads, and drives shall, to the fullest extent practicable, follow and utilize the natural contours of the land to minimize disturbance.
- Grading within street rights-of-way or tracts of land for private access roads is exempt from the disturbance calculations. Any roadway grading beyond the limits of the dedicated rights-of-way or private road tracts, or if required by the Town Engineer or his designee, shall be placed in slope easements and included within the calculations for land disturbance limitations.



- Grading for utility lines, including all water and sewer lines and taps, and electric, gas, telephone and cable services, shall be included within the calculations for land disturbance limitations. All disturbed lands shall be restored to the natural grade and revegetated with plant material as listed in the Town of Cave Creek Technical Design Guideline Number 4 - Landscaping.
- Grading for parks and retention basins or channels shall be included within the calculations for land disturbance limitations.
- Any land that has previously been disturbed within the Hillside Development Area shall be counted as land disturbance, regardless of the date or cause of disturbance, when calculating the total land disturbance area.
- The boundaries of construction and proposed disturbed areas shall be clearly staked in the field, with visible roping, prior to and during construction, and shall conform to the approved individual site analysis plan. No disturbance shall be permitted beyond the designated boundaries either during or after construction. Land disturbed in violation of these guidelines shall, upon notice of the Zoning Administrator, be required to be re-graded to natural contours and revegetated with the same species, size, and at a similar density present on undisturbed adjacent or nearby sites.
- All roadway easement alignments, whether public or private, that provide access through one property to serve another property shall not be counted as land disturbance against the property impacted.
- A private roadway or private driveway easement that runs through a property to serve another property shall not be counted as land disturbance whether it is disturbed or not.
- Proposed improvements or additions to existing structures or other improved property within Hillside Development Areas are subject to the limitations established in this section. Proposals for such improvements or additions shall be accompanied by an exhibit showing the calculations necessary to determine if such limitations have been met or exceeded. If the existing disturbed area equals or exceeds the limitations established herein, no further construction or improvements that will result in the disturbance of additional area shall be allowed.

At the discretion of the Zoning Administrator, restoration of disturbed areas within a project may be eligible for credit as non-disturbed area if the applicant/developer complies with the following restoration conditions:



- A restoration plan, prepared in accordance with the specifications of this guideline and the Zoning Ordinance, and sealed by an Arizona registered engineer and/or registered landscape architect, must be submitted to the Zoning Administrator for review and approval.
- Roadway fill slopes that: 1) are equal to or flatter than 5H:1V for areas extending beyond dedicated public rights-of-way or tracts with said areas being located within dedicated slope easements; and 2) that have been revegetated and contoured to reflect the natural environment.
- Contouring of the restored area shall follow the original, natural contours, with seamless blending to the natural terrain at the edges of the disturbance.
- Where appropriate, the restoration shall be treated with an aging agent approved by the Town Engineer and planted with indigenous desert material of the same species and at a similar density present on undisturbed adjacent sites.

3.2.3 Supplemental Site Plan Requirements

Development or improvement of lands determined to be at least partially located within a Hillside Development Area may, at the discretion of the Zoning Administrator and/or the Town Engineer, require the preparation and submittal of the following supplemental information at the time of the site plan review process:

Slope Analysis – the purpose of the slope analysis is to map and tabulate the various slope categories within a proposed development's property boundaries. Products of the slope analysis shall be compiled onto a map and sealed by an Arizona registered land surveyor or civil engineer. At a minimum, the map shall include a topographic map of the proposed development property with the following elements clearly delineated:

- Project Name or Identification, north Arrow, map scale, and name and address of the preparing land surveyor or civil engineer,
- Property boundary for the project area,
- All existing or proposed rights-of-way, tracts, and easements,
- Existing condition mapping with a minimum of two foot (2') contour intervals and NAD (North American Datum 1988),
- For lots less than ten (<10) acres in size, the scale of the topographical map shall not be less than 1"=20'. The minimum scale allowed is 1"=40' for all other developments greater than ten (>10) acres in size,



- Delineation of contour bands for the following slope categories:
 - Slopes less than 14.9%
 - Slopes 15% to 19.99%
 - Slopes 20% to 24.99%
 - Slopes 25% to 29.99%
 - Slopes 30% and steeper.
- Delineation of any ridgelines.
- The total number of acres in each of the slope categories and their percentage to the gross property acreage shall be calculated and summarized in tabular form.

Also, the grading and drainage plans for the proposed project shall include a clearly tabulated calculation of the amount of disturbance per slope category.

Geologic/Geotechnical Analysis – the purpose of the Geologic/Geotechnical Analysis (GGA) is to evaluate the project from a geological/geotechnical perspective and document any conditions and/or concerns regarding potential geologically based hazards associated with development of the site. If needed or appropriate, the analysis should also identify reasonable mitigation measures that may be implemented with the proposed development to address those hazards. Results of the GGA shall be compiled into a report and sealed by an Arizona registered geotechnical engineer and/or geologist as required by state statute. At a minimum, the report shall address the following:

- Current soils and bedrock conditions
- Stability/hazards of geologic features such as:
 - natural or man-made slopes
 - Boulder collapse and rolling
 - Rockfalls
 - Slope collapse (e.g. slumps and slides)
 - Talus slopes
- Results of a seismic refraction survey
- Summary of proposed engineering design of foundations, earth fill slopes, structure-bearing earth fills, and other measures for the mitigation of geologic hazards identified
- Address any proposed variations from the current version of building codes.



Additional Site Plan and/or Grading and Drainage Plan Requirements – for site plans involving development of any Hillside Development Area, the following items shall be required and are in addition to the normal site plan elements:

- Three or more cross sections taken at different locations throughout the building site and oriented generally perpendicular to the existing drainage pattern. Said cross sections shall be drawn with a vertical to horizontal ratio of 1:1 and shall clearly be shown on the topographic map.

3.3 PERIMETER AND RETAINING WALLS

General provisions governing the use, location, size and type of walls for the Town are summarized in the Zoning Ordinance. The following are offered as further design guidelines:

- Perimeter or landscape walls must not block natural drainage paths unless provisions have been made for conveying the drainage otherwise. This includes sheet flow, rill flow, and otherwise un-contained flooding that may impact the proposed wall.
- For any proposed wall crossing of a Major Wash, a detailed hydraulic and scour analysis shall either be included in the drainage report for the project or conducted and summarized in a brief report sealed by an Arizona registered civil engineer. The analysis shall demonstrate that adequate hydraulic conveyance capacity and sufficient scour protection have been provided for at the crossing.

3.3.1 Retaining Wall Requirements:

- A. The retaining-wall standards contain herein applies to all retaining-wall designs whether located on hillside areas or not.
- B. The height of a retaining wall is measured from the bottom of the retaining wall footing to the top of the wall. This distance measurement shall prevail whether the top of the wall is retaining earth or not.
- C. Open railings on the top of retaining walls are not included in the retaining wall height measurements.
- D. The height of a retaining wall shall be counted as part of the overall building height if the face of the building is within fifteen feet (15') of the retaining wall.
- E. For zoning purposes the average height of a retaining wall shall be computed by taking the total vertical surface area of the wall above grade and dividing it by its length.



- F. The finished surfaces of any retaining wall may be stucco or treated with other materials so as to match the building finish or blend into the natural setting.
- G. The maximum height and average height of retaining walls shall not exceed the following:

Table 3-1

Maximum height and average height of retaining walls

AVERAGE SLOPE AT BUILDING ⁽¹⁾	0%-15%	15%-25%	25%-30%	30%-35%	35% & over
Maximum Height (feet) ⁽²⁾	6'	10'	13'	13'	18'
Average Height (feet) ⁽²⁾	NA	6'	8'	9'	11'

- (1) The average slope at the building is determined by averaging the percentage of the slopes shown on sections through the building on the Site Plan submittal.
- (2) The maximum retaining wall height shall not exceed eight feet (8') without a minimum four foot (4') wide planter break.

3.4 STRUCTURES AND BUILDINGS

3.4.1 Finished Floor Elevations

All finished floor elevations for structures NOT located in a Special Flood Hazard Area must be set at a minimum of fourteen inches (14") above the highest adjacent grade and/or the ultimate lot outfall, whichever is higher.

All finished floor elevations for structures located in or near a Special Flood Hazard Area must be set at a minimum of two feet (2') above Base Flood Elevation. In addition, the finished floor elevation shall be referenced to the same datum as that published on the effective FEMA FIRM Panel covering the subject project.

Any exception to these policies will require certification by an Arizona registered Civil Engineer.



3.4.2 Structure Perimeter Grading

Perimeter grading around all structures shall provide positive drainage of surface water away from structure foundations and retaining walls at a minimum of six inches (6") within the first ten feet (10').

Lot grading around the perimeter of a structure shall provide a positive outfall for all accumulated runoff, and shall provide sufficient hydraulic capacity to convey the base flood (Q100) discharge at an elevation that is six inches (6") or more below the lowest finished floor elevation (except basements).

3.4.3 Foundational Soils Analysis

A geotechnical investigation shall be conducted to identify the structural soil properties of the foundation soils for the subject project. The investigation shall also provide mitigation remedies for problem soils. The results of the investigation shall be provided in report format with the site plan and shall be sealed by an Arizona registered Geotechnical Engineer.

3.5 REVEGETATION AND LANDSCAPE REQUIREMENTS

Revegetation and/or restoration of roadway grading, cut and fill slopes, utility corridors, and any other graded areas is required and shall be achieved using either indigenous materials transplanted from the allowable disturbance area of the site, or off-site materials brought onto the site provided they are in compliance with the approved materials listed in the Town of Cave Creek Technical Design Guideline Number 4 - Landscaping.

All cut and fill slopes shall be protected from surface drainage erosion with either a retaining wall or with a contoured slope to blend into the natural terrain. In either case, all exposed areas shall be revegetated per the Town of Cave Creek Technical Design Guideline Number 4 - Landscaping.

Boulders should be incorporated where appropriate to achieve a restored natural environment.

Retention/Detention basins and new drainage channels shall be given a natural desert character, wherever possible, using grading and landscape themes such as those conceptually depicted in Figures 3-2 and 3-3. The use of native materials in the construction of all storm water features (e.g. basins, channel bottoms, and headwalls) is encouraged. Contouring is required to replicate natural topography and enhance the aesthetics of all drainage basins, and channels.

Revegetated sites shall be temporarily irrigated to establish growth on the slopes and shall be required to maintain a success rate of eighty percent (80%) or better for a two year (2 yr.) period from the date of the Town approval of the landscaping.

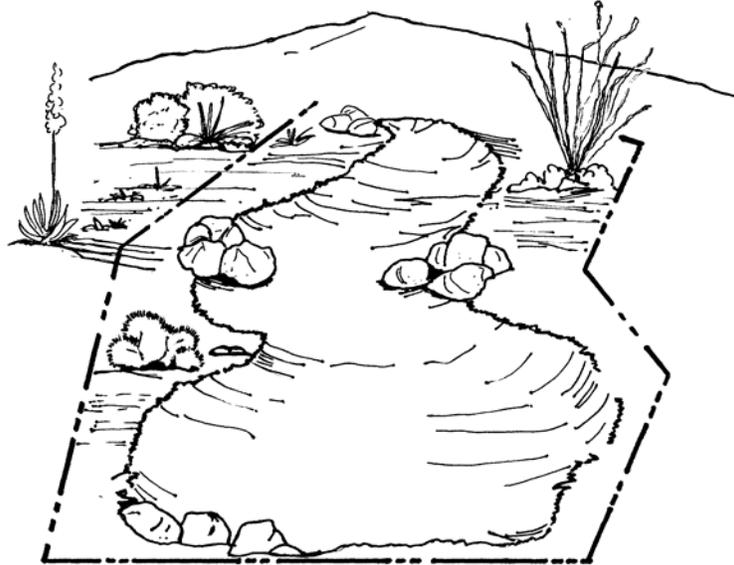


Figure 3-2

Retention/Detention Basin Grading and Landscape Concept



Figure 3-3

Natural Channel Landscape Concept



Cut or fill slopes steeper than 3H:1V shall require surface stabilization measures that are additional to, or in lieu of revegetation, for the mitigation of rilling and erosion. The proposed treatment of slopes steeper than 3H:1V shall be shown on the Native Plant Preservation, Salvage, and Landscape Plan required per the Town of Cave Creek Technical Design Guideline Number 4 - Landscaping and sealed by either an Arizona registered Landscape Architect, Civil Engineer, or Geotechnical Engineer as appropriate.



SECTION 4 - DRAINAGE DESIGN GUIDELINES

4.1 PURPOSE

The Town of Cave Creek recognizes that a comprehensive stormwater management program is essential to the Town's goal of protecting the health, safety, and welfare of its citizens, their property, and the environment. These guidelines outline the Town's planning desires and policies regarding drainage design and construction within the Town limits and planning areas.

This document is intended to be used in concert with the County Hydrology and Hydraulics Manuals and the EHZ Guidelines. Accordingly, wherever details presented herein differ from the County Hydrology and Hydraulics Manuals and/or the EHZ Guidelines, the more restrictive regulations shall take precedent.

4.2 SPECIAL DRAINAGE CONSIDERATIONS

The following are summaries of categories of drainage criteria and considerations that are unique and of special use within the Town of Cave Creek.

4.2.1 Major Wash

Definition – A Major Wash is defined as any watercourse within the Town limits that has one or more of the following characteristics:

- A tributary basin area of ten (10) or more acres, regardless of land-use.
- Is determined to be a jurisdictional "waters of the U.S." as defined and delineated under Section 404 of the Clean Water Act by the U.S. Army Corps of Engineers.
- Is delineated as a Special Flood Hazard Area (SFHA) by FEMA, the Flood Control District of Maricopa County, or the Town. The SFHA designation may include watercourses that are not included on published FEMA FIRM Panels, but that have been delineated for administrative or regulatory purposes separate from the NFIP.

Major Wash Design Policy – The following requirements shall be adhered to for all development of improvements involving Major Washes:

- A 100-year floodplain analysis and SFHA delineation shall be performed for all Major Wash watercourses that are not already delineated as SFHAs by FEMA, FCDMC, or the Town. The delineation shall include representation of the base flood elevations as well as the limits of the SFHA.
- An erosion setback analysis compliant with the EHZ Guidelines shall be performed and delineated for all Major Washes.



- All floodplain and erosion setback analyses shall be prepared under the direction of, and sealed by, an Arizona registered Civil Engineer.
- The SFHA and erosion setback corridor for all Major Washes shall be preserved in their natural condition, with allowances for roadway, driveway and utility crossings and their associated disturbances.
- A drainage easement encompassing the gross, combined limits of the SFHA and the erosion hazard setback lines shall be delineated and dedicated to the public for all Major Wash watercourses.
- All SFHA boundaries and base flood elevations, and erosion hazard setback lines impacting a project, shall be shown on the site plan, grading and drainage plan, preliminary plat, and/or final plat documents associated with that project.

Exceptions to this policy will require:

- The submittal of a detailed drainage analysis and report sealed by an Arizona registered Civil Engineer substantiating the requested exception
- Review and approval of the Town Engineer.

4.2.2 Minor Wash

Definition – A Minor Wash is any watercourse that does not meet any one of the criteria listed for a Major Wash

Minor Wash Design Policy – The following requirements shall be adhered to for all development of improvements involving Minor Washes:

- Minor Wash corridors shall be retained in their natural conditions wherever possible with all development set back a minimum of twenty feet (20') from the top of bank to allow the animal travel corridors to remain uninterrupted.
- The creation of nuisance water should be avoided whenever possible and shall be addressed in a manner which will mitigate or minimize any negative impact(s) to the site and upstream and downstream properties.
- All proposed rerouting of Minor Wash watercourses shall require drainage design and analysis to substantiate the new watercourse route. All new channels or alternative routings shall:
 - Accommodate the 100-year event with a minimum of one foot (1') of freeboard
 - Match to the existing hydraulic conditions at the upstream and downstream property boundaries
 - Be designed to look as natural as possible.



- Submit a drainage system plan and drainage report, prepared by an Arizona registered Civil Engineer, for review and approval by the Town Engineer.

4.2.3 First Flush

Definition – For development in the Town of Cave Creek, First Flush is defined as the first half inch (0.5”) of runoff produced by a precipitation event of sufficient magnitude and duration to produce at least 0.5 inches of runoff.

First Flush Design Policy – The following requirements shall be adhered to for all single lot, commercial, and/or subdivision developments:

- At a minimum, all developments shall be required to intercept one-hundred percent (100%) of the First Flush for all disturbed areas of the subject development. Intercepted runoff may either be routed through an approved stormwater treatment device or retained within a storage facility. Areas preserved in their natural state are exempt from this requirement.
- The locations of the treatment and storage facilities shall be such that all required First Flush discharges can be intercepted by the proposed treatment or storage system.
- Surface and subsurface retention storage methods are acceptable and must incorporate methods or devices for mitigation of petroleum and oil based contaminants and sediment.
- All stored runoff must be drained from a retention type of storage device or basin within thirty-six hours (36 hrs.).
- First Flush storage capacity may be credited towards the projects overall retention/detention requirement.

Exceptions to this policy shall be addressed on a case by case basis and shall require approval of the Town Engineer.

4.3 DRAINAGE ANALYSIS AND REPORT GUIDELINES

4.3.1 Purpose

The purpose of performing a drainage analysis and compiling a report is to:

- Estimate, assess and document the site and vicinity drainage conditions that may impact, or be impacted by, a proposed development or improvement of a subject property.
- Provide data supporting the design of facilities to be constructed for the management of stormwater runoff.



- Provide an assurance that all proposed structures are protected from flooding or failure due to storm events with return frequencies up to and including a 100-year event.

The complexity of the analyses and report depends upon the nature of the proposed project and the site on which the project will occur. In general, a drainage analysis and report must:

- ✓ Use the best and most current data available
- ✓ Provide safe, reasonable, and reliable results
- ✓ Are not unnecessarily complex or confusing
- ✓ Are technically and legally defensible
- ✓ Analyze existing and proposed conditions, and document the effect that a proposed project would have upon stormwater runoff;
- ✓ Provide data to insure that the project will be safe from flooding up to and including a 100-year event;
- ✓ Provide data supporting the design of drainage and flood control facilities.
- ✓ Reflect requirements of the Town Ordinances, these guidelines, and other applicable county, state and federal regulations

4.3.2 Activities Requiring Drainage Reports

Table 4-1 summarizes typical development or improvement processes that will require the submittal of a detailed drainage analysis and report.

All other development or improvements requiring a permit from the Town will at a minimum need to provide a letter, signed by an Arizona registered Civil Engineer, certifying that:

- 1) There are no significant drainage issues or concerns with the development or improvement of the subject property, and
- 2) The development or improvement of the subject property will not adversely impact the drainage of the neighboring properties.

All reports shall be prepared using standard letter sized paper that is bound together with appropriate appendices, maps, data CDs, and other enclosures as needed.

**Town of Cave Creek
 Technical Design Guidelines - Grading and Drainage**



Table 4-1

Summary of Cave Creek development processes requiring a drainage analysis and report

Development Process	Preliminary Drainage Analysis and Report	Final Drainage Analysis and Report	Master Drainage Analysis and Report
Subdivision – Preliminary Plat	Required	---	---
Subdivision –Final Plat	---	Required	---
Commercial Development – One Acre or less	---	Required	---
Commercial Development – Greater than One acre	Town Engineer's Discretion	Required	---
Single Lot Residential	---	Town Engineer's Discretion	---
Master Planned Developments or Communities	---	---	Required
Planned Area Developments	Town Engineer's Discretion	Required	Town Engineer's Discretion
Planned Unit Developments	Town Engineer's Discretion	Required	Town Engineer's Discretion
Any Property located within a FEMA delineated SFHA	Town Engineer's Discretion	Required	---
Any Property with a Major Wash running through or immediately adjacent to it	Town Engineer's Discretion	Required	---



4.3.3 Preliminary Drainage Report Elements

The following is a summary description of the minimum general drainage elements required to be addressed in each preliminary drainage report submitted to the Town. The following elements may also serve as a general report outline. It is recognized that in certain cases, one or more of these elements may not be applicable to a project, and as such, should be so noted in the drainage report.

1. TITLE PAGE

- Project Name
- Type of Drainage Report (Preliminary, Master Plan, Final, etc.)
- Engineer's Seal, Signature, and Date

2. TABLE OF CONTENTS

3. INTRODUCTION

- A paragraph stating the project and report purpose and objectives
- A narrative description of the project type, location, slope, natural terrain, vegetative cover, and existing drainage characteristics of the property. This will include a vicinity map that is derived using a current aerial photo, 800 scale or larger, showing the project site in context with the surrounding properties.
- A summary of the drainage characteristics of the surrounding properties including any drainage facilities.
- A summary of prior reports or studies with relevance to the current project site (i.e. – Flood Insurance Studies, Area Master Drainage Plans, Drainage Reports for adjacent properties, etc.)
- A summary of the current FEMA flood zone delineations over the site, including a copy of the FIRM Panel with the project boundary plotted on it. Any delineated SFHA will also be shown on other drainage maps or exhibits as appropriate



4. HYDROLOGY

A. Offsite Drainage

- Peak discharges from all offsite watersheds shall be estimated. Offsite drainage basins should be delineated using topographic maps, aerial photos, and field reconnaissance. All mapping should be of sufficient detail and scale to accurately depict drainage patterns, flow-paths, sub-areas and watershed boundaries. Contour lines shall be shown on all maps, with a contour interval appropriate for the slope and complexity of the terrain. Sources for recent aerial photography and topographic mapping may include the Town, the FCDMC, and the USGS.
- Peak discharges for the 10-year and 100-year events should be estimated for all property or project boundary concentration points and at sufficient locations upstream and downstream of the project to thoroughly depict the site drainage conditions in context with the overall watershed. The Q10 and Q100 shall also be indicated on the Preliminary Onsite Drainage Map at all project boundary locations.

B. Onsite Drainage

- Narrative description of existing onsite drainage patterns, natural and constructed watercourses, site vegetative cover, drainage basin boundaries, open channels, waste or delivery ditches, storm drains, storage basins, and any other drainage structures or improvements.
- Identification of all Major and Minor Washes within the project.
- Delineation of the 100-year floodplain and erosion hazard setback limits for all Major Washes.
- Depiction of all FEMA delineated SFHAs including floodplain and floodway limits, and base flood elevations.
- A description of the proposed onsite drainage plan including:
 - preservation corridors for Major Washes
 - New drainage infrastructure such as culverts, channels, roadside ditches, storm drains, and any other proposed changes to be made to the existing drainage patterns should also be presented.



5. HYDRAULICS

A. Major Wash 100-Year Floodplain – at a minimum, the 100-year floodplain must be delineated for all Major Washes using a one dimensional, steady state, backwater computer program model such as the most current version of HEC-RAS. Other more complex computer models may be warranted for hydraulically complicated or complex watercourses. A summary of the following modeling parameter data and results should be presented, mapped and discussed, as appropriate:

- Manning's n roughness coefficient selection
- Cross section descriptions
- Structures (bridges, culverts, and levees)
- Special drainage features (flow splits, islands, confluences)

B. Hydraulic Structure Designs – a narrative discussion of any preliminary hydraulic analyses should be presented and summarized. Such analyses may include:

- Normal depth hydraulic calculations (channels, roadside ditches, and other open channel conveyances)
- Culvert hydraulics
- Catch basin inlet sizing
- Storm drain modeling or hydraulic grade line (HGL) calculations
- Weir and spillway designs

6. RETENTION/DETENTION

Preliminary retention/detention required storage volume calculations and proposed basin locations and sizes, shall be summarized. A discussion of the proposed methodology for satisfaction of the First Flush requirements, as well as how the basin will be drained within thirty-six hours (36 hr.), shall be provided as well.

7. EROSION HAZARD SETBACK ANALYSIS

Erosion hazard setback limits (EHSL) shall be determined for all Major Washes within, or adjacent to, a project. Methodology for determining EHSLs are set forth in the EHZ Guidelines. The amount of analysis and report documentation will be dependent upon the Methodology Level chosen to determine the EHSL. At a minimum, the report must provide:



- A discussion of the Methodology Level chosen and documentation of all parameters, field reconnaissance, assumptions and conclusions associated with that Methodology Level.
- Supplemental maps as required (Geologic Map, recent aerial photo with bank positions and bend calculations mapped, etc.)
- A map of sufficient scale to accurately depict the determined EHSLs along the Major Wash corridors. This map shall include the project topography and preliminary locations of site improvements, buildings, property boundaries, and other features.

8. EROSION CONTROL DESIGN

For preliminary drainage reports, a discussion shall be provided to summarize the locations and types of erosion control measures proposed for the project, should they be required. The proposed measures should be shown on the Preliminary Onsite Drainage Map.

9. DRAINAGE MAPS

A. Offsite Drainage Map – a map, or maps, of all offsite watersheds shall be provided with the preliminary drainage report. All mapping should be of sufficient detail and scale to accurately depict drainage patterns, flow-paths, sub-areas and watershed boundaries. The map should also include other cartographic features such as a north arrow, bar scale, roadways, section lines, and the boundaries of the subject project. Contour lines shall be shown with a contour interval appropriate for the slope and complexity of the terrain. Sources for recent aerial photography and topographic mapping may include the Town, the FCDMC, and the USGS.

B. Preliminary Onsite Drainage Map – a map, or maps, depicting the existing conditions and preliminary proposed drainage systems, including all of the items listed under Onsite Drainage and any proposed retention/detention basins. The project preliminary plat shall also be plotted on the Preliminary Onsite Drainage Map.

4.3.4 Final Drainage Report Elements

The minimum final drainage elements required to be addressed in each Final Drainage Report submitted to the Town are similar to those required for the Preliminary Drainage Report, only with more detailed analysis of the final drainage plan elements. The following is a discussion of the elements that must be included and may also serve as a general report outline.



It is recognized that in certain cases, one or more of these elements may not be applicable to a project, and as such, should be so noted in the drainage report.

1. TITLE PAGE

- Project Name
- Type of Drainage Report (Preliminary, Master Plan, Final, etc.)
- Engineer's Seal, Signature, and Date

2. TABLE OF CONTENTS

3. INTRODUCTION

Same general information as provided in Preliminary Drainage Report, with modifications as warranted based on changes to the preliminary drainage plan.

4. HYDROLOGY

A. Offsite Drainage

Same general information as provided in Preliminary Drainage Report, with modifications as warranted based on changes to the preliminary drainage plan

B. Onsite Drainage

Same general information as provided in Preliminary Drainage Report, with modifications as warranted based on changes to the preliminary drainage plan and the addition of the following details:

- Delineation of onsite subbasins complete with discharge estimates for the 10-year and 100-year discharges. Engineer's Seal, Signature, and Date

5. HYDRAULICS

Same general information as provided in Preliminary Drainage Report, with modifications as warranted based on changes to the preliminary drainage plan and the addition of the following details:

- *Hydraulic Structure Designs* – a narrative discussion and detailed hydraulic analyses of any hydraulic structures or open channels proposed for the project. Such analyses may include:
 - Normal depth hydraulic calculations (channels, roadside ditches, and other open channel conveyances)
 - Culvert hydraulics
 - Catch basin inlet sizing
 - Storm drain modeling or hydraulic grade line (HGL) calculations
 - Weir and spillway designs



6. RETENTION/DETENTION

A narrative discussion detailing the:

- Required and provided retention/detention storage volume calculations for the project.
- Proposed basin locations and sizes.
- A discussion of the methodology for satisfaction of the First Flush requirement.
- Method for draining any retained stormwater within thirty-six hours (36 hr.)

7. EROSION HAZARD SETBACK ANALYSIS

Same general information as provided in Preliminary Drainage Report, with modifications as warranted based on changes to the preliminary drainage plan.

8. EROSION CONTROL DESIGN

A narrative discussion and detailed analysis summarizing the following erosion control related design elements:

- Determination of design toe-down depth for mitigation of scour. Elements of this analysis shall at a minimum include estimates of long-term degradation or aggradation and local scour.
- Erosion control measure analysis and design for elements such as riprap, geosynthetic erosion control mattresses, gabions, articulated concrete block mattresses, concrete, cement stabilized alluvium, etc.
- All erosion control design measures shall be shown on the Final Onsite Drainage Map.

9. DRAINAGE MAPS

A. Offsite Drainage Map – a map, or maps, of all offsite watersheds shall be provided with the preliminary drainage report. All mapping should be of sufficient detail and scale to accurately depict drainage patterns, flow-paths, sub-areas and watershed boundaries. The map should also include other cartographic features such as a north arrow, bar scale, roadways, section lines, and the boundaries of the subject project. Contour lines shall be shown with a contour interval appropriate for the slope and complexity of the terrain. Sources for recent aerial photography and topographic mapping may include the Town, the FCDMC, and the USGS.



B. Final Onsite Drainage Map – a map, or maps, depicting the existing conditions and preliminary proposed drainage systems, including all of the items listed under Onsite Drainage and any proposed retention/detention basins. The projects final plat shall also be plotted on the Final Onsite Drainage Map.

4.3.5 Master Drainage Report Elements

Master drainage analysis and reports will be required for large Master Planned Communities (MPC) and shall address elements similar to those required for a Preliminary Drainage Report, only at the scale and scope of the overall MPC. The following is a discussion of the elements that must be included in a Master Drainage Report and may also serve as a general report outline. It is recognized that in certain cases, one or more of these elements may not be applicable to a project, and as such, should be so noted in the drainage report.

1. TITLE PAGE

- Project Name
- Type of Drainage Report (Preliminary, Master Plan, Final, etc.)
- Engineer's Seal, Signature, and Date

2. TABLE OF CONTENTS

3. INTRODUCTION

Same general information as provided in Preliminary Drainage Report, with a focus on the overall elements of the master planned community or development.

4. HYDROLOGY

A. Offsite Drainage

Same general information as required for a Preliminary Drainage Report, with a primary focus on Major Washes.

B. Onsite Drainage

Same general information as required for a Preliminary Drainage Report, with a focus on hydrology as it relates to any proposed major infrastructure within the MPC. The narrative will also present a general drainage plan for the overall MPC development and detailed 10-year and 100-year peak discharge estimates for any infrastructure proposed to be constructed as a part of the MPC development.

5. HYDRAULICS

Same general information as required for a Preliminary Drainage Report, with a focus on the hydraulic analyses related to Major Washes and any propose drainage infrastructure. Drainage infrastructure designs shall include:



- A narrative discussion and detailed hydraulic analyses of any hydraulic structures or open channels proposed for the MPC. Such analyses may include:
 - Normal depth hydraulic calculations (channels, roadside ditches, and other open channel conveyances)
 - Culvert hydraulics
 - Catch basin inlet sizing
 - Storm drain modeling or hydraulic grade line (HGL) calculations
 - Weir and spillway designs

6. RETENTION/DETENTION

A narrative discussion detailing the proposed retention/detention strategy for the MPC shall be provided. Proposed retention/detention strategies that involve centralized storage basins and conveyance systems that are to be constructed with the MPC infrastructure, shall require supporting analysis and design calculations. Elements of the retention/detention strategy to be addressed shall include:

- For centralized retention/detention strategies:
 - Required and provided retention/detention storage volume calculations.
 - Proposed basin locations, sizes, and configurations.
 - Supporting HEC-1 analyses for detention basins.
 - A discussion of the methodology for satisfaction of the First Flush requirement.
 - Method for draining any retained stormwater within thirty-six hours (36 hr).
- For non-centralized retention/detention strategies, a statement or narrative describing:
 - How retention/detention requirements shall be satisfied by individual parcels of the MPC.
 - How retention/detention requirements for MPC constructed infrastructure shall be allocated and/or provided for.
 - A discussion of the methodology for satisfaction of the First Flush requirement.



- Method for draining any retained stormwater within 36 hours.

7. EROSION HAZARD SETBACK ANALYSIS

Same general information as required for a Preliminary Drainage Report.

8. EROSION CONTROL DESIGN

A narrative discussion detailing the proposed erosion control strategy for the MPC shall be provided. Proposed erosion control strategies for drainage facilities that are to be constructed with the MPC infrastructure, shall require supporting analysis and design calculations as follows:

- Determination of design toe-down depth for mitigation of scour. Elements of this analysis shall at a minimum include estimates of long-term degradation or aggradation and local scour.
- Erosion control measure analysis and design for elements such as riprap, geosynthetic erosion control mattresses, gabions, articulated concrete block mattresses, concrete, cement stabilized alluvium, etc.
- All erosion control design measures shall be shown on the Master Drainage Plan.

9. DRAINAGE MAPS

A. Offsite Drainage Map – a map, or maps, of all offsite watersheds shall be provided with the preliminary drainage report. All mapping should be of sufficient detail and scale to accurately depict drainage patterns, flow-paths, sub-areas and watershed boundaries.

The map should also include other cartographic features such as a north arrow, bar scale, roadways, section lines, and the boundaries of the subject project. Contour lines shall be shown with a contour interval appropriate for the slope and complexity of the terrain. Sources for recent aerial photography and topographic mapping may include the Town, the FCDMC, and the USGS.

B. Master Drainage Plan – a map, or maps, depicting the existing conditions and proposed drainage infrastructure and retention/detention systems. The master planning layout shall also be plotted on the Master Drainage Plan to provide reference and context to proposed drainage designs and systems.



4.4 HYDROLOGY

4.4.1 Purpose

The intent of this section is to provide supplemental technical guidance and design aides for the performance of acceptable hydrologic analyses within the Town of Cave Creek. Estimation of flood hydrology within the Town of Cave Creek shall be performed using the procedures set forth in the County Hydrology Manual and the supplemental criteria and aids provided herein.

4.4.2 Watershed Conditions

Watershed conditions that produce the greatest peak flow rate shall be used to size drainage facilities or to determine lowest floor elevations of a structure to protect from flooding. A watershed that is fully developed in accordance with the town's most current General Plan Land Use Element and providing only First Flush stormwater storage will usually produce the greatest peak flow rate.

Other interim conditions such as the current state or development of the watershed in accordance with existing zoning may produce a greater peak flow rate and must be considered.

4.4.3 Split-Flow Conditions

Split-flow or distributary flow conditions exist in parts of Cave Creek and must be taken into consideration when analyzing watershed hydrology. The alluvial watercourses where these splits are found are subject active geomorphological processes and may be generally unstable, and therefore unpredictable. In determining peak discharge estimates downstream of these split locations, considerable attention should be given to assigning flow-split values. In setting finished floor elevations relative to upstream splits, it is strongly recommended that the designer assume that one hundred percent (100%) of the flow could go in either branch for a worst case flood event. For cases where the division of flow is based on an estimate of current split hydraulics, it is recommended that the resulting peak discharge estimates be increased by a minimum safety factor of 30 percent or more. All assumptions and adjustments should be clearly noted in the drainage report.

4.4.4 Precipitation/Rainfall

Table 3-3 summarizes point rainfall data to be used in the Town of Cave Creek for all watershed analyses substantially located within the Town boundaries. The rainfall data found in Table 3-3 were developed for the Town using rainfall data presented in the County Hydrology Manual, Appendix A.1 and the PREFRE program developed by the U.S. Bureau of Reclamation.



For watersheds where more than ten percent (10%) of the area is situated outside of the Town boundaries, the engineer should use the procedures outlined within the County Hydrology Manual to obtain more accurate point rainfall values.

4.4.5 Rational Method IDF Curves

Flood hydrology for small, uniform, regularly shaped drainage watersheds of less than 160 acres in size may be calculated using the Rational Method, as outlined in the County Hydrology Manual. A primary part of those procedures requires developing a set of Intensity-Duration-Frequency (IDF) curves for the watershed to be analyzed. Figure 4-1 represents IDF curves developed for the Town of Cave Creek and is intended for use on watersheds where no more than 10 percent of the watershed area is situated outside of the Town boundaries. For all other cases, the design engineer should use the procedures outlined within the County Hydrology Manual to obtain more accurate IDF curves.

Table 4-2

Summary of depth-duration point rainfall values for use in determining flood hydrology in the Town of Cave Creek

Return Period (years)	Duration (hours)					
	1	2	3	6	12	24
2	1.02	1.20	1.32	1.55	1.88	2.20
5	1.34	1.57	1.72	2.01	2.41	2.82
10	1.57	1.82	2.00	2.32	2.78	3.25
25	1.88	1.93	2.38	2.76	3.31	3.86
50	2.12	2.18	2.68	3.11	3.72	4.33
100	2.37	2.46	2.98	3.45	4.13	4.80

4.5 HYDRAULICS

4.5.1 Purpose

The intent of this section is to provide supplemental technical guidance and design aides for the hydraulic design and analyses of drainage structures within the Town of Cave Creek. All hydraulic analyses within the Town of Cave Creek shall be performed using the procedures set forth in the County Hydraulics Manual and the supplemental criteria and aids provided herein.



4.5.2 Roadside Drainage Ditches

The preferred street section for all public and private roadways within the Town is a crowned pavement section with opposing two percent (2.0%) cross slopes, ribbon curbs, and roadside drainage swales on both sides of the road.

Alternative configurations may be allowed at the discretion of the Town Engineer.

All roadside drainage ditches must be designed to convey intercepted runoff from a 10-year (Q10) storm to the nearest available watercourse or detention basin.

Driveways that must cross a roadside drainage ditch shall be constructed either with a dip crossing (preferred), or with a culvert sized to convey the peak 10-year discharge within the ditch. The minimum culvert size acceptable to the Town for this application is twenty-four inches (24") in diameter.

Appropriate erosion and/or scour protection must be provided for design channel velocities that exceed four feet per second (4 fps) within the roadside ditch.

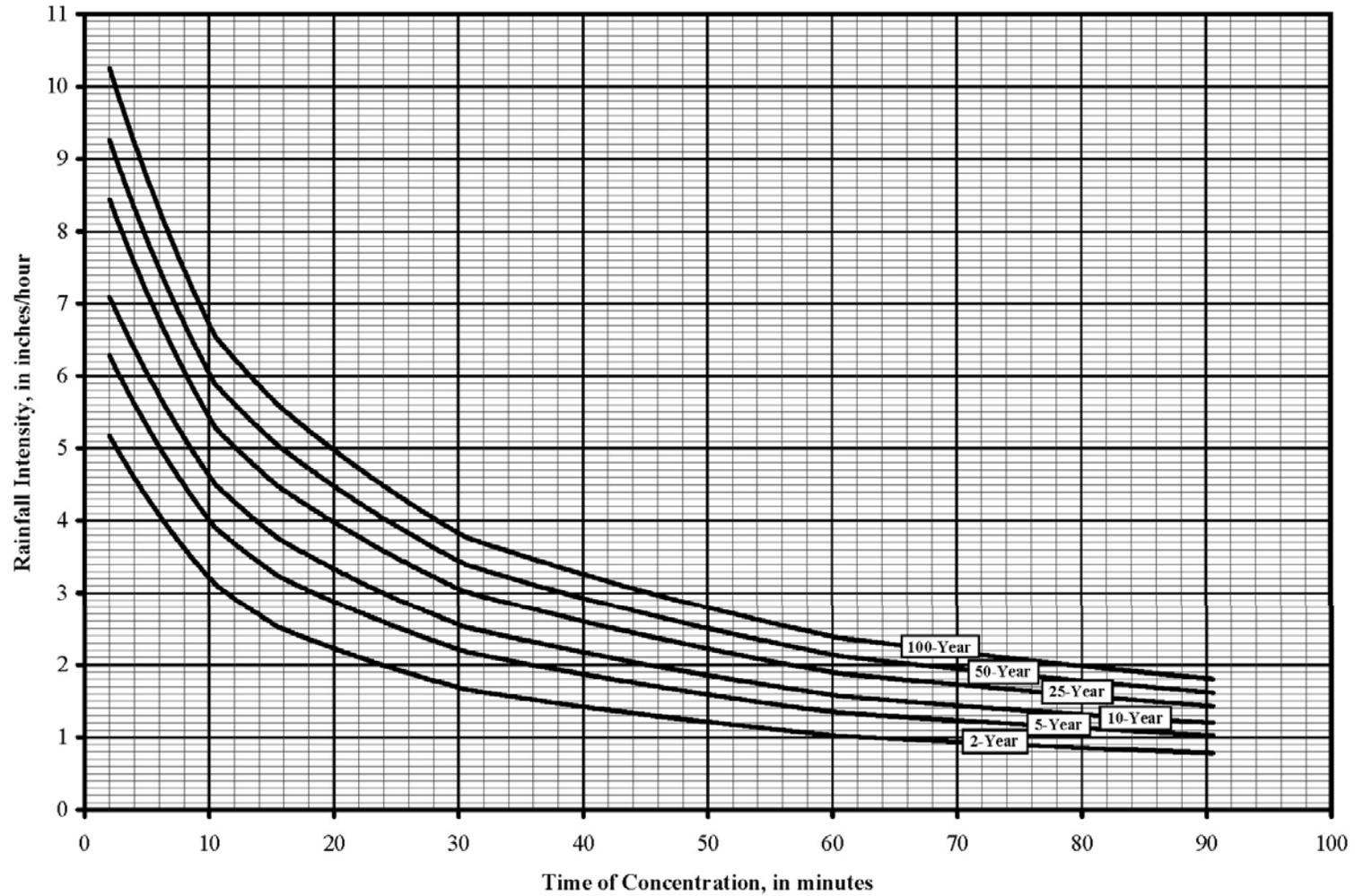


Figure 4-1
IDF Curves for the Town of Cave Creek

All roadside ditches shall be constructed a minimum of six inches (6") deep, with the flow line offset a minimum distance of five feet (5'), as measured from the outside edge of the ribbon curb. This is illustrated in Figure 4-2.

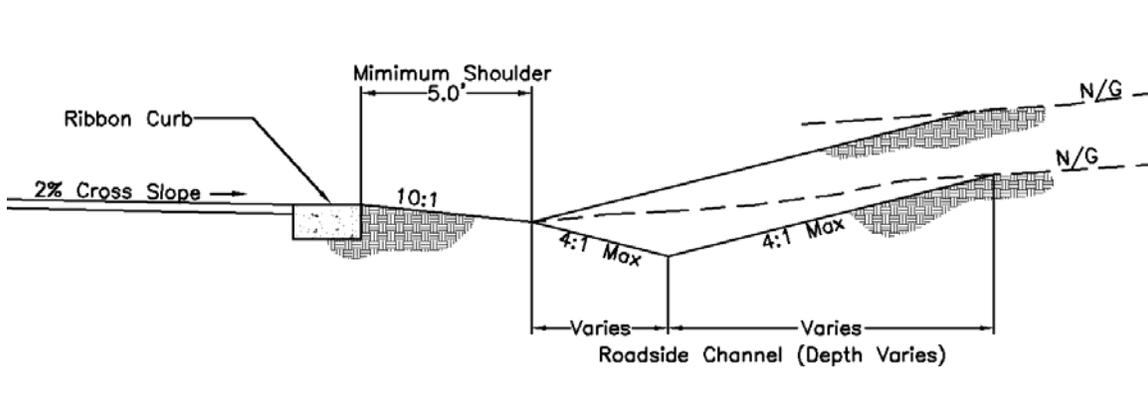


Figure 4-2

Typical Roadside Ditch Geometry

4.5.3 Dip Crossings

At the discretion of the Town Engineer, at-grade dip crossings may be allowed for the following scenarios:

- Broad and shallow wash crossings where the construction of a culvert or bridge is not practical and/or cost prohibitive.
- Crossings where the maximum depth of flow over the roadway can be limited to one foot (1') or less for a 100-year flood.
- Crossings that service a single lot or residence
- Crossings that do not serve two (2) or more lots or residences as an emergency access route or are required to provide all weather access.

The pavement for all dip sections should be concrete and should be constructed with flush curbs and medians, and a one way slope in the direction of flow.

Upstream and downstream cutoff walls and aprons shall be provided to minimize the effects of headcutting and erosion.

4.5.4 Storm Drains

In general, storm drains shall not be used to convey offsite water through a site or project, unless previously approved by the Town Engineer.



The minimum allowed storm drain pipe diameter is eighteen inches (18") for any system located within the Town of Cave Creek. The minimum pipe size for any system receiving runoff from two or more laterals shall be twenty-four inches (24") in diameter.

Sediment entrance into a storm drain shall be minimized using sediment traps at locations where runoff is introduced into the storm drain system.

Storm drains shall be designed to provide an average velocity when running full of not less than three feet per second (3 fps). Maximum velocities should be limited to no greater than ten feet per second (10fps).

Calculations establishing the design storm hydraulic grade line (HGL) calculations are required for all storm drains. The HGL shall be maintained a minimum of one foot (1') below the rim or grate elevations at all manholes, catch basins, inlets, etc. Exceptions to the HGL elevation limitations may be allowed on a case-by-case basis, as approved by the Town Engineer.

When the pipe changes direction equal or more than thirty degrees (30°) there shall be a drop, between invert match points, of at least 0.1 feet.

In no case shall the deflection angle be greater than ninety degrees (90°).

The maximum length between access openings shall not exceed four-hundred feet for pipes less than or equal to thirty-six inches (36") in diameter or six-hundred feet (600') for pipes greater than thirty-six inches (36") in diameter. Access opening may be in the form of an inlet, manhole, junction box or other approved appurtenance.

4.5.5 Culverts

The minimum allowable culvert size is twenty-four inches (24") in diameter.

All culverts shall be installed with upstream and downstream headwalls of appropriate type, using MAG Standard Details.

All headwalls shall include handrails, painted to match the surrounding desert terrain in color.

The conveyance capacity of culverts with inverts located more than 0.5 feet below the natural wash flowline elevation must be reduced by the amount represented by the cross sectional area below the natural wash flowline elevation.

Culverts for Major Washes shall:



- Be designed to convey the 100-year flow (Q100) without overtopping.
- Be sized to fit the existing wash geometry as closely as possible (i.e. – constructing culverts with widths that are significantly greater than the wash bottom, or alternatively, significantly narrower than the existing wash bottom).
- Be able to provide sediment transport continuity for all storm events up to and including the 10-year flood.

All culverts shall make provisions for protection against scour at the outlet using the methods outlined in the County Hydraulics Manual.

4.5.6 Open Channels

All open channels shall be designed to convey the 100-year peak discharge (Q100) with freeboard as required in the County Hydraulics Manual

All new open channels shall include an emphasis creating a "natural" looking channel section that replicates the natural washes within the surrounding area.

Whenever possible, the maximum design velocity for open channels shall not exceed the scouring velocity of the native soil with a natural covering. When the scour velocity is exceeded, additional erosion protection shall be provided.

If channel lining or landscaping material is used it must be inlaid or located below the design invert (bottom) of the channel such that the surface of the in-place lining or landscaping is equivalent to the design finished grade elevations of the channel. Alternatively, the design engineer can provide technical justification for increasing the channel roughness and thereby, decreasing its conveyance capacity.

4.5.7 Street Drainage

In general, street drainage concerns within the Town of Cave Creek should normally be limited to the design of roadside ditches and cross culverts; however, extenuating circumstances may require the use of curb and gutter within some areas of the Town. In those cases, street drainage design should be based on the details presented in the County Hydraulics Manual and the following supplemental guidelines:

- Local Streets
 - The 10-year flood (Q10) shall be conveyed below the top of curb elevation.
 - The 100-year flood (Q100) shall be conveyed within the right-of-way and shall not exceed one foot (1') in depth at the curb.



- Collectors and Arterials
 - The 10-year flood (Q10) shall be conveyed below the top of curb elevation.
 - A minimum of a twelve foot (12") driving lane in each direction shall be maintained for the 10-year flood.
 - The 100-year flood (Q100) shall be conveyed within the right-of-way and shall not exceed one foot (1') in depth at the curb.
- In cases where the above capacities are exceeded, catch basins and storm drains or scuppers shall be used to reduce the flooding impacts within the street.
- Concrete valley gutters (MAG Std. Detail. 240, as may be amended hereafter) shall be constructed at all intersections where the drainage pattern requires them. Valley gutters are not allowed to cross major arterial or arterial streets. All valley gutters not located at intersections shall be a minimum of six feet (6') in width. Asphalt valley gutters are not allowed on any public street or alley.
- Scuppers are not to be used unless grade limitations mandate it. Scuppers that use a metal cover (walking surface) will not be allowed. MAG Standard Detail 206 shall be used as basis of scupper design unless prior approval of another design is obtained from Town Engineer.

4.6 STORMWATER STORAGE

4.6.1 Stormwater Storage Policy

Stormwater storage systems serve two primary purposes in drainage design. The first is to minimize the discharge of construction or development related pollutants into watercourses adjacent to or within the project property. The second is to provide a stormwater storage system that will retain or detain a sufficient volume of runoff to mitigate increases in runoff volumes typically associated with development or improvement of a property.

As policy, all new developments are required to provide stormwater storage for all runoff developed by a 100-year, two hour (2 hr.) storm. Waivers of this requirement may be requested of the Town Engineer if it is determined that said retention is impractical due to conditions such as steep terrain, poor percolation, or incompatibility with existing or surrounding improvements. As a condition of the waiver, the Town Engineer may require additional drainage analyses to



determine if a drainage problem will be created on adjacent or downstream properties.

At a minimum, all new developments receiving a waiver shall provide one hundred percent (100%) storage for the First Flush, as defined herein.

4.6.2 Retention/Detention Design

For subdivisions with lots that are less than one acre (1 ac.) in area, stormwater storage shall be provided in common tracts that are to be dedicated to the public and maintained by a Homeowner's Association.

On-lot retention on individual single family residential lots is not permitted as a solution to subdivision retention requirements, unless lot sizes are one acre (1 ac.) or greater.

Stormwater storage basins shall be located such that they can intercept the flows from the entire site. This can be satisfied using one or more storage facilities.

Commingling of offsite and onsite drainage by means of routing offsite stormwater through onsite storage basins is discouraged and will require prior approval from the Town Engineer. Basins located on-stream interrupt the natural flow regime of the wash and can:

- Create a continual debris and sediment maintenance problem for the property owner
- Affect the ability of the basin to drain within the required thirty six hours (36 hr.)
- Cause a potential dam/levee failure flood hazard for downstream residents if constructed with storage above grade.

Storage of stormwater within the right-of-way is limited to satisfying the storage requirements for right-of-way generated runoff.

Stormwater storage may be allowed in paved parking areas of commercial and industrial developments, provided that the following requirements are satisfied:

- The maximum depth of ponded water does not exceed eight inches (8").
- The first third of the required runoff volume be provided for off of paved areas (to avoid nuisance water constantly ponding on the pavement).
- Interference with pedestrian traffic will be minimized in the design of the storage facility.

Stormwater storage systems designed to operate as detention basins shall demonstrate effective attenuation of the 2-year, 10-year, and 100-year storms, such that the post-development peak discharges do not exceed the pre-development discharges for each return period. Demonstration of this



attenuation shall be accomplished using the U.S. Army Corps of Engineers' HEC-1 model and the methodologies presented in the County Hydrology and Hydraulics Manuals.

Stored stormwater shall be designed to drain to a Major Wash, if available.

It is the intent of the Town that all stormwater storage basins present an aesthetically pleasing appearance that replicates the natural desert landscape as closely as possible. To accomplish this, the design engineer shall contour the sides and bottoms of the basins to enhance appearance through varied and naturally appearing slopes. The use of native materials in the construction of all basins is also encouraged.

Side slopes shall not be steeper than 4H:1V. Exceptions to slope requirements may be approved by the Town Engineer when innovative and esthetically pleasing design features are presented and public safety is not compromised.

All stormwater storage basins shall have a design capacity such that the ponded water depth is limited to a maximum of three feet (3'). The Town Engineer may approve greater water depths as long as a positive method of water disposal is used or available.

Constructed underground retention storage structures shall have a minimum 50-year service life and shall be equipped with manhole access points for maintenance and inspection.

Storage basins shall have an emergency spillway, where appropriate, to safely direct any overflow into a Major Wash.

4.6.3 Stormwater Disposal

All stored stormwater shall be disposed of within thirty-six hours (36 hr.) following the cessation of a storm. Acceptable methods of disposal include gravity outfalls (via pipe or culvert), natural percolation, drywells, and pumps. The following are some general design guidelines for various allowable methods:

Natural Percolation – For all storage basins proposed to be drained by natural percolation, an initial shallow pit percolation tests shall be performed at the storage basin area(s) to determine natural percolation rates. Tested rates shall be reduced by fifty percent (50%) to account for the natural process of consolidation and siltation of surface soils. Tests shall be conducted prior to mass grading, and results shall be submitted to the Town Engineer prior to approval of drainage plans.

Drywells – Drywells are comprised of an interception chamber and a drilled shaft that either penetrates into porous strata material or has a sufficient contact area with surrounding soils to effectively accommodate percolation requirements. The drilled shafts are engineered to preserve the integrity of the shaft using filter



fabrics, gravel filters, and perforated pipes. The following are summaries of design guidelines for the use of drywells:

- Drywell inlet grates shall be located a minimum of two inches (2") above the bottom elevation of the storage basin.
- For the purposes of determining the number of drywells required to drain the retained volume within thirty-six hours (36 hr.), drywells shall be assumed to percolate at a maximum rate of 0.2 cubic feet per second. Alternatively, the design engineer may use certified percolation rates, reduced by fifty percent (50%) for deterioration, that are derived from a constructed drywell in the subject storage basin.
- Multiple drywell installations shall be located a minimum of one hundred feet (100') apart, unless waived by the Town Engineer, and a minimum of twenty feet (20') away from a basin inlet.
- All drywells receiving stormwater directly from paved areas, or that drain areas containing fuel or oil storage and dispensing facilities, must have oil interceptors installed on them.
- Drywells shall be located a minimum of one hundred feet (100') away from water wells, underground storage tanks.
- Drywells are not to be located within public street right-of-way or private street roadway tracts unless authorized by the Town Engineer.
- The property owner of record shall be responsible for the performance, operation, registration, and maintenance of drywells used. All drywells must be registered with the Arizona Department of Environmental Quality (ADEQ).
- Drywell inspections are to be performed annually or whenever ponding is still evident thirty-six hours (36hr.) after a storm. Inspections shall be documented utilizing ADEQ's inspection checklist and kept on file by the drywell facility owner. Should inspection reveal that a drywell is no longer effective and cannot be returned to effective use, a new drywell shall be installed.

Gravity Pipe Drains - The time to drain basins serviced by gravity pipe outfalls should be maximized to ensure the effectiveness of the basin. The target design drain time should generally be between sixteen (16) and twenty-four (24) hours. The minimum allowable pipe diameter is eighteen inches (18"); however, the discharge from the basin may be regulated with an orifice plate over the entrance of the outlet pipe to reduce discharge rates.

Pump Stations – Pump stations, when proposed, shall comply with the requirements of County Hydraulics Manual. All design calculations and analyses shall be documented and submitted to Town Engineer for review and approval



4.7 OPERATION, ACCESS AND MAINTENANCE

All properties, as a condition of development, must be accessible during the 100-year frequency storm event. Access is considered to exist if it is demonstrated that at least one access road, consisting of a structural roadway section such as asphalt, concrete, or compacted aggregate, has a depth of flow no greater than 1 foot during the peak flow for the 100-year event.

All drainage control, flood control, and erosion control facilities, both public and private, shall be regularly maintained.

Accumulations of silt, trash, litter, or stagnant water which create a health or safety hazard, or which endanger the design function of the facility, are not permitted. Excessive growth or accumulation of woody vegetation in channels and on dams and levees shall not be permitted. Active erosion due to wind or water associated with drainage control, flood control, and erosion control facilities shall be mitigated.

The Town shall regularly maintain the drainage control, flood control, and erosion control facilities for which it has responsibility. Privately owned drainage control, flood control, and erosion control facilities shall be maintained according to the general standards above and such that adjacent upstream or downstream public or private facilities are not damaged or endangered.

Maintenance of stormwater storage facilities within the Town of Cave Creek are typically the responsibility of the property owner or the subdivision's homeowners association. Specific maintenance responsibilities shall be called out on the recorded plat and the grading and drainage plan.

4.8 EROSION HAZARD SETBACK LIMITS

4.8.1 Policy

Erosion hazard setback limits (EHSL) shall be determined for all Major Washes within, or adjacent to, a project. Methodology for determining EHSLs are set forth in the EHZ Guidelines. The amount of analysis and report documentation required, will be dependent upon the Methodology Level chosen to determine the EHSL.

4.8.2 Type of Erosion Hazards

Most of the erosion hazards affecting or contributing to lateral movement of washes within the Town of Cave Creek, are illustrated in Figure 4-3 (Figure 2.1 in the EHZ Guidelines) and can be grouped into the following categories:



- Type A, or channel erosion, occurs within the main channel and the portions of the floodplain subject to high velocities, scour, and high rates of sediment transport.
- Type B, or avulsive channel movement, occurs within parts of the floodplain where flood depths and velocities are high enough to form new channels away from the main channel.
- Type C, or lateral bank erosion, occurs at sites located near enough to the main channel to be damaged if the channel erodes its banks or migrates within its historical channel corridor. Type C lateral erosion may also occur within the part of the Type B avulsion erosion area located near the channel bank.
- Type D erosion hazards occur within the portion of the floodplain not subject to avulsions or bank migration, where relatively low flood depths and velocities occur. Type D erosion hazards may be exacerbated where the natural shallow flooding flow paths are disturbed by development.

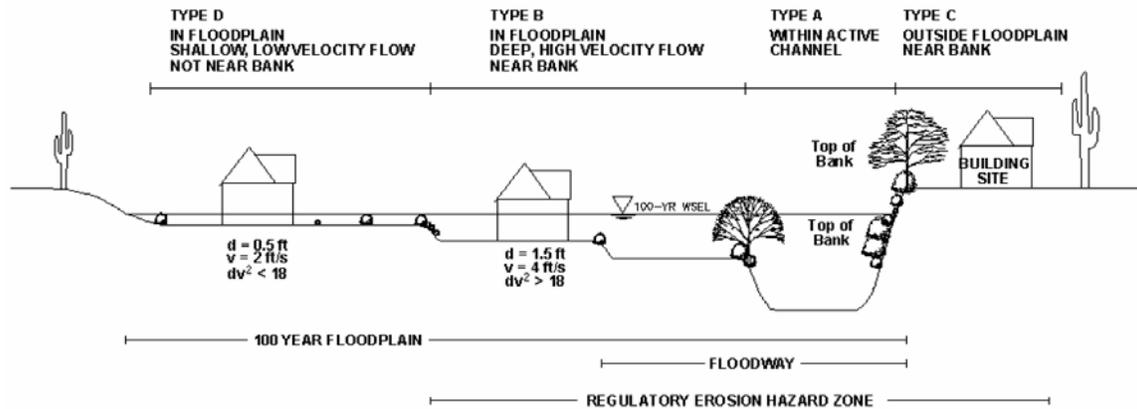


Figure 4-3

Categories of Erosion Hazards Typical to the Town of Cave Creek

More than one type of erosion can affect a specific building site. Design of new structures shall consider the potential impacts from each of the four types of erosion hazard.

Normally, the regulatory erosion hazard zone will include areas affected by Types A, B and C erosion hazards.



Type D erosion hazards can typically be adequately addressed by elevating the structure, protecting the foundation or fill pad, and preventing concentration of floodwater conveyance through the property boundaries.

Other erosion hazards that are typically associated with drainage structures, may include scour at culvert outlets, bridge scour, scouring along spillways, and sill and end scour at roadways and drop structures.

4.8.3 Levels of Analyses

There are three levels of analysis methodology provided for within the EHZ Guidelines, which are summarized as follows:

Level 1 – The Level 1 methodology requires the lowest level of effort and generally results in conservative erosion hazard zone delineation.

The Level 1 methodology is typically applied only to small, single lot, or non-commercial developments, but can be applied to any type of development in watersheds less than 50 square miles.

Level 2 – The Level 2 methodology requires site information, basic hydraulic modeling, and a greater level of effort than the Level 1 methodology, but results in a site-specific erosion hazard zone more appropriate for the existing site conditions at the proposed development. The Level 2 methodology is typically applied only to small, single lot, or non-commercial developments, and may be difficult to apply over long stream reaches.

Level 3 – The Level 3 methodology consists of a detailed erosion hazard analysis, which requires special expertise in hydrology, hydraulics, sediment transport, river mechanics, fluvial geomorphology, and local stream system dynamics. A Level 3 analysis typically requires the greatest level of effort and cost. The Level 3 methodology is appropriate for multi-lot and commercial development, long stream reaches, and large watersheds.

The design engineer for each development shall determine which of the levels is most appropriate for the project and submit the corresponding analyses and maps with the drainage report.

4.9 EROSION CONTROL AND PREVENTION MEASURES

4.9.1 Non-Structural Measures

The recommended non-structural erosion hazard management approach consists of limiting development to areas outside the erosion hazard zone, and particularly the construction of habitable structures, retaining walls, pools, driveways, and other permanent types of improvements typically associated with development.



Typical land uses that may be permitted within an erosion hazard zone include agricultural, open space, park, passive recreation, limited parking, trails, and unimproved/non-essential roads.

4.9.2 Structural Measures

Structural erosion control measures involve the placement or construction of facilities for the mitigation of erosion hazards. All encroachments of the determined EHSL will require some form of structural erosion control measure.

Typical structural measures might include loose or grouted riprap, gabion cubes and mattresses, concrete lining, articulated concrete revetment blocks, cement stabilized alluvium, roller compacted concrete, three-dimensional turf reinforcement mattresses, retaining walls, gravity walls, and others.

In some cases, passive erosion control measures such as riprap launch trenches and buried gabion cubes and mattresses, may be implemented to provide protection to structures without impacting floodways or Section 404 jurisdictional areas.

In all cases, the design engineer should attempt to use materials and configurations that will blend into the surrounding natural desert terrain as closely as possible.

4.9.3 Design Guidelines

Detailed guidelines for determining design scour depths and structural erosion control measures are provided in the County Hydraulics Manual, and shall be used for the design of all erosion control measures within the Town. The following general design guidelines apply to any erosion control structures proposed for development in an erosion hazard zone:

- Structural measures must be designed to have no short-term or long-term adverse impact on adjacent properties.
- Structural measures must be designed to withstand at least the 100-year event.
- Maintenance and inspection requirements should be clearly identified.
- Piecemeal bank protection should be avoided. Piecemeal bank protection consists of bank stabilization measures or designs that are not continuous along a watercourse.
- Erosion protection constructed anywhere within the erosion hazard zone shall be toed-down below local and long-term scour depth of the main channel.



- Erosion protection shall be tied in upstream and downstream to a stable area outside the erosion hazard zone. The requirement for upstream and downstream tie-in may preclude use of structure measures on some small lot developments in erosion hazard zones.
- Flexible bank protection (e.g., rip rap) is preferred over rigid bank protection (e.g. concrete).
- Grade control may be required where potential for long-term degradation exists.
- Bank protection should be buried and revegetated wherever possible.
- Bioengineering techniques are acceptable if they meet the other criteria listed above.



SECTION 5 - REFERENCE MATERIALS

Arizona Department of Water Resources (ADWR), 1985, Design Manual for Engineering Analysis of Fluvial Systems.

Arizona Department of Water Resources (ADWR), 1996, State Standard 5-96, State Standard for Watercourse System Sediment Balance.

Arizona Department of Water Resources (ADWR), 1998, State Standard 7-98, State Standard for Watercourse Bank Stabilization.

Flood Control District of Maricopa County, 2000, Floodplain Regulations for Maricopa County.

Flood Control District of Maricopa County, 2003, Drainage Design Manual for Maricopa County, Arizona – Volume I-Hydrology.

Flood Control District of Maricopa County, 2003, Drainage Design Manual for Maricopa County, Arizona –Volume II-Hydraulics.

Flood Control District of Maricopa County, 2003, Erosion Hazard Zone Delineation and Development Guidelines, Draft version dated May 6, 2003.

Town of Cave Creek, Zoning Ordinance

Town of Cave Creek, Subdivision Ordinance



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