STORM DRAINAGE DESIGN MANUAL

TOWN OF PARADISE VALLEY

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TOWN OF PARADISE VALLEY

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FOREWORD

STORMWATER DRAINAGE DESIGN

This chapter provides guidance for complying with specific federal, state, county, and town regulations applicable to floodplain management, water quality, and stormwater management. It presents guidance for preparing drainage reports and grading and drainage plans using the design standards and methodologies adopted by the Town of Paradise Valley, the Flood Control District of Maricopa County, the Arizona Department of Water Resources, and the Federal Emergency Management Agency.

Natural wash through neighborhood in Paradise Valley

Fully charged drainage in Paradise Valley

Erosion in Paradise Valley

Stormwater management facilities integrated with natural landscape

OVERVIEW

1-1 GENERAL INFORMATION

A. This document, entitled the Paradise Valley Storm Drainage Design Manual (SDDM):

1. Administers Chapter 5, Article 5-10-3 and 5-11-1 to 27 of the Paradise Valley Town Code.
2. Provides guidance for complying with federal, state, county and town regulations applicable to floodplain management, water quality and stormwater management.
3. Outlines requirements for preparing drainage reports and grading and drainage plans.

B. This document is intended to provide guidance for designing meaningful flood protection, but such protection can be challenging because much of the natural grade has already been disturbed, existing development may constrain drainage options, or other reasons. In such cases, the Floodplain Admnistrator may require different or additional flood protections to:

1. Avoid any increased danger or damage to persons or property, and
2. Meet the general intent and purposes of the regulations.

1-2 GOVERNMENT AUTHORITIES

A. Federal authorities

1. Federal Emergency Management Agency (FEMA)
2. U.S. Environmental Protection Agency (EPA)
3. The U.S. Army Corps of Engineers (Corps)
4. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Services

B. State authorities

1. Arizona Department of Water Resources (ADWR)
2. Arizona Department of Environmental Quality (ADEQ)

C. Local authorities

1. Flood Control District of Maricopa County (FCDMC)
2. Maricopa County Department of Public Health
3. Town of Paradise Valley (PV)

D. Coordination

Applicants are responsible for coordinating with other interested parties, including utilities, federal and state agencies. Other agency permits may be necessary before applying for Town permits. Applicants should consider the time frames for obtaining those other permits.

1-3 STANDARDS

A. FEMA 44 CFR

http://ecfr.gpo.gov/cgi/t/text/text-idx?&c=ecfr&tpl=/ecfrbrowse/Title44/44tab_02.tpl

B. ADWR State Standards

http://www.azwater.gov/azdwr/SurfaceWater/FloodManagement/StateStandards.htm

C. Drainage Design Policies and Standards for Maricopa County

http://www.fcd.maricopa.gov/downloads/2016-Drainage-Policies-Standards-Manual.pdf

D. Paradise Valley Storm Drain Design Ordinance (1987)

http://paradisevalleyaz.gov/documentcenter/view/3953

1-4 RESOURCES

A. Federal

1. National Flood Insurance Act
   http://www.fema.gov/library/viewRecord.do?id=2216
2. Flood Insurance Rate Maps (FIRMs)
   http://www.fema.gov/hazard/map/firm.shtm
3. Clean Water Act (CWA)
   http://www.epa.gov/owow/watershed/wacademy/acad2000/cwa/
4. USDA Natural Resources Conservation Services (NRCS) soil survey maps
   http://www.nrcs.usda.gov/
5. National Oceanic and Atmospheric Administration (NOAA)
   http://www.nws.noaa.gov/oh/hdsc/currentpf.htm
6. US Environmental Protection Agency, Storm Water Management Model (SWMM)
   https://www.epa.gov/water-research/storm-water-management-model-swmm#description
7. US Environmental Protection Agency, Low Impact Development (LID)
   https://www.epa.gov/polluted-runoff-nonpoint-source-pollution/urban-runoff-low-impact-development

B. State

1. ADWR
   http://www.azwater.gov/azdwr/default.aspx
2. ADEQ
   www.azdeq.gov/environ/water/permits/stormwater.html

C. Local

1. Paradise Valley Town Code, in particular Chapters 5 and 8
   http://paradisevalleyaz.gov/DocumentCenter/Home/Index/30
2. Paradise Valley Document Center
   http://paradisevalleyaz.gov/documentcenter
3. Paradise Valley Area Maps
   http://paradisevalleyaz.gov/DocumentCenter/Index/16
4. Paradise Valley Record Request Form
   http://paradisevalleyaz.gov/documentcenter/view/137
5. Flood Control District of Maricopa County
   www.fcd.maricopa.gov
6. Maricopa County Health Department Standards
   http://www.maricopa.gov/clk_board/Ordinances/P14_Health_Code.pdf

FLOODPLAIN MANAGEMENT

2-1 GENERAL INFORMATION

A. The Town's design, construction and documentation requirements for development in Special Flood Hazard Areas (SFHAs) and pending SFHAs are in this manual. Unless otherwise approved by the Floodplain Administrator, each project must conform to the Town's requirements as referenced in Article 5-11.

B. All habitable structures must be designed so that they will not flood in a base flood as defined in 5-11-1.

2-2 PERMIT REQUIRED

A. Appropriate permits are required before construction or development begins within any SFHA, as mapped on the FIRMs. Applications for permits shall be made on Town forms and may include, but are not limited to, plans drawn to scale showing the nature, location, dimensions and elevation of the area of development, existing or proposed structures, fill, excavation, storage of materials, and drainage facilities. Specifically, the following information is required:

1. Proposed elevation in relation to North American Vertical Datum (NAVD 88) of the lowest floor (including basement) of all structures.
2. Proposed elevation in relation to NAVD 88 to which any non-residential structure will be floodproofed.
3. Certification by an Arizona licensed engineer that the floodproofing methods for any nonresidential structure meet the floodproofing requirements of the Town and FEMA.
4. Base floor elevation for all development within or contiguous to floodplains.
5. Description of the extent to which any watercourse will be altered or relocated as a result of proposed development. See Section 6, Drainage Report and Plans.

2-3 SPECIAL FLOOD HAZARD AREAS

A. Portions of the Town fall within special flood hazard areas, as mapped on the FIRMs. Special flood hazard areas are flood zone designations that begin with an "A" and require particular attention when being analyzed and designed for development.

2-4 SUBSTANTIAL IMPROVEMENTS AND SUBSTANTIAL DAMAGE IN SFHAS

A. This section applies when a structure in an SFHA is not in compliance with current standards, and:

1. Improvements requiring a building permit are proposed; or
2. Repairs to damage, requiring a building permit, are proposed.

B. Upon application to the Community Development Department for a building permit, if it appears that this section is applicable to the project, the applicant shall submit an appropriate Substantial Improvement/Substantial Damage Worksheet, available from Town Engineer. The Substantial Improvement/Substantial Damage Worksheet is a screening tool to establish which projects exceed 60% or are less than 40% of the structure's existing market value before the improvements or repairs utilizing FEMA criteria.

C. If it appears that the project costs between 40% and 60% of the structure's existing market value, the applicant shall provide an appraisal of the value of the existing structure (excluding land value and other improvements to the property such as a swimming pool or accessory structures, before improvements and/or repairs), and a construction proposal signed by an Arizona licensed contractor.

D. An applicant may bypass the Substantial Improvement/Substantial Damage Worksheet, or challenge the Worksheet's calculation, by providing an appraisal of the value of the existing structure as described in C above and a signed construction proposal from an Arizona licensed contractor.

E. In case of substantial improvements or repairs to substantially damaged structures, defined as projects costing 50% or more of the value of the existing structure, the entire structure must be brought into compliance with the Town's floodplain management regulations.

For information refer to FEMA's guide to substantial damage and substantial improvements. http://www.fema.gov/library/viewRecord.do?id=1636

The Town's substantial improvement/substantial damage worksheets are available upon request from the Town Engineer.

Stormwater Management

3-1 GENERAL INFORMATION

A. Use the design standards and methodologies described in the Drainage Design Manual (DDM) for Maricopa County, Arizona, latest edition, which includes Volume I - Hydrology, Volume II - Hydraulics and Volume III - Erosion. The SDDM prevails in any conflict between the DDM for Maricopa County and the Town's SDDM whenever the latter is more restrictive. Design Engineer should discuss any conflict with the appropriate Town staff for resolution before submitting reports and plans for review.

3-2 STORMWATER STORAGE

A. Generally

1. Stormwater storage facilities are designed primarily as retention facilities. Other stormwater management facilities, such as detention basins, dry wells, pumps and injection wells, will only be allowed as approved by the Town Engineer.

2. All new developments shall make provisions to retain the runoff of a 100-year, 2-hour duration storm falling within the boundaries of the development unless the drainage can be conveyed directly to an existing major channel or natural drainageway, and the developer can demonstrate no adverse off-site impacts to the satisfaction of the Town Engineer.

3. Lot to Lot drainage within a new development is prohibited unless permanent drainage facilities are constructed in dedicated drainage easements or tracts that are maintained by the Town or a homeowners association (HOA).

4. Developments with HOAs may locate retention facilities in private dedicated drainage tracts. These tracts will be maintained by the homeowners association.

B. Stormwater Storage Volume

1. Design Volume

a. For all new development, the standard formula for determining the required stormwater storage runoff volume is shown below.

$$Vr = C(R/12)A$$

Vr = Required storage volume in cubic feet.

R = Precipitation amount = The depth in inches of the 100-year, 2-hour rainfall, from FCDMC Hydrology Manual Figure A.56 at the site.

A = Area (square feet) of entire project site, including:

(1) Easements, tracts and rights-of-way within the development, plus

(2) Where the development includes improvements to the rights-of-way on the perimeter of the property, the area of those improvements up to the ROW centerline.

C = Weighted average runoff coefficient over entire site, per the FCDMC Hydrology Manual tables 3.2 and 3.3

b. For single family residential lots (not hillside)

$$Vr = C(R/12)A$$

100% retention amount

c. For hillside lots (steeper than 10% slope)

$$Vr = \triangle C(R/12)A$$

100% of the pre-vs.-post calculated amount

d. Volume requirement may be prorated based on average slope steepness across the entire site as measured at its midpoint. General guidelines are:

- 10-20% slopes require 100% of the pre-vs.-post calculated retention volume
- 20-30% slopes require 50% of the pre-vs.-post calculated retention volume
- slopes steeper than 30% require 0% (no retention required).

The Town Engineer may waive requirement if proved otherwise, based on certain criteria, such as adverse impact and soil type.

e. The Town encourages the use of Low Impact Development (LID) techniques, as described in Chapter 6, to both reduce the amount of impervious surfaces constructed, and to provide required storage volume. LID techniques can be used to reduce the site composite runoff coefficient, thus reducing the overall storage requirement.

2. First Flush Volume

a. Where detention is allowed, first flush volume shall be retained on all lots or within common retention areas, and a reasonable attempt shall be made to route all runoff from disturbed areas to the first flush basin(s) subject to grading plan approval.

b. The first flush volume shall be calculated using the following formula:

$$Vf = CPA$$

Vf = the required first flush storage volume, in cubic feet;

C= the weighted average runoff coefficient for the disturbed area of the proposed development;

P= the required precipitation depth of 0.5 inches, converted to feet; and

A= the disturbed area of the proposed development, in square feet.

c. If retention of the first flush volume is provided, the stormwater storage facility must be fully evacuated within 36 hours. The maximum allowable infiltration rate shall be 50% of the in-situ tested rate of the as-constructed basin. Testing shall be conducted using double-ring infiltrometer methodology in accordance with FCDMC standards.

3. Certified Volume

a. Before acceptance, or before the issuance of a certificate of occupancy, the engineer of record/property owner must provide the Town with certified, as built dimensions of the facilities, and the actual volume of storage provided.

b. The actual volume of storage provided must:

i. Be based on as-built topographic surveys performed by an engineer or surveyor;
ii. Reflect permanent, finished landscaping in place;
iii. Meet or exceed the required volume;
iv. Be constructed to perform as designed; and
v. Be certified by an engineer.

c. The volume of storage provided must equal or exceed the approved design volume before the Town will issue a Certificate of Occupancy. See volume table in Appendix 6A.

C. Storage Facilities Design

1. All on-site water retention areas other than piped systems shall be entirely landscaped. Storage facilities shall be located to intercept the flows generated for each tributary area within the entire development, to the maximum extent practicable.

2. Storage facilities shall be set back at least 5 feet from adjacent properties, rights-of-way (ROW), public utility easements (PUE's) or other utility easements or as approved by the Town Engineer.

3. In-stream storage facilities are prohibited because they interrupt the natural flow of the wash and can create debris and sediment obstructions.

4. Retention/detention facilities should be designed with a positive gravity drain system whenever possible.

5. Basin side slopes shall not exceed a 4:1 (4 foot horizontal to 1 foot vertical) ratio.

6. The design depth of stored water in a facility shall not exceed 3 feet except as otherwise approved by the Town Engineer.

7. Ultimate outfall of basins must be one (1) foot below adjacent finished floor elevations.

8. Facilities shall have an emergency spillway to safely direct overflow into a recognized watercourse or to the historical outfall of the lot.

9. Above-ground storage facilities contained by an embankment are generally prohibited. If above-ground storage facilities are permitted, they must be designed and constructed according to generally accepted geotechnical and, if necessary, structural-engineering principles. Slope stability, piping, seepage, sliding, overturning and material integrity shall be considered.

10. Except as provided in 11 below, stormwater storage facilities for residential subdivisions shall be located in a tract.

11. Stormwater storage facilities for a residential subdivision may be located on a private lot if the owner:

    a. Provides a physical demarcation around the stormwater storage facility, to avoid interference with its purpose, in accordance with an approved plan, and dedicates unobstructed physical, legal and visual access from the right-of-way to the facility.

    b. Constructs and maintains an approved cistern for rainwater harvesting.

12. Detention basins and related facilities shall be designed to drain to a recognized watercourse, such as a established wash, or to the historical outfall of the lot. Unless otherwise approved by the Town Engineer, stormwater may not be discharged onto a street, alley, storm drain or gutter.

13. A stormwater storage facility shall not detain or retain standing water longer than thirty-six (36) hours unless the facility is designed and constructed to be a permanent body of water with appropriate health, safety, and water quality measures. Consistent with requirements specified in the DDM for Maricopa County, double-ring infiltrometer testing shall be required with a factor of safety of 2 to demonstrate adequate drawdown within 36 hours for all basins.

14. Drain time should be maximized to ensure the effectiveness of the facilities. Drain time should generally be from 12 to 24 hours. Discharge from the detention basin may be regulated with a hinged orifice plate, with a minimum diameter of 6 inches, over the entrance of the outlet pipe if the outlet pipe meets the minimum size requirements. Storage facilities shall be equipped with a baffle, or other approved method, to keep oil, grease and other floatables in the basin. Baffles, if utilized, shall extend 6 inches below the bleeder invert elevation.

15. Storage facilities shall be designed to allow for regular maintenance activities, such as providing access for inspection vegetation and soil management, and removal of sediment, debris and other obstructions.

16. Stormwater storage may occur in a private road, driveway or parking lot if the following conditions are met:

    a. At least the first 50% of the required storage volume is provided in a stormwater storage basin or underground storage tank, if approved;

    b. No more than 50% of the required storage volume is provided;

c. The depth of water does not exceed six inches; and

d. Interference with pedestrian traffic is minimized.

3-3 UNDERGROUND STORMWATER STORAGE POLICY

A. This policy supplements the Town Code requirements for all stormwater storage. Underground stormwater storage involves constructing underground tanks, pipes, or vaults that accept stormwater runoff by means of inlets and storm drain pipes. The Town will only approve underground storage after rigorous analysis of storage system location, specifications, access, operation and maintenance, liability, and signage.

B. Projects qualifying for underground stormwater storage must meet the following criteria:

1. Projects located within a commercial, non-residential or multi-family development with a viable property maintenance organization or other maintenance mechanism to assume continued maintenance of the underground stormwater storage system and protect the public interest.

2. Single family residences with an underground storage easement instead of a drainage easement.

C. General Criteria for Underground Stormwater Storage System Design

1. Underground stormwater storage systems must demonstrate protection of public health, safety, and welfare as established by the Town Code and related policies.

2. All underground stormwater storage elements must meet industry standards or stricter standards.

3. Storage system must not be located under buildings or parking garages.

4. The owner must dedicate a drainage easement to the Town which meets the standards for all drainage easements.

5. Design must address:

a. Water quality protection measures to protect underground and surface water resources to meet applicable water quality standards.

b. Vector control within storage system.

c. Redundancy in case of storage system failure, with particular attention to the possibility of structure or street flooding, sediment accumulation, or storm events that are greater than the 100-year, 2-hour event.

d. Initial suspended sediment load removal.

e. At least a 75 year life of entire system, including the lining and coating of the underground storage tank.

f. Drainage by gravity. Pumped systems or drywells will only be considered if no other reasonable alternative exists.

D. Specific Criteria for Underground Stormwater Storage Design

1. Outfall—underground storage systems must have some sort of outfall, such as gravity drains or pumps.

2. Pipes—underground storage system pipes must have a smooth interior floor to prevent debris from collecting in the pipe, reducing its effective volume.

3. Installation—excavation, bedding, and backfill procedures and materials must be in accordance with MAG standards.

4. Access—a minimum of two access points must be provided for each underground storage system to enable inspections and removal of accumulated sediment and debris. Access must be in accordance with MAG standards.

E. Criteria for Operations, Maintenance and Liability

1. Operations and maintenance generally—owner must provide:

   a. Contractor or maintenance staff with experience in operating, inspecting, and maintaining an underground stormwater storage system.

   b. An Operations and Maintenance Manual on site for the system that includes:(i) a schedule for inspections and maintenance, and (ii) provisions for emergency operations due to power failure, pump failure and clogged outlet structures.

   c. A log of the inspections and required maintenance services.

2. Inspections and maintenance required—In addition to maintenance required by the Town Code and other applicable requirements, owner shall:

   a. Inspect system after each storm event of 0.6 inch or more, and semiannually,preferably before summer and winter rains.

   b. Remove accumulated trash and debris from inlet and outlet structures as needed to ensure free flow of stormwater.

   c. Inspect all other elements of the drainage system (pipes, geotextiles, and stone) and repair/replace elements as needed for the storage system to operate at peak efficiency.

3. Signage—Before receiving a certificate of occupancy, the owner must install signs at each end of the underground storage tank that read "Notice—Underground Stormwater Storage Tank." The size, color, and locations of signs are subject to Town staff approval.

4. Liability—Owner assumes all liability for the design, construction, maintenance and failure of the underground stormwater storage system in perpetuity and hold the Town harmless from any such liability. Before receiving a certificate of occupancy, the owner must record a signed and notarized document to this effect, in a form satisfactory to the Town Attorney, in the Maricopa County Recorder's Office.

3-4 STORMWATER STORAGE WAIVERS

A. Waiver of Stormwater Storage Requirements

A waiver approval does not relieve the developer of liability if flood damage occurs resulting from the waiver.

B. Waiver of First Flush

Generally, there is no waiver permitted for stormwater storage volume required to hold runoff from the first one-half inch of precipitation. However, the owner may provide a smaller basin and/or alternative stormwater controls, if it meets the approval of the Town Engineer.

C. Waiver Process

To apply for a waiver, the developer shall complete and submit with the final drainage report:

1. A Request for Stormwater Storage Waiver Form, including in-kind contributions calculations sheet, which may be obtained from the office of the Town Engineer, and

2. A certified engineering report stamped by a licensed Arizona engineer, along with documentation satisfactory to the Town Engineer that the project qualifies for a waiver.

The Town Engineer may request additional information and may deny the waiver, approve it, or approve it with conditions.

Unless the project is designed to provide full storage, the Town Engineer will not accept final improvement plans without a copy of the approved Waiver Form.

3-5 STREET DRAINAGE

A. Access

Generally, street improvements for new development shall provide access to properties during a base flood. To prove access, an engineer must demonstrate that at least one structural roadway section with asphalt, concrete or compacted aggregate has a depth of flow no greater than 1 foot during a base flood. Refer to Fig. 1.3-1, Street Hydraulic Design Criteria Chart, for limits of inundation for specific street sections.

B. General Design Standards

Streets may carry water from adjacent property and from local areas, but should not be used as major water carriers in lieu of natural washes or man-made channels. The design criteria below imply that water may flow deeper than a normal vertical curb height, for a short distance over sidewalk or other back-of-curb areas, but the flow is always confined to the right-of-way or drainage easements. Engineers should provide catch basins, scuppers, or similar facilities, together with necessary channels, at appropriate locations (particularly street sag areas) to remove water flowing in the streets to comply with MAG, DDM and the design criteria below.

HYDRAULIC DESIGN CRITERIA dmax = maximum depth at any point within the right-of-way			
Drainage Feature	Peak Frequencies		
	10-Year	25/50-Year	100-Year
Street with Curb & Gutter	Contain runoff within street curbs. For collector and arterial streets maintain one 12-foot-wide dry driving lane in each direction.	N/A	Contain runoff below the building's lowest floor. Confine runoff to street rights-of-way or drainage easements. dmax = 8 inches.
Street without Curb & Gutter (Dirt Roads, Ribbon Curbs)	Contain longitudinal runoff within roadside channels with water surface elevation below pavement subgrade.	N/A	Contain runoff below the building's lowest floor. Confine runoff to street rights-of-way or drainage easements. dmax = 8 inches.
Street without Storm Drain System	Add pipes or roadside channels if runoff from 10-year flood exceeds street capacity, unless waived.	N/A	Add storm drain systems if a base flood inundates building's lowest floor. Provide catch basins, scuppers, etc. to remove water so dmax = 8 inches.
Cross Road Culvert or Bridge for Collector & Arterial Streets	N/A	Convey runoff by culvert or bridge under street with no flow overtopping the street for a 50-year flood.	Convey runoff by culvert and by flow over the street so dmax =6 inches.
Cross Road Culvert or Bridge for Collector Streets, and Local Streets	Convey runoff by culvert or bridge under street with no flow overtopping the street.	For a 25-year event, convey runoff by culvert or bridge and by flow over the street with so dmax = 6 inches.	dmax = 12 inches.
Any street or watercourse crossing that provides the only access to residential area.	N/A	N/A	Make all lots and structures accessible by at least 1 street with dmax = 12 inches for a base flood.
Local Streets with Low Volume Average Daily Trips	N/A		

FIGURE 3.1 STREET HYDRAULIC DESIGN CRITERIA CHART

C. Valley Gutters

Valley gutters are permitted on local streets to transport runoff when a storm drain system is not required. Valley gutters are generally not acceptable on collector or arterial streets. In unusual cases, valley gutters may be necessary to convey runoff across a collector street. In such situations, the valley gutter shall be a minimum of 8 feet wide to lessen the impact on traffic.

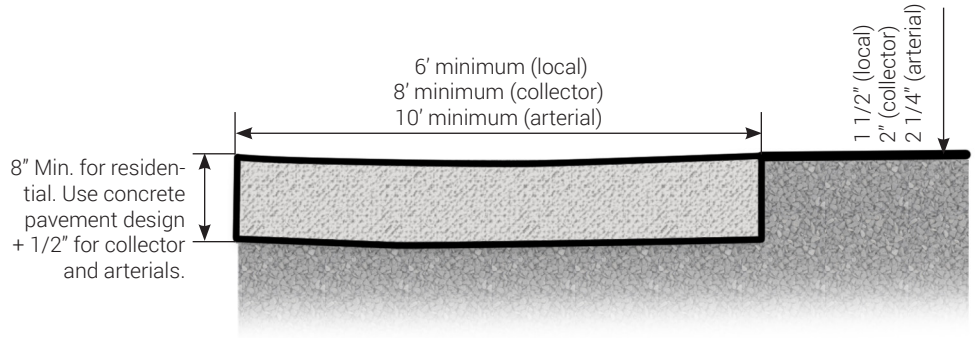

FIGURE 3.2 TYPICAL SECTION FOR VALLEY GUTTER

D. Roadside Swales

Unless waived by Town staff, swales must intercept and safely convey flow to the nearest recognized watercourse within the same watershed. If velocities exceed 5 feet per second, then the engineer must design the swale to provide erosion and scour protection. Swales are necessary to prevent:

1. Runoff and debris from washing onto the roadway,
2. Erosion of roadway areas adjacent to the edge of pavement or curbing, and
3. Roadway runoff from flowing into front yards, driveways, garages and homes. Refer to Figure 3.3 Typical Cross Section for Roadside Swales, on non-raised curb street or straight cross slope.

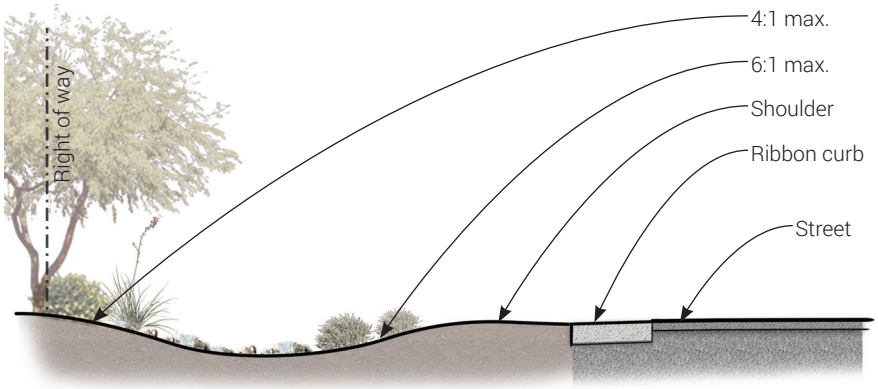

FIGURE 3.3 TYPICAL CROSS SECTION FOR ROADSIDE SWALES

E. Wet Crossings

1. For wet crossings of road, calculate flow velocity for sediment erosion. Erosion control measures for scour protection must be evaluated and documented.
2. Wet crossings shall be constructed of concrete paving or include continuous ribbon curb per MAG standard detail.

F. Pools and Spas

1. Pools and spas shall not be drained or backwashed into a street, storm drain or natural wash. The Town's two sanitary sewer providers, (City of Scottsdale and Phoenix) currently allow the disposal of pool or spa water into their collection systems. If discharging into a sanitary sewer, pool or spa water shall enter the sewer on private property by appropriate means, such as through a sanitary clean-out. Some other examples of appropriate locations to backwash a pool or spa may include onsite retention basin(s) with adequate volume, or an approved septic tank hauling service.

3-6 CHANNEL DRAINAGE

A. Channel Design

Man-made Channel: When man-made channels are required, the emphasis will be placed on a "natural" appearance and on safety. Native landscape lining will be allowed, with side slopes 6:1 or flatter, with specific Town approval. Full channel lining will be considered on a case by case basis.

1. Design shall be in accordance with the Drainage Design Manual for Maricopa County, Arizona Department of Water Resources; Delineation of Riverine Floodplains and Floodways in Arizona, State Standard Attachment SSA 2-96; the State Standard for Detention/Retention, SSA8-99; and the Watercourse Bank Stabilization, SSA 7-98; or the current version of the aforementioned. The developer is required to coordinate compliance with any requirements of the Army Corps of Engineers Section 404 Certification. The developer is required to coordinate all revisions to the FEMA flood insurance rate maps resulting from construction of bank protection.

2. Channel sections shall be designed so the final finish grade is the surface of any channel lining for erosion protection. Channel capacity shall be designed for increased capacity to accommodate any reduction that might occur from landscaping, vegetation and/or sediment accumulation, as shown in Fig. 3.4 Channel Lining Design Capacity.

FIGURE 3.4 CHANNEL LINING DESIGN CAPACITY

3. Maximum Velocities/Erosion Protection: In general the maximum velocity shall not exceed the scouring velocity of the soil (with natural cover). When the scour velocity is exceeded, additional erosion protection shall be provided. Bank/channel protection may consist of one or more of the following:

   a. Concrete or gunite lining, reinforced with 4 inch x 4 inch WWF-12GA.

   b. Natural stone grouted riprap 4-inch to 12-inch diameter stones - leave a minimum 1/4 diameter exposed.

   c. Natural Stone loose riprap 4-inch to 12-inch diameter stone.

   d. Gabion Baskets/Gabion Mattresses.

   e. Soil Cement.

3-7 CULVERTS AND STORM DRAINS

A. Culverts and bridges within the Town are generally within the public right-of-way for the road. Additional easement or right-of-way, beyond the normal street width may be required to facilitate the construction, operation and/or maintenance of the structure. Design plans for the structure shall include the proposed easement and/or right-of-way limits. Maintenance issues and access shall be considered in the structure design, and appropriate measures should be included to facilitate proper maintenance (i.e. access road if necessary, etc.).

B. The minimum pipe size of culverts and storm drain laterals in the public right of way shall be 18 inches in diameter. Where debris may be expected, follow the FCDMC requirements for preventing clogging.

C. Culverts and storm drain laterals on private property should be sized to manage the 100-year runoff event, but shall not be less than 12 inches in diameter. Culverts that do not have 100-year peak flow capacity must be designed to adequately convey the balance of runoff by channel or other means to the appropriate watercourse or storage basin.

D. In special cases, if a culvert invert is placed below the natural wash flowline, the design capacity of the culvert shall be reduced by the cross-sectional area below grade level as approved by Town Engineer.

E. Stormwater runoff shall not be conveyed in a culvert or pipe under structures, except to drain a fully enclosed courtyard, where redundancy is required. Exceptions may be made where a lot is considered otherwise unbuildable, as approved by the Town Community Development Director or Town Engineer.

F. Manholes or junction structures are required at all horizontal and vertical changes in culvert alignment, pipe junctions, and changes in pipe diameter.

1. The hydraulic grade line in storm drains shall be no higher than six inches below the gutter line in a 10-year storm event.

2. Minimum drainage easement widths shall be calculated using the following formula:

Width = pipe outside diameter + 2 feet + 2x depth to invert

G. Storm drain inlets and outlets shall be designed to meet current Town and MAG standards. Structures shall be buried or otherwise blended with surrounding grade with colors and textures to match or complement adjacent structures as approved by the Town.

H. Headwalls shall extend a maximum of 18 inches above top of pipe with top of wall not to exceed finished grade of surrounding areas. Slope to top of headwall maximum 4:1. Where vertical drop is greater than 30 inches install guardrail meeting Town and MAG standards. Retaining walls shall be constructed of natural stone or poured-in-place concrete. Concrete walls shall be finished with integral color and form liner as approved by Town.

I. Fence and Wall Openings, Trash Racks and Railings shall be designed in accordance with Town and MAG standards. Steel fabrications shall consist of evenly spaced slats 8 inches on center max., smooth coved welds, primed and painted to match adjacent structures as approved by Town. Grates are required on private lots only and shall be cleaned and maintained by property owner.

J. Obstructions. Obstructions to drainage are fences, walls, berms, swales, retaining walls, patios, pools, decks, sheds, pens, corrals, water troughs, canals or any other construction that alters redirects, impedes or suspends drainage from its natural course. Obstructions can occur in landscaping which includes mounding, raised beds, edging, furrowing, gardens, water harvesting, planter boxes, or any other landscape method or construction that alters, redirects, impedes or suspends drainage from its natural course.

K. Ownership and Maintenance Requirements. As part of the initial layout design, the designer must consider and accommodate the future need of vehicular access for maintenance purposes. Preliminary design should minimize long-term maintenance requirements. It is essential that maintenance be considered during the planning, design and construction of drainage facilities. Maintenance is provided so that the facility is maximized. Common maintenance problems associated with drainage facilities includes growth of undesirable vegetation, debris accumulation, sedimentation, erosion, scour, soil piping, soil settlement, structural damage and failing to plan for maintenance access. Culverts and bridges are to be designed to avoid impacts to existing sediment transport conditions.

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Erosion Hazard management

4-1 GENERAL INFORMATION

A. The Town uses, as a minimum, the design standards and methodologies described in the ADWR Erosion Hazard Guidelines and FCDMC Hydraulics Manual. These apply to:

1. Structures that could fail or incur significant damage as a result of erosion.
2. Proposed structures that, if built, could result in adverse impacts to adjacent properties.
3. Watercourses that do not have identified erosion hazard zones.
4. Watercourses within existing or proposed land divisions.
5. Watercourses identified by the Town as having significant potential flood hazards.
6. Watercourses with drainage areas equal to or greater than 30 acres or a 100-year peak discharge estimate of more than 50 cfs, as estimated using the procedures in the FCDMC Hydrology and Hydraulics volumes.

B. Erosion hazard zones consistent with ADWR may be required for all properties under development where watercourses will be left in an undisturbed state. The Town may require further analysis (ADWR Level II or III) under certain geomorphic conditions where staff is concerned that erosion limits may exceed those estimated by a Level I analysis. The Town may also require a slope stability analysis.

4-2 HILLSIDE DEVELOPMENT

A. Hillside Overlay Districts:

The Town of Paradise Valley has a hillside zoning ordinance (Article XXII) that restricts development on lots that have slopes greater than 10%. The Hillside Building Committee will review all applications for development in these areas.

B. Purpose and Need:

Hillside lots have special needs for stormwater management due to the higher runoff rates and difficulty establishing retention areas on site. This is exacerbated by construction of impervious surfaces that increase runoff intensity and volume during a storm event. These sites are also likely to be more visible from surrounding off-site areas. The purpose of these requirements is to preserve the character of the hillsides while accommodating responsible development and protecting people and property from potentially hazardous conditions unique to hillside development.

C. Storm Drainage on Hillside Lots:

The first priority of hillside development is to properly site buildings, structures and use areas to preserve natural drainageways on the site. This can be accomplished by clustering development while preserving connected natural washes and linear open spaces that convey and store stormwater. Development restrictions for hillside lots are identified in the Town's hillside zoning ordinance.

Development shall be accomplished in such a way to minimize changes to existing topography, including natural drainageways. Where excavation and filling is required for approved site improvements grades and vegetation shall be restored to meet the requirements of the Town Landscape Design Guidelines. Application of Low Impact Development (LID) approaches, as identified in Section 6, can reduce the amount of impervious surfaces in order to mimic predevelopment runoff conditions on the site. The Town may consider waivers to on site retention requirements only in such cases where approved LID practices, such as porous pavements, green roofs and/or reduced pavement areas are proposed that are equal to, or exceed, required on-site retention.

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Stormwater Quality

5-1 CONSTRUCTION GENERAL PERMITS

A. Arizona Department of Environmental Quality (ADEQ) administers the Construction General Permit under the Clean Water Act (CWA). The Town requires evidence that the development will comply with the ADEQ Construction General Permit, when applicable, before issuing development permits.

B. Stormwater runoff from construction sites can include pollutants such as phosphorous, nitrogen, pesticides, petroleum derivatives, construction chemicals, solid wastes and sediment that adversely affect water quality. Compliance with the Construction General Permit will help prevent these pollutants from entering washes, lakes, other surface waters and the Town's storm drain system.

5-2 HOW TO OBTAIN STATE AND TOWN APPROVAL

A. The operator of a construction site is responsible for applying for appropriate permits from ADEQ. The operator may be the owner, developer, general contractor or individual contractor responsible for operational control. When this responsibility is shared, all operators must apply for ADEQ approval. ADEQ will require a Notice of Intent (NOI) and Stormwater Pollution Prevention Plan (SWPPP). The Town requires submittal of the SWPPP for review prior to submittal to ADEQ.

B. After ADEQ approval, the operator must include 2 copies of the approved NOI and SWPPP with improvement plan submittal to the Town.

5-3 OPERATIONAL REQUIREMENTS

A. The operators must keep a copy of the SWPPP on site. In addition to ADEQ enforcement, the Town will enforce stormwater management requirements, through inspections, responding to complaints and other means.

5-4 COMPLETING CONSTRUCTION

A. Once construction is completed, as defined in the Construction General Permit, the operators must send a Notice of Termination (NOT) to ADEQ and the Town.

5-5 SECTION 404 PERMITS

A. The Town requires developments to comply with Section 404 of the CWA.

5-6 ACTIVITIES REGULATED UNDER SECTION 404

A. The US Army Corps of Engineers (Corps) and EPA jointly administer Section 404 of the CWA. The CWA regulates the discharge of dredged or fill material into washes, rivers, streams, lakes, certain man-made canals and other waters of the United States, including wetlands.

Examples of activities that might be regulated under this program include:

1. Stream crossings;
2. Dam construction and flow regulation;
3. Water diversion for canals, irrigation systems and stock tanks;
4. Streambed modification and stabilization; and
5. Building subdivisions, master planned communities, nonresidential structures, highways and airports.

B. Projects that are determined by the Corps to have a minimal environmental impact, require compliance with nationwide permits in a streamlined process. Projects with potentially significant impacts may require individual permits and public notice.

C. Projects cannot jeopardize the continued existence of a threatened or endangered species or its

critical habitat. Developers should consult with the Corps or the US Fish and Wildlife Service for guidance concerning threatened and endangered species in the Town.

5-7 SECTION 401 CERTIFICATION

A. Before the Corps can issue a Section 404 permit, Section 401 of the CWA requires ADEQ to certify (possibly with additional conditions) that the draft permit complies with effluent limits, state water quality standards, and appropriate requirements of state law. No discharge of dredged or fill material is permitted if:

   1. A practicable alternative exists that is less damaging to the aquatic environment, or
   2. The nation's waters would be significantly degraded.

B. ADEQ may grant, deny or waive water quality certification for both individual and nationwide Section 404 permits.

5-8 COMPLIANCE REQUIREMENTS

The Town will not issue any development permit where Corps action is required but not yet taken. An applicant must comply with the requirements of Sections 401 and 404 of the CWA, as applicable, prior to commencing construction.

5-9 WASTE DISPOSAL SYSTEM LOCATIONS

A. Waste disposal system locations shall comply with Arizona Revised Statutes, Section 48-3609. Refer to

   http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/ars/48/03609.htm&Title=48&DocType=ARS

B. Waste disposal system locations shall comply with Maricopa County standards. Refer to

   http://www.maricopa.gov/EnvSvc/AboutUs/pdf/C2S2.PDF

   and

   http://www.azsos.gov/public_services/title_18/18-09.pdf

Low Impact Development

6-1 GENERAL INFORMATION

Low Impact Development (LID) is a sustainable approach to stormwater management that utilizes the landscape to absorb storm runoff, reducing flows that can contribute to flooding and increase infrastructure costs. The goal of LID is to mimic and sustain a predevelopment hydrologic regime by applying techniques that are included in this chapter. LID strategies can divert, store and utilize stormwater runoff to support native and designed landscapes. They can be utilized to supplement, and sometimes reduce the need for, traditional methods for stormwater management. While traditional methods often channelize and pipe runoff away from development, LID utilizes this water close to its source, to support vegetation growth and reduce runoff volume.

LID is adaptable to a wide range of land use types and project scales. Low impact development can be particularly effective reducing increased runoff for hillside development. Breaking down developed areas into their constituent components – private property and public realm; buildings, paved areas and landscape – presents a way to organize potential actions to implement LID. These approaches are encouraged by the Town.

6-2 POTENTIAL BENEFITS

Increased stormwater runoff is directly related to the amount of impervious surfaces in a given area and to how land is developed and improved. Improvements in managing stormwater can have multiple benefits for cities and their residents and businesses. LID actions can be taken by governments, organizations and private interests. The benefits of LID have been published for many national and local examples, and are supported by the Environmental Protection Agency (EPA) in its Municipal Separate Storm Sewer System (MS4) requirements.

A. Direct benefits:
   1. Detains stormwater close to its source, potentially reducing runoff volume and velocity downstream.
   2. Collects sediment and reduces pollutants in storm-water runoff.
   3. Utilizes stormwater to support native vegetation and landscape improvements.

B. Indirect benefits:
   1. Reduces irrigation water requirements for landscape areas.
   2. Reduces impacts on existing stormwater infrastructure and the need for new channels and pipes.
   3. Is compatible with the protection and restoration of natural systems, which supports climate resiliency.
   4. Complements site improvements for human activities.
   5. Provides and sustains habitat for wildlife.
   6. Supports tree canopy growth for increased shade, which can significantly decrease urban heat-island effects.
   7. Adds value to property through efficient use of space and resources.
   8. Provides multiple-use opportunities, such as open space and landscaping, that improve a community's quality of life.

6-3 APPLICATIONS

A. The LID tools identified in this chapter can be used to:
   1. Enhance the built environment by implementing LID projects that use ecologically friendly and aesthetically pleasing design solutions that provide multiple benefits for the community.
   2. Mitigate impacts on proposed development sites to produce the amount of impervious surface and reduce stormwater runoff potential.
   3. Provide means for hillside development that satisfies the Town's stormwater storage requirements.
   4. Review and assess current Town policies, codes, regulations and checklists to determine which updates are required to enable and encourage the implementation of LID techniques.
   5. Educate Town agencies, residents, businesses, and developers about the advantages and benefits of LID.

LID MATRIX

SOURCE

BUILT OR PROPOSED ORIGIN OF STORMWATER RUNOFF

	PUBLIC STREETS IN PARKING AREAS	HOMES AND BUILDINGS ROOF TOPS

ACTION

METHOD OF MANAGING STORMWATER RUNOFF

	CONVEY	STORE	INFILTRATE

TOOLS

MEANS TO ACCOMPLISH ACTIONS

GREEN STREET	VEGETATED SWALE	BIORETENTION	POROUS PAVEMENT
Curb Cuts	Landscaped Channel	Vegetated Basin	Stabilized Aggregate
Ribbon Curb	Restored Wash	Bioretention Cell	Pervious Asphalt
Curb Cut with Sediment Capture			Pervious Concrete
Wheelstop Curb			Permeable Pavers
			

TECHNICAL VARIATIONS

DRIVEWAYS AND PATIOS

LANDSCAPE AREAS

FILTER

EVAPO-TRANSPORATE

REUSE

GROUNDWATER INFILTRATION

Underdrains

Recharge

GREEN ROOF

Rooftop Garden

Downspout Disconnection

RAINWATER HARVESTING

Cisterns

Underground Storage

LANDSCAPE

Tree Preservation

Soil Amendment

Impervious Surface Reduction

Plant Selection

6-4 LID TOOLKIT

A. Source

The tools included in this document have been derived from, and include, pioneering work for southwest applications of LID by the cities of Mesa, Glendale and Tucson, and the Watershed Management Group. Tools have been identified that are appropriate for the low density, natural character landscape of Paradise Valley. The EPA has published several guides to LID that describe LID methods that have been implemented throughout the country.

This LID Toolkit provides a representative cross section of Best Management Practices (BMPs) that can be developed in Paradise Valley and throughout the region.*

B. Tools

As described in the LID matrix on the previous page each tool is categorized by its context within a site or system, and by which action(s) the tool is intended to perform with respect to the stormwater that is being managed.

These tools are compatible with development methods and building codes in Paradise Valley. Tools are appropriate in developed or developing areas and are consistent with current or proposed city policies.

C. Technical Variations

Many of the BMP techniques illustrated in the LID Toolkit have multiple variations and/or site specific adaptations. The arid region in which we live, requires special understanding and care when implementing these techniques. Within the appropriate site and project context, LID tools can be effectively deployed to achieve the Town's stormwater management goals.

Context and site specific issues that should be considered when applying the LID Toolkit to the stormwater management system include:

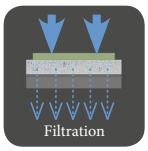
1. Knowledge of local codes and regulations (The Town of Paradise Valley will determine which practices are appropriate for each application).
2. Anticipating high intensity storms that may exceed the capacity of LID facilities.
3. Extended periods of drought require vegetation to have access to supplemental irrigation.
4. Periods of extreme heat requiring adapted and highly tolerant vegetation.
5. Extreme daily temperature fluctuations leading to expansion and contraction, affecting design requirements.
6. Opportunities and constraints associated with the type and use of local materials.
7. Dusts, sediment and debris accumulation between storms.

* LID Tools are not intended to address all requirements of local, state, federal, and other codes, regulations, and standards. Additional analysis will be required for each application.

Functions

Some LID tools provide a specific function related to stormwater. Most LID tools can perform several functions. The function intended by the designer is often a determining factor in the selection of which tool/technique to use in the design.

Flow Control
-the regulation of stormwater runoff flow rates.



Filtration
-the sequestration of sediment or pollutants from stormwater runoff through a porous medium.

Detention
-the temporary storage of stormwater runoff to allow for metered discharge that reduces peak flow rates.

Infiltration
-the vertical movement of stormwater runoff through soil, recharging groundwater.

Retention
-the storage of stormwater runoff on-site to allow for sedimentation of suspended solids.

Treatment
-processes that use plant materials, soils and bacterial colonies to metabolize contaminants in stormwater runoff.

Shade
-promotes vegetated shade

Recreation
-allows for recreational uses

Design
-encourages creative solutions to stormwater management

Heat Island
-reduces or mitigates heat island effects

Habitat
-provides wildlife habitat area

Aesthetics
-enhances attractiveness and beauty

Education
-provides learning opportunity

Infrastructure
-reduces impact on existing or future infrastructure

Benefits

LID can provide benefits that go well beyond stormwater management. By managing stormwater close to its source, they can nourish a healthy community landscape. This provides visual interest in the landscape, reduces water and energy use, improves water quality and reduces the cost of stormwater infrastructure. and contaminants downstream. These icons identify the multiple benefits associated with each LID practice.

Location

Some LID tools are specific to certain locations and types of development. Other tools can be used in multiple locations and be adapted to different development types. In order to be context sensitive, it is important to assess which locations and applications each tool is appropriate for during the design process. The locations and development types identified by the following icons are intended to be scalable. For example, a landscaped yard around a residence can be considered similar to the site area around a small business or school. Open space can describe a park, or a large landscaped area on the campus of an institution or corporate facility.

Street Buffer
-landscaped area between street and building

Pedestrian Path
-designed walkway for pedestrians

Street Median
-distinct island in middle of road designed to guide traffic

Driveway
-private vehicular accessway

Parking Island
-distinct island in parking area designed to guide traffic

Parking Lot
-designated area for parking

Residential Landscape
-unpaved and hardscape areas outside homes

Nonresi Landscape
-unpaved and hardscape areas outside non-residential buildings

Parks and Open Space
-large contiguous landscape areas for public or common use

Parking Shading
-trees or structures that provide shade

Nonresi Building
-buildings without residential uses

Residential Building
-buildings with residential uses

Green Street – Standard Curb Cut & Ribbon Curb

Description

A. Standard Curb Cut

Standard curb cuts are openings created in a curb to direct stormwater from an impervious surface, such as streets, parking lots, or hardscape areas, into a lower landscaped area (LID facility). The curb cut is a useful tool for retrofitting existing development with green infrastructure practices without major reconstruction. Since curb cut openings are perpendicular to the flow of stormwater on the street, they will usually collect only a portion of the water flowing along the gutter. If attenuating stormwater flows along the street is the goal, place multiple curb cuts at intervals along the street.

B. Ribbon Curb

Ribbon curbs allow, distributed stormwater runoff from impervious surfaces into landscaped areas and stormwater facilities. Stormwater flow is distributed more evenly which reduces the potential for erosion and clogging along a pavement edge.

Installation

A. Standard Curb Cut

1. Openings should be at least 18 inches wide, but up to 36 inches is preferred for ease of maintenance.
2. Locate curb cut openings at low points and space them based upon stormwater velocity and volume, and the capacity of the area behind curb for retention/detention infiltration and access to overflow systems.
3. The curb cut can either have vertical or angled sides. The design intent is to create a smooth transition from the paved surface to full curb height.
4. Curb cuts work well with relatively shallow stormwater facilities that do not have steep side slopes that might erode.
5. Set the elevation of the bottom of the curb cut to maximize flow into the landscape area.
6. A drop in grade should occur between the curb cut entry point and the finish grade of the landscape area to allow for passage of sediment.
7. Small amounts of hand placed rip-rap can be used on the LID facility side of the curb cut opening to reduce the potential for erosion in landscaped areas.

B. Ribbon Curb

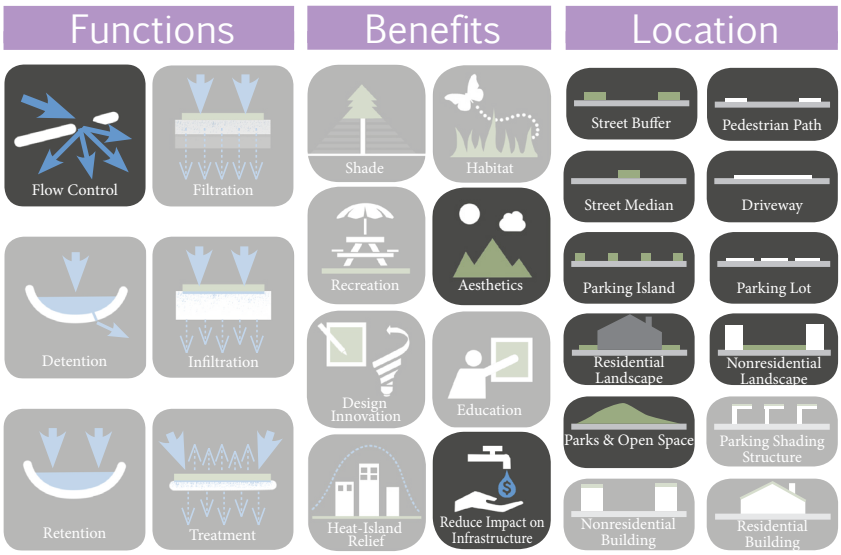
1. Top of concrete curb should be installed flush with the pavement surface, with allowances for subgrade compaction and future settlement, and should have the same cross-slope as the adjacent pavement.
2. A drop in grade should occur between the top of the flush curb and the finished grade of the landscaped area to allow for passage of sediment and debris to drop out.
3. Utilize temporary erosion control measures when seeding or planting adjacent areas to reduce the portential for erosion.
4. A wider surface area and contrasting color for the flush curb provides an important visual cue when used on roads, driveways and bicycle paths.
5. This tool will be considered on a case by case basis for street rights-of-way, per Paradise Valley and MAG standard curb details.

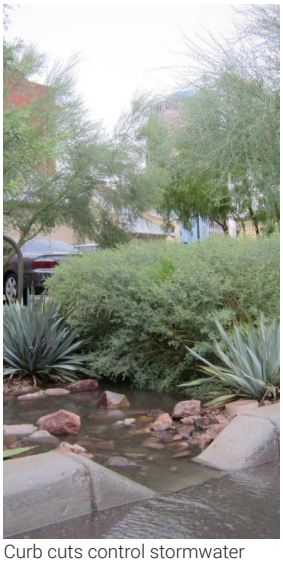
Maintenance

A. Standard Curb Cut: regularly clear curb cuts of any debris and sediment that prevents the free flow of stormwater into LID facility (1-2 times per year and after storm events). Periodically check rip rap areas for signs of erosion damage. Repair and reinforce as necessary (annually and after storm events).

B. Ribbon Curb: check the flush curb for signs of damage or settlement causing ponding or concentration of stormwater runoff. Check landscape edge condition for signs of rilling or erosion and repair or reinforce as needed (annually). Remove sediment and debris from landscape area, that may cause water to pond or backup.

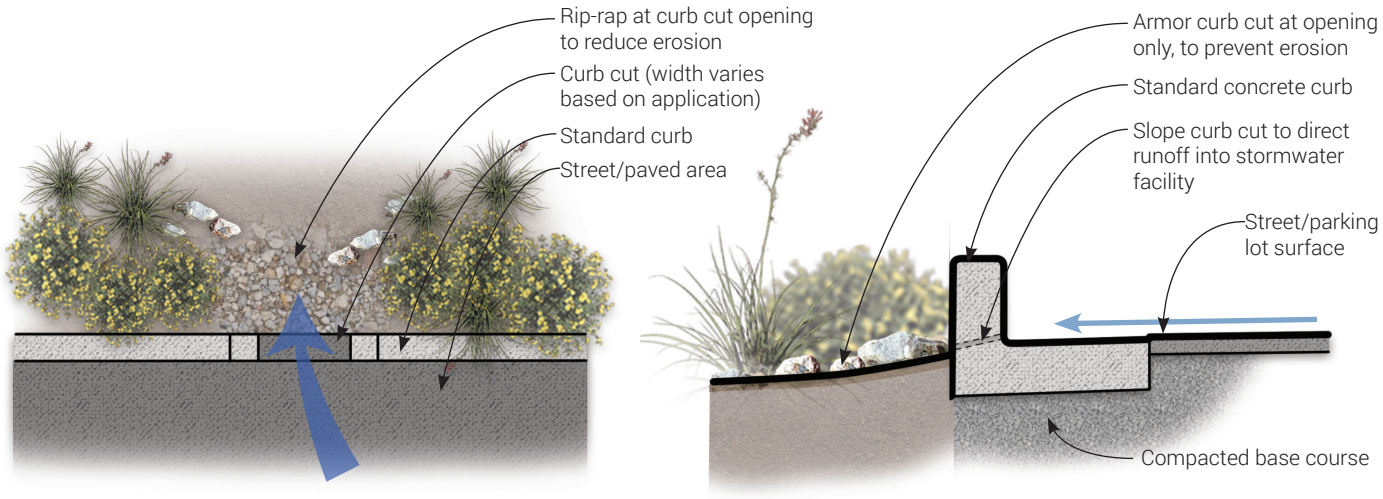
Source: http://flowstobay.org/files/greenstreets/pg132-136ch5.pdf





Curb cuts control stormwater flow from streets to LID facilities.

Ribbon curbs allow stormwater to sheet drain to landscape areas.



Curb Cut Plan

Curb Cut Section

Figure 6.1 - Standard Curb Cut

Ribbon Curb Plan

Ribbon Curb Section

Figure 6.2 - Ribbon Curb

Vegetated Swale – Swale & Restored Wash

Description

A. Vegetated Swale

Vegetated swales are stormwater runoff conveyance systems that provide an alternative to piped storm sewers. They can absorb low flows and direct runoff from heavy rains to storm sewer inlets or directly to surface waters. Vegetated swales improve water quality by enhancing infiltration of the first flush of stormwater runoff and promoting infiltration of storm flows they convey. Costs vary greatly depending on size, plant materials, and site considerations. Vegetated swales are generally less expensive when used in place of underground piping.

B. Restored Wash

The natural Sonoran Desert consists of washes that flood infrequently yet allow established native riparian plants to flourish. Wash restoration follows natural drainage patterns and supports a healthy naturalistic landscape palette, requiring little or no supplemental irrigation. Restored washes provide natural beauty, wildlife habitat and recreation opportunities that are valuable to city residents. Restoring washes recreates riparian systems while accommodating flood protection.

Installation

A. Vegetated Swale

1. Deep-rooted native plants are preferred to promote water infiltration and reduce erosion and maintenance requirements.
2. Evaluate site soil conditions. Ideally soil infiltration rates should be greater than one-half inch per hour. Soil Amendments may be needed to achieve ideal infiltration rates.
3. A meandering alignment is preferred where space allows, with side slopes that do not exceed 4:1, and slopes adjacent to walkways or accessible hardscape areas that do not exceed 6:1. In some contexts, a more linear alignment may be appropriate.
4. Refer to the adopted building codes for maximum depths allowed without a guardrail requirement. In any case, a vertical drop of more than 30 inches will require guardrail protection.
5. Current standards require that all swales that retain or detain stormwater shall completely drain within 36 hours.

B. Restored Wash

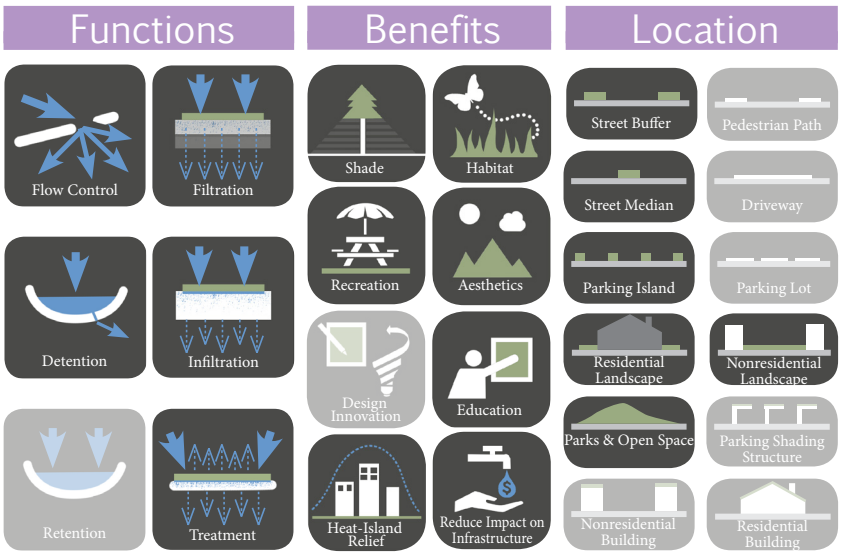
1. Channel alignments and side slopes must be designed in close coordination with civil engineers to ensure that they convey stormwater while minimizing erosion damage.
2. Employ erosion control and channel stabilization techniques that encourage upland and riparian vegetation to establish over time.
3. Provide access for regular inspection and maintenance efforts.

Maintenance

A. Vegetated Swale: vegetation in the swale will require regular maintenance such as removal of debris and dead branches, and occasional pruning. Supplemental irrigation may be required to maintain healthy landscape plants. Removal of sediment and regrading will be necessary to maintain the swale shape and volume over time. As with plant waste, sediment should be removed and disposed of properly. See also: http://paradisevalleyaz.gov/523/Wash-Maintenance

B. Restored Wash: restored washes have unique maintenance needs due to native and riparian vegetation and the potential for soil erosion. These areas must have a maintenance plan executed by experienced professionals.

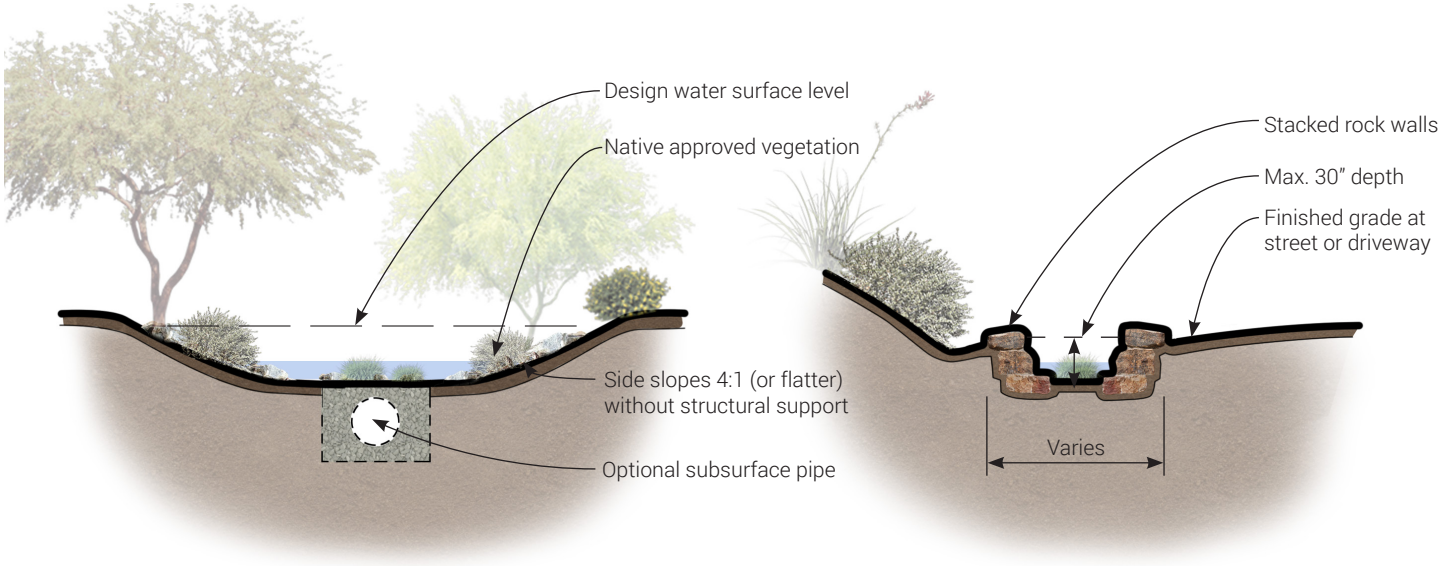
Source: http://www.bfenvironmental.com/pdfs/veggieSwale.pdf, http://watershedmg.org/tech-trainings/urban-streams http://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=687544, http://www.streamdynamics.us/



Vegetated swales accept storm-water for conveyance, storage and infiltration.

Restored washes maintain hydrology, reducing infrastructure costs.

Plan



Section at Swale

Section at Channel

Figure 6.3 - Vegetated Swale

Bioretention – Vegetated Retention Basin & bioretention cell

Description

A. Vegetated Retention Basin: Bioretention basins are shallow depressions in the landscape that typically include plants and a mulch layer or ground cover. Porous soils allow stormwater to infiltrate and supply plants with needed water. In addition to increased groundwater recharge, bioretention basins can improve water quality during smaller, more frequent storm events. In addition to removing sediments coming off paved areas, pollutants can also be removed through absorption into plantings and evaporation. Bioretention basins often referred to as rain gardens, can be used in residential settings, to accept runoff from a roof or other impervious surface.

B. Bioretention Cell: Bioretention cells are shallow depressions with a designed soil mix and plants adapted to the local climate and soil conditions. These are used in more urban conditions and where subsoils are porous and allow infiltration into the subgrade. Bioretention cells capture and infiltrate stormwater into the ground below the cell and have an overflow that carries excess stormwater to a discharge point. Bioretention cells that include vegetation for stormwater absorption are called bioretention planters.

Installation

A. Vegetated Retention Basin:

1. Creative shaping and planting of bioretention basins can utilize soil excavated from the basin to accommodate sloping berms.
2. Adding hand placed stones where stormwater enters the basin from a curb cut, pipe or downspout can help dissipate concentrated flows and reduce erosion.
3. Vegetation should be selected based on local microclimate and soil conditions. Plants should be set in the ground so the surface soil is level with the bottom of the basin. Once the plants are installed, the area should be mulched to retain soil moisture and reduce erosion.
4. Basin side slopes should not exceed 4:1. Where adjacent to walkways or accessible hardscape areas they should not exceed 6:1.
5. An irregular or meandering shape may be most appropriate. More geometric configurations are appropriate in a more urban context.
6. Current standards require all basins that detain stormwater to completely drain within 36 hours.

B. Bioretention Cell:

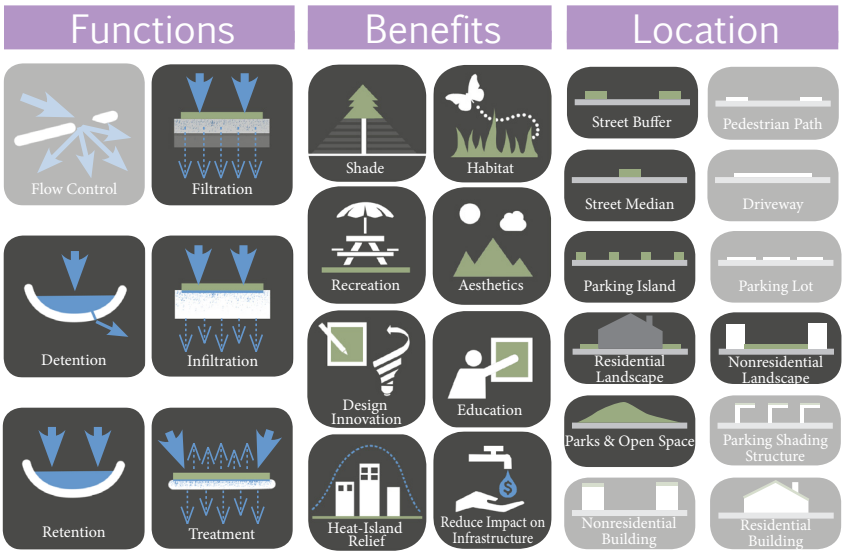
1. Bioretention cell bottoms should be relatively flat and not lined. The bottom surface should be loosened several inches deep prior to placing the bioretention soil mix. The cell bottom area should be designed based on the ability of the soil to freely drain into the subgrade.
2. Stormwater enters the bioretention cell by surface flow or pipe inlet. A sediment capture area can be designed to protect the bioretention cell by slowing incoming flows at the point of entry.
3. A minimum depth of specially graded soil is necessary for the proper function of a bioretention cell.
4. An appropriate surface mulch layer should be selected to reduce weed establishment, regulate soil moisture and temperature, and add organic matter to the soil.
5. Stormwater ponding above the cell provides storage for storm flows, settles out particulates such as sediment, and provides for uptake and filtering of pollutants within the cell.
6. Plants used must be drought tolerant, and suitable for occasional saturation.
7. Overflow for the bioretention cell should transport excess stormwater to an approved discharge point.

Maintenance

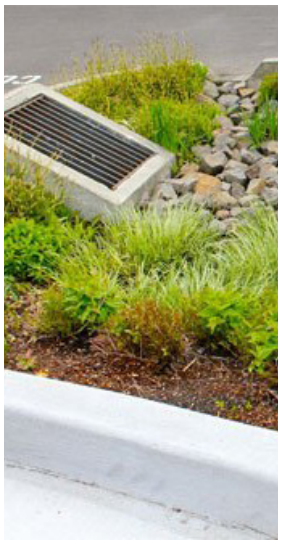
A. Vegetated Retention Basin: plantings should get adequate supplemental irrigation until fully established. Maintain landscaped areas including pruning shrubs to remove dead material and encourage new growth. The roots of healthy vegetation will improve the function of the basin. Regularly check for erosion, remove sediment and debris (vegetative litter as well as trash). Long-term maintenance activities include repairing erosion, continued weed control, removing weeds and invasive species, and controlling mosquitoes.

B. Bioretention Cell: Regularly check bioretention cells for blockages from debris and sediment. Remove sediment and debris and dispose of properly. Maintain landscape by replacing dead vegetation, pruning healthy vegetation and removing weeds regularly. Do not use herbicides in stormwater facilities. Bioretention soil may need to be replaced if soil percolation rates fall below the design flow capacity. Check percolation rates if bioretention cells have been contaminated by sediment inflows.

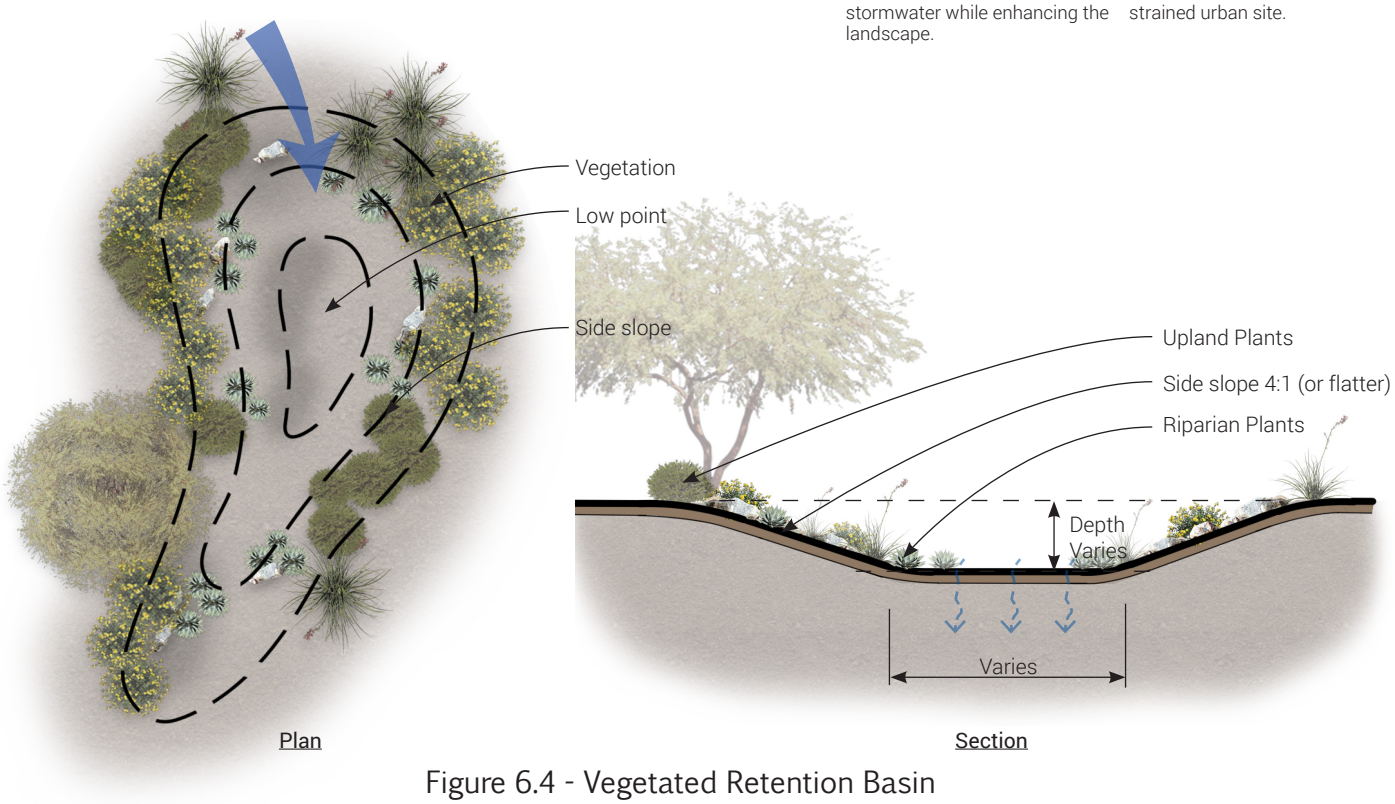
Source: http://buildgreen.ufl.edu/fact_sheet_bioretention_basins_rain_gardens.pdf, http://www.seattle.gov/DPD/Publications/CAM/cam532.pdf



Bioretention areas detain stormwater while enhancing the landscape.



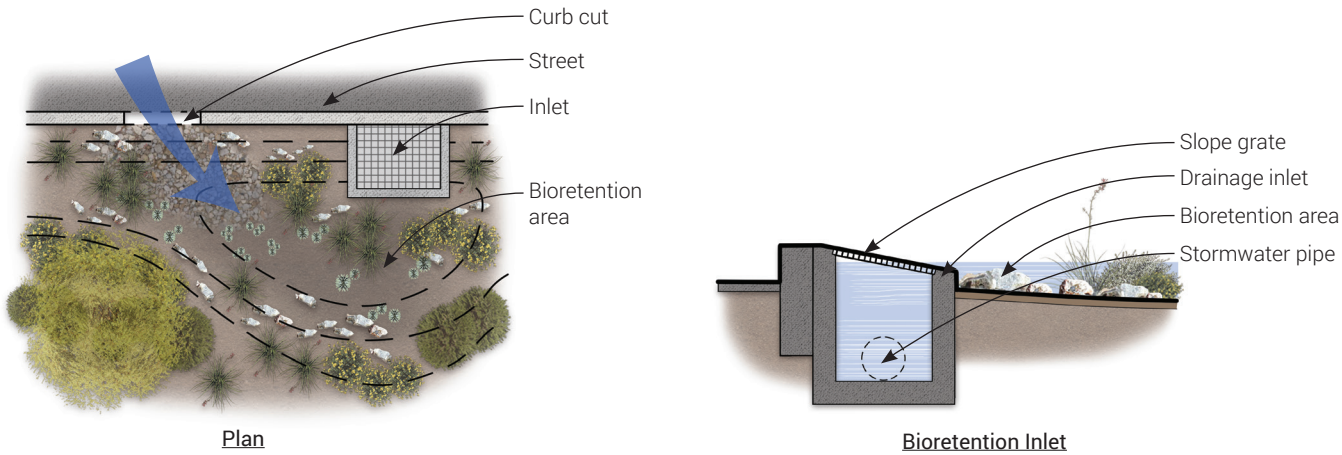
Bioretention cells fit into constrained urban site.



Plan

Section

Figure 6.4 - Vegetated Retention Basin



Plan

Bioretention Inlet

Figure 6.5 - Bioretention Cell

Permeable Paving – Permeable Pavers & Porous Concrete

Description

A. Permeable Pavers: Permeable pavers are comprised of precast concrete unit pavers designed to be set on a compacted base and highly permeable setting bed with joints filled with sand or fine gravel. Water enters the joints between the unit pavers and flows through an open-graded base, to infiltrate into the subgrade or be carried out into the storm system via underdrain piping. The void spaces in the subbase store water and infiltrate it back into the subgrade, or allow it to evaporate providing local air cooling. The sand joints provide surface permeability and helps filter stormwater sediments and pollutants.

B. Porous Concrete: Single size aggregate, also know as porous concrete, consists of a special mix design with void spaces that make it highly permeable. Aggregates are normally screened to provide particles that can fall within narrow limits to ensure porosity. About 30% to 40% of the material is void space, and its permeability is often measured in hundreds of inches per hour. Porous concrete reduces the velocity and volume of stormwater runoff delivered into storm sewer system and can reduce contaminants in runoff prior to its discharge to the storm sewer system

Installation

A. Permeable pavers:

1. A stable compacted subbase is essential for any flexible pavement such as porous pavers. The depth of rock and gravel must be capable of holding rainwater long enough for the soil underneath to absorb it.
2. Excavate to required subgrade depth, compact subsoil using a roller or vibratory compactor, and install geotextile fabric.
3. Prepare base material and compact using a roller or compactor. Install the crushed rock in separate layers and recompact. Install bedding layer and then paving stones with edge restraints.

B. Porous concrete:

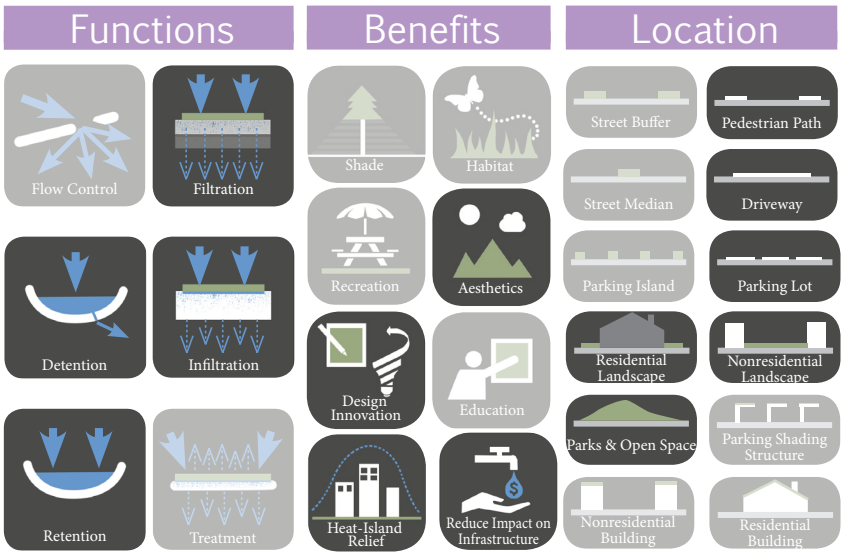
1. The porous concrete mix must be designed and installed by an experienced contractor. Poor materials and/or installation can result in a higher risk of failure.
2. The design for porous concrete consists of several layers, including a compacted sub-base, geotextile, a reservoir stone aggregate, and poured surfacing layer, formed with a screed finish.
3. Porous concrete is normally set flush with adjacent pavements or grades.
4. The subgrade reservoir should allow for drainage to the stormwater system through underdrain tile or piping, especially if the subgrade does not allow adequate infiltration. Underdrain tile or piping is sometimes necessary to achieve proper drainage.

Maintenance

A. Permeable pavers: inspect pavers regularly for settlement and broken pavers. Replace broken pavers immediately to prevent structural instability. Pavers can be removed individually and replaced during utility work. Do not pressure wash concrete unit pavers. Sweeping and vacuuming should be performed when paver areas are dry. Although a more expensive option for permeable pavement, concrete unit pavers are the most effective at reducing runoff and are often the most aesthetically pleasing option.

B. Porous concrete: Maintenance includes the regular vacuuming of surface areas to remove sediment and minimize clogging. With regular maintenance, porous concrete can have a service life of at least 20 years. Porous concrete should be checked periodically for settlement and cracking, and damaged areas repaired to match the original pavement design.

Source: http://www.icpi.org/permeable, http://www.wikihow.com/Install-Permeable-Pavers, http://www.perviouspavement.org/materials.html



Permeable paving is an attractive way to provide runoff reduction in paving and pedestrian areas.

Porous concrete can reduce runoff sustaining in sidewalks and plaza areas.

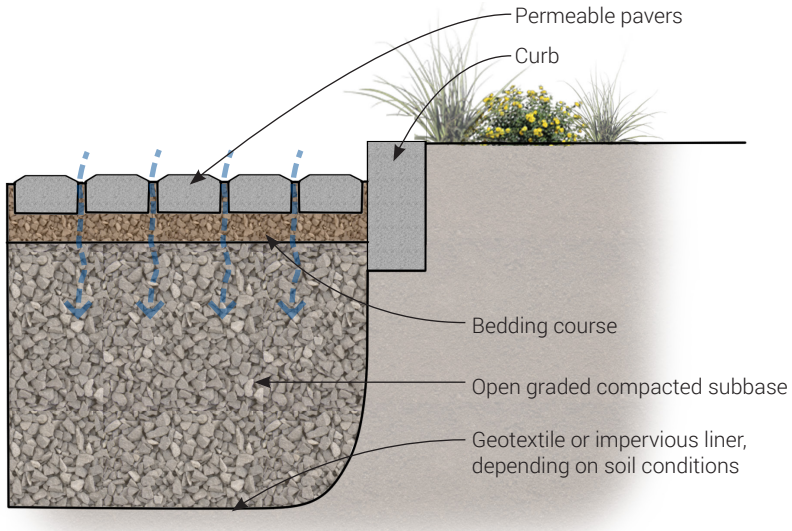


Figure 6.6 - Permeable pavers

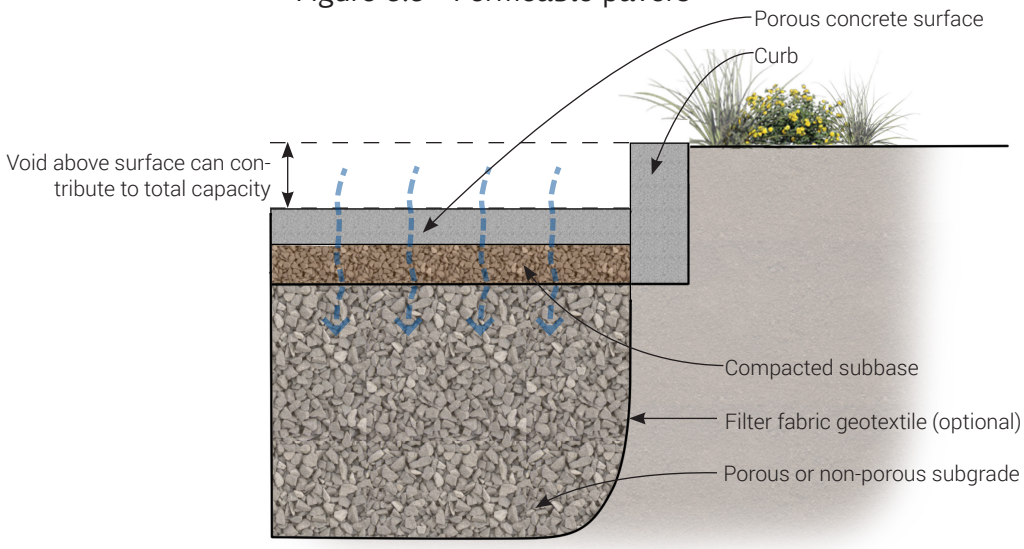


Figure 6.7 - Porous Concrete

GREEN ROOF – Rooftop Garden & downspout disconnection

Description

A. Rooftop garden

A green roof or Xeriscape living roof is when the roof of a building or structure is at least partially covered with a growing medium and vegetation planted over a waterproofing membrane. It may also include a root barrier, drainage mat and irrigation system. There are two types of green roofs: Extensive and Intensive. The difference is in the depth of soil and the ability to support simple groundcover planting (extensive) versus larger materials such as trees and shrubs (intensive). Green roofs provide stormwater storage and absorption, reduce runoff from buildings, and insulate buildings from solar gain and heat loss.

B. Downspout disconnection

Downspout disconnection is the practice of directing rainwater from the rooftop into a landscaped yard instead of into a piped system or into the street. Downspouts can direct stormwater to landscape areas where it is used to irrigate landscape plants, store or infiltrate into the ground.

Installation

A. Rooftop garden

1. The intended function of a green roof will have a significant effect on its design.
2. The height of the roof above grade, its exposure to wind, orientation to the sun and shading by surrounding buildings will all impact types of materials used and maintenance requirements. Views to and from the roof will also determine where elements are located for maximum effect.
3. Professionals must be consulted for the design and construction of the green roof. A qualified architect, structural engineer, landscape architect and facility maintenance personnel are critical to the success of a green roof project.
4. Access to a green roof site is crucial - not only for installation and maintenance, but also for delivery of materials, soil and plants.

B. Downspout disconnection

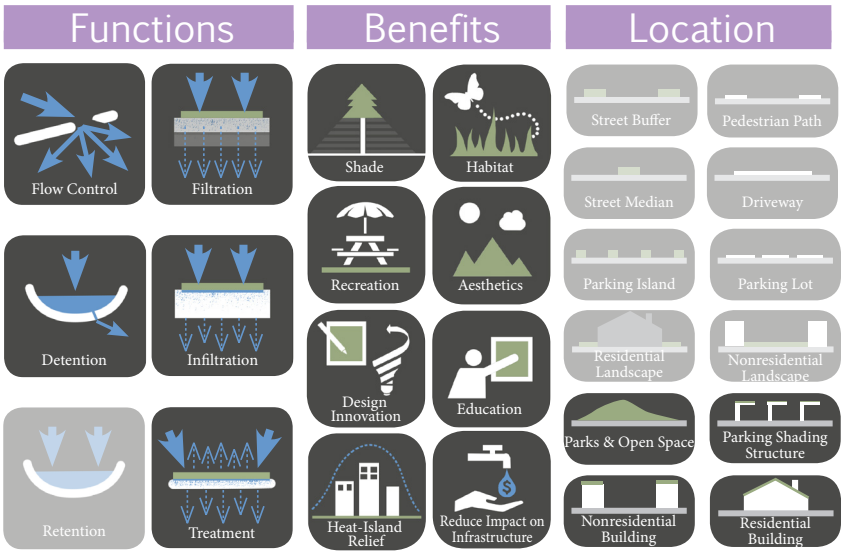
1. Direct downspout extensions away from building foundations or adjacent properties to avoid structural damage or nuisance flooding.
2. Firmly anchored splash blocks or hand placed rock can be installed to direct downspout drainage to landscaped areas.
3. Ensure that the offsite overflow is sufficiently lower than the building floor elevation to reduce the potential for building flooding.

Maintenance

A. Rooftop garden: only very hardy plants should be used in our desert environment and supplemented irrigation will be required. Depending on whether the green roof is extensive or intensive, required plant maintenance will range from two to three yearly inspections to check for weeds or damage, to weekly visits for irrigation, pruning, and replanting. Both plant maintenance and maintenance of the waterproofing membrane are required. To ensure continuity in the warranty and the maintenance requirements, the building architect, structural engineer and/or owner should specify and maintain everything up to and including the waterproof membrane. The greenroof designer and installer is only responsible for those items above the waterproof membrane, including soils, drainage and plantings.

B. Downspout disconnection: clean gutter at least twice a year, and more often if there are overhanging trees. Make sure gutters are pitched to direct water to downspouts. Caulk leaks and holes. Make sure roof flashing directs water into the gutters. Look for low spots or sagging areas along the gutter line and repair with spikes or place new hangers as needed. Check and clear elbows or bends in downspouts to prevent clogging. Each elbow or section of the downspout should funnel into the one below it. All parts should be securely fastened together. Maintain landscaping so that there is positive drainage away from all structures. Don't build up grade, soils, groundcover mulches, or other materials near the building that might inhibit positive drainage.

Source: http://www.cmhc-schl.gc.ca/en/inpr/bude/himu/coedar/upload/Design-Guidelines-for-Green-Roofs.pdf, Green Roof Service LLC, http://www.dwsd.org/downloads_n/announcements/general_announcements/downspout_disconnect_brochure.pdf, http://www.rwra.org/wp-content/uploads/2012/03/Owensboro-Downspout-Disconnect-Guidelines.pdf



Green roofs store and utilize stormwater to reduce runoff from building sites.

Disconnecting a downspout allows rainwater to supplement irrigation in the landscapes.

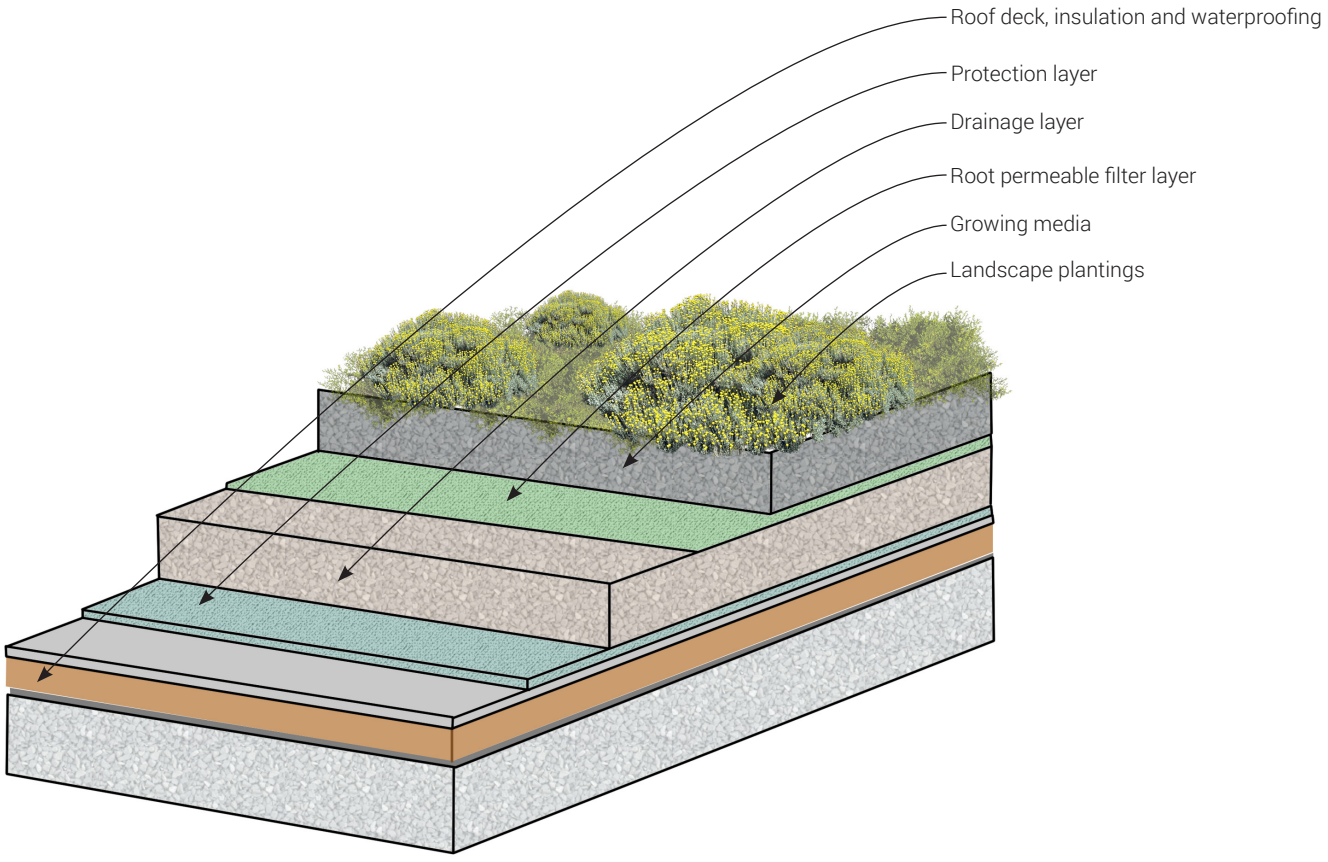
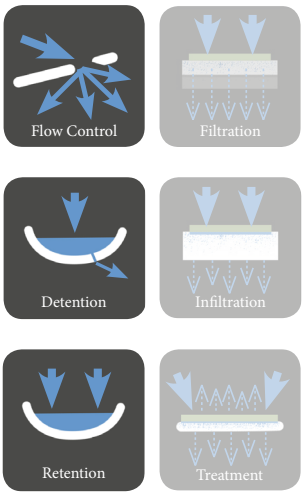


Figure 6.8 - Rooftop Garden

Rainwater Harvesting - Cisterns

Functions



Benefits

Location

Cisterns can store rainwater to be re-used for future landscape irrigation.

Description

A. A rainwater harvesting system captures stormwater runoff, often from a rooftop, and stores the water for later use. The storage capacity of a rainwater cistern depends on several factors, including the amount of rainfall available for use, the roof-catchment area available for collecting rainfall, the daily water requirements of the household and costs.

B. A rainwater harvesting system consists of four main components: a gutter system that collects runoff from the rooftop and directs it into the cistern, a cistern that stores runoff for later use, an overflow pipe that allows excess runoff to leave the cistern in a controlled manner, and an outlet pipe, sometimes connected to a pump, that draws water from the bottom of the cistern for irrigation use.

Installation

A. The most commonly available cisterns are made of plastic, fiberglass, or galvanized metal. Underground cisterns may be constructed of concrete or fiberglass. The size of the cistern can have the greatest impact on system cost and performance. Several factors must be considered, including contributing rooftop area, rainfall patterns and anticipated usage.

B. The primary constraint in selecting a cistern location is the position of the gutter downspouts. It is generally easiest and most cost effective to place the cistern near an existing downspout. When possible, locate the cistern near the site where water will be used.

C. A building, stone or gravel backfill or a poured concrete pad, may be required to provide structural support to an aboveground cistern.

D. Some type of overflow or bypass is required to release water when the cistern has reached its capacity.

E. To draw water from the cistern, some type of faucet or outlet pipe must be installed.

F. An existing gutter system can be easily modified to direct rainwater into a cistern.

G. Above-ground cisterns must meet all Town zoning requirements and receive all necessary permits.

Maintenance

A. Regularly check the gutters to make sure debris is not entering the rainwater harvesting system.

B. Inspect the screens annually to make sure debris is not collecting on the surface and that there are not holes allowing mosquitoes or other insects to enter the cistern.

C. Clean the inside of the cistern twice a year to prevent buildup of debris. Clean out debris twice a year, preferably prior to the beginning of each rainy season.

D. Maintain pumps or filters used in the rainwater harvesting system in accordance with manufacturer's recommendations.

Source: http://www.ces.ncsu.edu/depts/agecon/WECO/documents/WaterHarvestHome2008.pdf

Drainage Reports and Plans

7-1 Activities Requiring a Drainage Report and Grading Plans

A. An applicant may be required to submit a Drainage Report and Grading Plans when submitting any of the following applications. The specific nature of the plans and reports, and the requirements for submittal, will be determined by Town staff during the pre-application process.

1. Re-zoning
2. Special Use Permit
3. Development Plan
4. Preliminary and/or Final Subdivision Plat
5. Hillside Building Committee
6. Board of Adjustment
7. Final Plat, lot splits, lot line adjustment, lot combination and/or improvement plans
8. Right-of-way Permit
9. Building Permit with a grading component
10. Grading Permit
11. Modification or release of a dedicated drainage or retention easement

7-2 Types of Drainage Reports and Grading Plans

A. There are sequential levels of drainage reports and grading plans as development proposals range from broad and conceptual to project specific and detailed, as well as requirements for master-planned development proposals. Drainage reports and grading plans address stormwater flows and drainage issues that affect a proposed development, plus adjacent and nearby sites; and drainage solutions, in accordance with applicable ordinances and standards, to mitigate adverse effects resulting from the proposed development. Each drainage report and grading plan shall describe how the proposed development will manage stormwater runoff, the details of infrastructure to be constructed, the sequence of infrastructure installation, and any phasing of the project. Drainage reports and grading plans for single-family residences may vary from the sequence below, subject to town staff approval.

1. Conceptual Drainage Reports and Grading Plan. With re-zoning and special use permits, the applicant shall submit a Conceptual Drainage Report and Grading Plan that identifies the basic drainage conditions that apply to the site and possible stormwater management solutions that relate to the proposed development and unique condition of the site. In many cases, the Conceptual Drainage Report and Grading Plan will be included in a Development Plan (DP). The Conceptual Drainage Report and Grading Plan shall show how the drainage systems on the site will relate to and extend existing drainage systems serving adjacent and nearby properties. The Conceptual Drainage Report and Grading Plan shall establish the key elements for consideration in any future drainage reports and grading plans for the site, including applicable FEMA floodplain designations.

2. Preliminary Drainage Report and Grading Plan. With preliminary plat, subdivision, Master Plan and Hillside Building Committee or Board of Adjustment applications, the applicant shall submit a Preliminary Drainage Report and Grading Plan. While a Preliminary Drainage Report and Plan will not contain sufficient detail and accuracy to function as improvement plans, the Preliminary Drainage Report and Grading Plan must provide detailed design concepts, specifications for proposed drainage facilities, and management plans for operating and maintaining the drainage facilities. The Preliminary Drainage Report and Grading Plan presents the justification for final improvement plans and lowest floor elevations, the plan for connecting the proposed development to existing and planned drainage facilities on and adjacent to the site; pre- and post-project topography; and stormwater runoff calculations including off-site drainage that enters the site.

The Preliminary Drainage Report and Grading Plan shall also demonstrate consistency with any applicable Conceptual Drainage Report and Grading Plan and stipulations associated with approval.

3. Final Drainage Report and Grading Plans. With improvements plans for final plats, construction plans for public infrastructure, the modification of a drainage or retention easement, and construction plans for on-site development, the applicant shall submit a Final Drainage Report and Grading Plan. A Final Drainage Report and Grading Plan is intended for construction and therefore must be fully detailed; compliant with Town of Paradise Valley design standards and applicable regional, State and Federal statutes; and consistent with previously approved Preliminary Drainage Reports and Grading Plans and stipulations, if any.

4. Master Drainage Reports and Grading Plans. For multi-phased and complex development proposals, the Town may require the applicant to submit a Master Drainage Report and Grading Plan after a rezoning and intermediate/major special use permit amendment approval. A Master Drainage Report and Grading Plan provides the basis for constructing major common drainage improvements that serve an individual phase or property within the proposed development, the entire proposed development, or a portion of the regional drainage requirements. A Master Drainage Report and Grading Plan also establishes the drainage improvement requirements necessary for each phase of the development. A Master Drainage Report and Grading Plan shall be submitted before or with the first Preliminary Plat or Development Review case for the site.

7-3 STANDARDS

A. All drainage reports and grading plans should be prepared in conformance to the requirements in this chapter. Hydrology calculations may be performed using Drainage Design Management System for Windows (available at no cost through the FCDMC), HEC-1, HEC-HMS or the Rational Method. Hydraulic calculations may be performed using HEC-RAS. However, the Town encourages sound, innovative design and the use of new techniques where special conditions or needs exist. With prior Town staff approval, alternate methods, models and procedures may be used with appropriate supporting documentation.

B. Development shall not increase peak discharge rates above the historic peak discharge rates for 10-year and 100-year storm events.

C. Proposed grading shall be at least 0.5% to allow for positive drainage.

D. At a minimum, drainage reports should meet the following standards:

1. Reflect Town, County, State and Federal requirements
2. Use the best and most current data available
3. Provide a clear narrative of the methods used, parameters selected in the analysis and conclusions drawn
4. Be technically and legally defensible
5. Be well-organized and concise
6. Provide safe, reasonable and reliable results
7. Provide results that are consistent with adjacent jurisdictions

E. All drainage reports and grading plans shall conform to Town of Paradise Valley codes and standards.

7-4 LIMITATIONS

The Town does not guarantee the reliability of specific hydrologic methods, techniques and/or parameter values. The engineer is expected to validate the reasonableness of the estimated values and design the plan to keep the development and the Town relatively safe from flooding. The owner must submit the completed Warning and Disclaimer of Liability form, as available from the Town Engineer, with each grading and drainage plan.

7-5 GRADING AND DRAINAGE PLANS—METHODOLOGY AND CALCULATIONS

A. There are two methods to determine peak discharge:

1. The Rational Method (generally used for watersheds less than 160 acres that are regularly shaped and uniformly contoured). The methodology is provided in the FCDMC Hydrology Manual.
2. A rainfall runoff model using the Corps' HEC-1 or HEC-HMS Flood Hydrograph Package (generally used for watersheds that are larger than 160 acres, irregular in shape and contour, or if routing of flows is necessary).

B. Watershed Conditions

Watersheds are subject to change. Grading and drainage plans shall consider all watershed conditions that would result in the greatest peak discharge rate, to:

1. Size drainage facilities, and
2. Determine lowest floor elevations.

C. The Rational Methods

1. Precipitation. Precipitation input is rainfall intensity, "I," and can be obtained directly from NOAA 14 at http://hdsc.nws.noaa.gov/hdsc/pfds/sa/az_pfds.html.
2. Time of Concentration. Time of concentration "Tc" is the total time of travel from the most hydraulically remote part of the watershed to the concentration point of interest. The calculation of "Tc" must follow FCDMC Hydrology Manual procedures.
3. Runoff Coefficients. Use Runoff Coefficients for Use with Rational Method, as detailed in the Maricopa County Hydrology Manual, pages 3-5/3-6, to obtain the runoff coefficients or "C" values. Applying weighted average values calculated for the specific site is an acceptable approach.

D. HEC-1 or HEC-HMS Model

1. Minimum submittals.
   a. A printout of the input data
   b. A schematic (routing) diagram of the stream network
   c. The runoff summary output table, including drainage basin name, area, 100-year flow and 10-year flow values
   d. Electronic input file(s) on CD or DVD
   e. Supporting documentation and source material for parameter selection
   f. A narrative detailing the impact of adjustments to the modeling parameters made to address warnings and error messages
2. Precipitation. Determine precipitation values for modeling using the FCDMC Hydrology Manual, specifically PD and JD records for point rainfall and area reduction factors. Capital Projects shall use the ADOT manual and methodology when specified. Precipitation values are to be obtained from the Isopluvial maps for the specific frequency addressed, see the FCDMC Hydrology Manual at

   http://www.fcd.maricopa.gov/downloads/manuals/Hydrology-Manual.pdf.
3. Infiltration. Determine infiltration or soil losses using Green and Ampt (G&A) procedures per FCDMC Hydrology Manual. Use the following, most recent, applicable USDA NRCS soil survey maps of the area to determine the hydrologic soil group or surface soil texture for the G&A procedures:

a. Aguila Carefree Area

b. Parts of Maricopa and Pinal Counties

c. Eastern Maricopa and Northern Pinal Counties

4. Hydrograph Generation. Generate small basin or sub watershed hydrographs using the Clark unit hydrograph procedure or S-graph method as described in the FCDMC Hydrology Manual.

5. Time of Concentration ("Tc"). Use the estimated time of travel from the most hydraulically remote part of the watershed to the concentration point. The FCDMC Hydrology Manual is recommended for obtaining Tc.

6. Channel Routing. Use the Normal Depth (Modified Puls), eight point routing procedure as described in the FCDMC Hydrology Manual for channel routing.

7. Existing and Proposed Discharge Analysis. Use the following analysis procedures when necessary to compare existing and proposed discharge (runoff)conditions. Reflect full development conditions by:

a. Increasing the percentage of impervious surfaces on the LG card to show the amount of impervious surface that will exist after full development.

b. Recalculating the time of concentration (Tc) based on the proposed drainage system, after full development.

c. Subdividing, as necessary, the existing condition model to create concentration points that match the sub-watershed areas above each proposed storage facility after full development.

d. Modeling each proposed storage facility as it will physically exist after full development, with appropriate routing and combining operations through each facility and through the entire watershed. Modeling storage capacity provided, as one hypothetical facility at the outlet with all upstream storage arbitrarily combined in the facility, is not acceptable.

e. Analyzing the 10-year and 100-year frequency events, at a minimum.

f. Comparing discharge values for existing and full development at concentration points just downstream from each proposed storage facility,other critical locations such as road crossings, and points where flows exit the development.

E. Calculation of Runoff Volumes

1. Standard Formula for Runoff Volumes The standard formula for determining the required stormwater storage runoff volume is in Section 3.2 above.

2. HEC-1 and HEC-HMS Computer Modeling. HEC-1 and HEC-HMS modeling may be used for storage basin design,routing and analysis. Use modified Puls level pool routing option in HEC-1 forhydrograph routing through storage basins and lakes. For permanent lakes,assume no available storage below the normal water surface elevation.

F. Methods for Estimating Water Surface Elevations and Inundation Limits

The engineer may use any standard method for determining water surface elevations. The Town prefers the U.S. Army Corps of Engineers' HEC-RAS, to determine inundation limits. If the applicant uses the U.S. Army Corps of Engineers' HEC-RAS Computer Models, the minimum required submittals for HEC-RAS are:

1. A printout and CD or DVD of the input and output data.

2. A plan of the contributing stream network and sub-basins with cross section locations and stationing, including flow obstructions, ineffective flow areas modeled and other appropriate parameters at a sufficient scale to support the modeling. Overlay the cross sections on the topographic work map.

3. A detailed output summary table, including flow rates, velocities, water surface elevations,

bank stations, n-values, ineffective flow stations, flow obstruction stations and other relevant parameters.

4. Cross section profiles.
5. Supporting documentation and source material for parameter selection.
6. A narrative to validate warning and error messages with details of the impact of adjustments to the modeling parameters on the output, if the Town staff allows warning or error messages.

7-6 GRADING AND DRAINAGE PLANS—ADDITIONAL REQUIREMENTS BY PLAN TYPE

The following requirements are in addition to the above requirements depending on the type of plan or development. Some requirements may apply to other plan types depending on the nature of the project and improvements.

A. Special Use and Multifamily Permits

The plan must show:

1. The location, orientation and an outline of refuse enclosures, including approach slabs.
2. Details of driveways conforming to town standard details, plus existing gutter grades at tie in, longitudinal slopes, the location of grade breaks, sidewalk ramps,curb return radii, existing curb and asphalt removal and asphalt replacement.
3. Horizontal control for proposed buildings, drive aisles, parking space dimensions and any other substantial improvements.
4. All drainage features such as catch basins, curbs and gutters, pipes, headwalls, basins, and drywells, along with flow arrows and appropriate elevations for each feature.
5. High and low points for driveway paving, with elevations.
6. Building setback lines.
7. Traffic and parking striping.
8. Access to underground parking areas.

B. Residential Subdivisions

The plan must show:

1. Lot numbers.
2. Tract names and street names from the final plat.
3. Street, tract and rights-of-way widths, and street centerlines from paving plans.
4. All drainage features such as catch basins, curbs and gutters, pipes, headwalls, basins, and drywells, along with flow arrows and appropriate elevations for each feature.
5. Street longitudinal and cross slopes.
6. 10-year and 100-year peak discharge rates at curb cuts and catch basins.
7. Flow path for small washes or swales through lots in custom residential subdivisions.
8. High and low points within streets, with elevations.
9. Building setback lines.
10. Top of curb elevations at the intersection of lot lines with the tract or rights-of-way lines.

C. Requirements for single-family development can be found at http://www.paradisevalleyaz.gov/DocumentCenter/Home/View/10.

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Drainage Easements

8-1 GENERAL INFORMATION

A. Drainage Easement Requirements

Refer to Town Code Section 6-3-8. Drainage easements are required for:

1. Watercourses with a 100-year, peak discharge rate of 50 cfs or greater.
2. Washes having historical banks, a bed and a cross sectional area of least 10 square feet.
3. All drainage and stormwater storage facilities.

Forms are available on the Town's website at http://paradisevalleyaz.gov/24/Permits-and-Handouts.

B. Extent of Drainage Easement Dedication

A drainage easement shall be dedicated to the Town to the limits of stormwater inundation from a base flood for the watercourses described above, plus drainage and stormwater storage facilities. Drainage easement dedications shall encompass all physical structures and sufficient area to access and maintain the facilities, including a setback from the property line. If the drainage easement is not contiguous to the right-of-way, a minimum 16-foot access easement, to maintain the drainage facility with mechanical equipment, shall also be dedicated, regardless of who maintains the drainage facility.

If a stormwater storage facility is fenced or barricaded, the access easement shall include a 20-foot setback between the fence or barricade around the perimeter of the facility. If a stormwater storage facility is not fenced or barricaded, the access easement shall include a 5-foot setback from the top of the bank around the perimeter of the facility.

Refer to Section 5-10-7 Paragraph C of the Town Code for easement requirements.

C. Maintaining a Drainage Easement

1. Unless otherwise indicated on the document dedicating the drainage easement or in a recorded agreement, the property owner is responsible for maintaining the drainage easement.
2. In addition to the requirements for maintaining a drainage easement in the Storm Drain Design Ordinance, the owner shall:
   a. Inspect the drainage facilities after each storm event of 0.6 inch or more, and semiannually, preferably before summer and winter rains.
   b. Remove accumulated trash and debris from inlet and outlet structures as needed for the free flow of stormwater.
   c. Inspect all other elements of the drainage system (pipes, geotextiles, and stone) and repair/replace elements as needed for the storage system to operate at peak efficiency.

D. Releasing a Drainage Easement

1. A drainage easement may be released only if the applicant documents one of the following circumstances:
   a. Upstream flows have been physically cut off or diminished;
   b. More detailed or accurate topographic mapping and/or aerial photography show the original dedication is incorrectly located; or
   c. The original hydrology is outdated or in error.
2. The Town staff may determine that retaining the easement is in best interest of the Town, and may not grant the release. The Town staff may impose reasonable conditions before releasing a drainage easement. Once all conditions have been satisfied, as determined by Town Council, Town Council may grant the release.

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Grading Permits

9-1 GENERAL INFORMATION

A. A review of the improvement plans must be completed by Town staff before applying for a grading permit.

B. Before a grading permit is issued:

1. All substantial grading and drainage issues associated with a project must be resolved to the satisfaction of the Town Engineer.
2. The Town Council must have approved the final plat, or other entitlement if applicable, for the project. This requirement may be waived by the Town Engineer at the Applicant's own risk.
3. The owner must complete a Native Plant Preservation Plan. The Native Plant Preservation Plan shall be placed with the improvement plans submitted for the preliminary grading permit.
4. If applicable, the owner must obtain a Haul Permit.
5. If applicable, the owner must obtain a Stormwater Storage Waiver.
6. The completed No Conflict signature box must be placed on the cover sheet, signed and dated, and all applicable No Conflict letters submitted.
7. The owner must provide a copy of the approved AZPDES Notice of Intent (NOI) and SWPPP.
8. When applicable the owner must provide a completed Section 404 Certification form and a copy of a permit from the US Army Corps of Engineers.
9. The owner must submit 2 full size sets of grading plans (24 inches x 36 inches).
10. The owner must meet any other project specific requirements to issue a final grading permit.

C. A Grading Permit may only be issued upon approval by Town staff.

9-2 STOCKPILE PLANS

A. Upon Town staff approval, an applicant may temporarily store on-site excess soil from construction operations. To receive approval, the applicant must submit:

1. A letter signed by the applicant stating the duration of the stockpile and the methods used to control dust.
2. A plan prepared in conformance with grading and drainage plan requirements showing the stockpile location.
   a. The stockpile may not be located on, or within, any easements, rights-of-way or watercourses.
   b. The plan must provide at least one cross-section through the stockpile, labeling the side slopes and the maximum height of the stockpile, and show the total volume of the stockpile.
   c. The plan must show and label all proposed open space areas.
   d. The plan must manage drainage runoff from the stockpile and upstream watersheds by considering stockpile location, stockpile design and grading, and/or temporary stormwater storage.
3. A Native Plant Preservation Plan for the area to be used for stockpile. The Native Plant Preservation Plan shall be placed on the stockpile plan.

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DESIGN AND MAINTENANCE GUIDELINES

10-1 SITE CONTEXT

A. The following guidelines focus on the relationship of a proposed site plan to the natural terrain of the property, as well as the relationships this proposal will have with existing or planned uses adjacent to it. The goals are to fit development into the natural site with minimal intrusion, and to be sensitive to adjacent uses.

1. Site features, such as washes or native desert vegetation, should be kept in as natural state as possible.
2. Washes should be used as amenities for the site. Common recreational, patio, outdoor dining, and other such facilities should be oriented toward such natural features.
3. Major desert vegetation specimens should be kept in place wherever they are located, particularly if they are located in required setbacks, parking area, landscape islands, or other such open space areas.
4. On sites where there is significant change in the grade levels from the site to adjacent properties, the site design should accommodate the grading transition through design techniques such as landscaped terraces, landscaped slopes of 4:1 (run-to-rise) or gentler, or some similar gradual technique.
5. Refer to Town Zoning Code Chapters 22 and 24 for retaining wall and fence requirements.

10-2 NATURAL AREAS

A. Preservation:

Grading and design of landscape improvements will preserve and restore natural wash corridors that provide stormwater conveyance.

B. Aesthetic Standards:

All designed channels shall be formed to blend with the surrounding landscape, including contoured site grading for earthen channels and matching plant types and density.

C. Landscaping:

Utilize Sonoran Desert indigenous plant material wherever appropriate in landscaping associated with construction and maintenance of public property and easements for stormwater conveyance. Town Landscape Guidelines can be found at: http://www.paradisevalleyaz.gov/DocumentCenter/Home/View/37

D. Visual Character:

In order to create high quality and high performance landscapes that reflect the positive character of the Town, drainageways, wash corridors and other storm drainage facilities will be designed to provide visual and physical continuity through attractive, cohesive and diverse design elements consistent with the Town Landscape Guidelines.

E. Natural Wash Corridors:

Town rights-of-way and easements along natural wash corridors are important to maintain and preserve the natural environment and landscape features. Natural Wash Corridors shall include, whenever feasible, a landscape buffer area of at least 5 feet on each side, perpendicular from the top of the bank.

F. Maintenance:

Regular (annual) inspections are required by the property owner, to determine the condition of drainageways, including erosion, sedimentation, dead or unhealthy vegetation, potential for blockage and need for maintenance. Dead or dying plants shall be replaced immediately. Vegetation shall be pruned regularly to remove dead limbs and overgrowth.

Figure 10.1 - Typical Natural Wash Landscape

G. Access:

For Natural Washes, new development should provide, if possible, a minimum 10-feet wide accessible clear zone area for emergency and ordinary maintenance vehicle access. For access to minor drainageways and basins including roadside swales, ditches and sediment basins, allow for reasonable access for regular maintenance and emergency use. Access may be combined with trails.

10-3 DRAINAGE PLANNING

A. The analysis of hydrologic and hydraulic hazards within this region must consider impacts to all downstream areas. Failure to consider these impacts may result in hazardous diversions of flow, increases in peak discharge flow rates and disruption of the transport equilibrium. Any of these phenomena could increase the flooding and erosion potential to downstream properties and create a liability.

1. Design drainage facilities to maintain the natural runoff and channel characteristics.
2. Do not adversely impact drainage patterns, including the location and configuration of watershed boundaries.
3. Maintain the stability of natural drainage channels, particularly the channel banks, as much as is possible.
4. Do not increase the natural volume of existing channel flows.
5. Maintain the natural sedimentation characteristics of an existing drainage way.
6. Do not restrict or obstruct natural habitat condition or movement with improvements to existing channels.
7. Maintain the natural vegetation density and diversity of existing channels.
8. Preserve the viewshed characteristics of large washes and vista corridors.
9. Design retention and detention basins to blend into the natural contours and undulations of the site and the local natural terrain.
10. Locate retention and detention basins within a subdivision in separate tracts, not on individual lots. Exceptions may be made by the Zoning Administrator or designee if the following conditions are met:

    a. The basins will be maintained by a property owners association or its equivalent;

    b. Appropriately sized drainage and maintenance access easements are provided; and

    c. The basin is accessible from a street.

B. Retention Basins

1. The design depth of water stored in the basin shall not exceed 3 feet.
2. The maximum side slope of the basin is 4:1 unless otherwise approved by Town staff.
3. Round and contour the bottom and top edges of the side slopes in order to achieve a gradual slope transition.
4. Where retaining walls are utilized as part of a basin, use textured and/or dark surface treatments on the portion of the wall that could be inundated to minimize the visibility of water staining. Guardrails may be required at the top of such walls per the Town's adopted building code.
5. Use only plant materials in basins that are capable of surving while being inundated. Trees and woody shrubs are preferred; avoid succulents and herbaceous shrubs in basins. In areas where natural desert plants are being used, use plants that are typical to desert riparian areas, such as mesquite, blue palo verde, desert willow, wolfberry, desert hackberry, desert holly, jojoba and beloperone, etc.
6. Basins shall not occupy more than 50 percent of the frontage landscaped area unless specifically approved by the Town.
7. Unless otherwise waived by the Town Engineer, drainage basins should not be placed on individual lots unless all of the following criteria are met:
   a. Basin is designed to retain pre-vs.-post volume per Section 3
   b. Basin is directly accessible and visible from a street or alley
   c. Maintenance of the basin is designated to a property owners association
   d. Basin and its access are placed within a drainage and access easement
8. Landscape installation shall conform to the most current Town supplement to MAG Section 430 and related details.
9. Natural growth habits shall be taken into consideration to minimize maintenance frequency and intensity.
10. Landscaping should not create hazards to public safety through either plant growth habit, structure, or location.
11. Trees should not be planted within 10 feet of an existing private wall, sign, light pole, or fire hydrant.
12. Install boulders with 2/3 of their volume below the ground and place them at least 10 feet away from any curb and at least 4 feet from any walkway

C. Surface Channels

Site plans should incorporate the following criteria in the placement, design and use of surface drainage facilities:

1. Keep major natural vegetation specimens along washes in place wherever possible.
2. Place amenities for on-site use, such as dining patios or pathways, next to drainage ways where feasible.
3. Landscape any engineered and constructed channels in a manner that helps to manage the storm flows and provides the channel as a visual amenity for the site and community. Concrete and rock surfaces should be kept to a minimum. If such materials are used, they should be formed and applied in a "natural" manner or designed to integrate with the onsite buildings.
4. Any rock used in any drainage facility shall be native and/or crushed rock. Do not use river-run cobbles.

10-4 CONTEXT SENSITIVE DEVELOPMENT OF STORMWATER FACILITIES

A. Planning and Design:

Planning of drainage facilities should be based upon integrating natural waterways, designed channels and other storm drainage improvements into the development of a desirable setting where aesthetic enhancement is a primary motive. Storm drainage facilities that are designed to be sensitive to their site and community context can provide multiple benefits and encourage proper care and maintenance. Since drainageways and washes are normally continuously connected, they provide unique opportunities for linear open space and vista corridors, as well as landscape buffers, trail connections and wildlife linkages across the community.

B. Conveyance and Storage:

Wherever possible drainage corridors and stormwater storage basins should be combined with open space and neighborhood parks to create focal points and use areas for the community. Passive recreation activities such as hiking, jogging, and enjoyment of natural areas is highly compatible with the function of natural wash corridors and stage facilities. Avoid placing recreation facilities in the bottom of stormwater facilities to minimize risk of damage and harm. Amenities within the inundation area of a storm water facility shall be adequately secured to prevent them from becoming waterborne debris.

C. Aesthetic Design of Materials:

Concrete channels are generally not permitted in stormwater conveyances. Use of concrete structures shall be minimized and all structures shall be designed with colors and finishes appropriate to their context. Flat or sloped concrete surfaces shall be designed with a roughened surface to discourage inappropriate recreational use. Exposed concrete structures require the use of integral colored concrete with a formed finish as approved by the Town. Railings are highly discouraged, but where required shall be designed and finished to blend with the surrounding landscape as approved by the Town. Use of rip-rap for channel protection is discouraged.

10-5 IMPROVEMENTS TO NATURAL WASHES

Design any improvements to natural washes to compliment the natural function and appearance of the site. It is preferable to leave the washes in an undisturbed state and use sufficient building setbacks to preclude the need for artificial bank protection.

Avoid any disruption of the natural geometry and bed-profile of washes to the greatest extent feasible. This includes any unnatural diversion of water into or from these washes. Such diversion could upset the system equilibrium and induce accelerated bank erosion and long-term degradation of the channel bed.

A. Incised Natural Washes

Virtually all washes in the Hillside areas are well incised. As such, they generally have capacity equal to or exceeding that necessary to contain the projected storm flows. The steep slopes in the Hillside areas promote very high velocity flows. This creates a potential for bank erosion and bed scour.

Due to bedrock outcrops and relatively large diameter sediment particles found in these washes, bed scour may be arrested by channel armoring, particularly in association with road crossings. This phenomenon will be evaluated on a case-by-case basis. Avoid the use of structures that might form an artificial grade control. Consider clear span bridges for crossings where multiple barrel culverts impede flow due to the amount of sediment transport or debris that is likely during major storm events. Include the entire top-of-bank to top-of-bank dimension that exists naturally in addition to the area normally required to contain the 100-year storm within drainage easements along incised washes.

B. Over-bank Flow and Braided Washes

In portions of the watershed area washes do not have natural channels with adequate capacity to contain major storm flows. In major storms, flows will fill the visible channel, inundate adjacent lands and divert into other braided channel courses and/or become sheet flow not confined to any particular drainage way.

Modifying or restructuring the natural drainage way may be needed to protect structures and public

infrastructure. To maintain control of flood flows along such drainage ways, provide reinforced channel banks by using reinforced embankments, flood walls, raised pads for buildings or other such methods.

Reconstructing or relocating a natural channel will only be considered when there is no other reasonable approach available. Relocated wash channels shall be designed and constructed in a manner that restores the wash to a natural condition with revegetation of native desert plants typical to local washes and contours that blend into the natural topography. Placing channels into underground drain pipes shall not be used unless there is no other possible solution for managing the storm flows.

C. Residential Development

1. Design residential street systems to avoid diverting or blocking historical drainage patterns.
2. Contour and align streets so water is directed into the historical drainage course on the site.
3. During the construction phase of residential development, minimize erosion on disturbed ground surfaces (utility alignments, street cuts, etc.).
4. Disperse on-site flows from improved portions of residential properties to minimize off-site erosion or direct flows into a defined drainage course to minimize erosion and maintain flow characteristics of the drainage way.

D. Utility Installations

1. Complete the installation of underground utilities to avoid conditions that could lead to the alteration of historical drainage patterns.
2. Keep utility crossings of drainage ways to the minimum extent feasible.
3. Wherever possible, place utility crossings in conjunction with road crossings and diagonal to the flow path of the drainage way.
4. Place utility crossings in natural or man-made channels below the maximum expected scour depth of such channels, in addition to the usual depth of cover.
5. Do not place utility corridors alongside drainage ways within the area that could be inundated in a 100-year storm flow or through the native riparian vegetation along the drainage way.

E. Culverts and Grade Crossings

1. Account for potential clogging due to sediment and debris in the design of culvert capacities.
2. Construct headwalls and wingwalls at culvert entrances. In addition, an erosion resistant apron may be necessary when analysis indicates the need. Consult the Federal Highway Administration's manuals that address the design of such facilities.
3. Consider the possibility of flow over the roadway in the design of culverted roadway crossings and provide erosion resistant bank protection on both the upstream and downstream side-slopes as needed.
4. Where "wet" crossings of washes are approved (by Town Engineer), a concrete road surface may be necessary for that portion of the street inundated during a 25-year storm. Concrete cutoff walls shall be designed and constructed on both the upstream and downstream sides of the roadway. All "wet" crossings shall be posted with warning signs.

10-6 STREET GRADING

This section establishes criteria for cut and fill slopes, slope stabilization, erosion controls and restoration of scarred areas due to grading associated with street construction. All improvement plans and street design must be done under the supervision of a registered Civil Engineer.

A. Side Slopes

1. Consider stability, maintenance and appearance of cut and fill slopes during construction. Use geotechnical reports for safe slope gradients.
2. The maximum slope gradient for fill slopes within the right-of-way is 4:1 (horizontal to vertical) and for cut slopes is 3:1, unless otherwise approved by the Town engineer.
3. In areas where the engineer anticipates unstable soils or potential erosion, flatter slopes or specific mitigation techniques may be accepted. Design measures to mitigate unstable slope conditions and potential erosion problems must be identified in the geotechnical report.
4. Steeper slopes are allowable provided that geotechnical conditions are properly analyzed and a stable embankment is detailed on the construction plans. Fill slopes steeper than 4:1 may require the use of guardrails.
5. The maximum height of cuts and fills for roadway improvements is 8 feet, as measured vertically from the pavement surface to the natural grade at the toe or top of the constructed slope.
6. When retaining walls are used, the exposed height should be the height of the retaining wall plus the vertical height of the retaining slope.
7. Maintain an average height of 6 feet for any continuous slope. Determine the average slope height by using individual slope heights measured at 50-foot intervals.
8. Where there is a combination of cut and fill slopes at any 1 station along the roadway, do not exceed a combined slope height of 12 feet.
9. Heights exceeding the above criteria may be allowed by the Town engineer provided the applicant demonstrates that objectives of the Storm Guidelines are met.
10. Round all slopes to blend into the existing terrain to produce a contoured transition from the slope face to the natural ground.
11. Town staff may require mitigation techniques for cuts and fills greater than 8 feet. Slopes and fills must be engineered in accordance with the recommendations of the geotechnical report.

B. Retaining Walls

Retaining walls may be used to reduce the horizontal and vertical distances required to construct cut and fill slopes.

1. All retaining walls, regardless of height, shall comply with the Town building code and also conform to the following requirements. The heights and types of retaining walls shall be subject to Town engineer approval, based upon the visibility and magnitude of the proposed structure.
2. Acceptable types of retaining walls include stone gravity, structural masonry and reinforced concrete. Do not use other types, such as metal cribbing walls and rock gabion walls, unless approved by the Town.
3. Consider terraced walls in place of a single wall for instances requiring retaining walls in excess of 6 feet in height. The minimum dimension of the landscaped level located between the lower and upper terrace walls shall be at least equal to the visible height of the lower wall, but not less than 4 feet. Refer to chapter 22 and 24 of the Town Zoning Code for retaining wall and fence requirements.
4. In general, match the finish material and color of retaining walls with the surrounding natural stone, rock or soil color.

5. Plans for retaining walls greater in height than 3 feet must be signed and sealed by a registered Civil Engineer or Structural Engineer in the State of Arizona.

C. Drainage Controls

1. Design all drainage facilities to carry surface waters to their historical outfall.
2. Do not pond water above cut or fill slopes.
3. Construct and maintain erosion controls (temporary or permanent) to prevent erosion of all slopes and graded areas.
4. Provide surface drainage interceptors at the top of cut and fill slopes where surface runoff will create erosion problems.
5. Subsurface drainage facilities may be required for stability and protection of affected areas due to ground water seepage.

D. Slope Restoration

Restoration and stabilization of all exposed slopes created by grading shall be completed within 90 calendar days after rough grading of the roadway. Restoration shall consist of revegetation with native species of a type and mix consistent with local natural conditions and/or artificial weathering of rock faces. A revegetation plan including plant species, locations, sizes and methods of transplanting must be

10-7 PLANT MATERIALS

Protected Native Plants

A. Species

Specific native plants are protected as described in the Town's Native Plant Ordinance.

1. Trees over four (4) inches caliper of the following species:

BOTANICAL NAME	COMMON NAME
Acacia constricta	Whitethorn Acacia
Acacia greggii	Catclaw Acacia
Cercidium floridum (Parkinsonia florida)	Blue Palo Verde
Cercidium microphylum (Parkinsonia microphyllum)	Foothills Palo Verde
Olneya tesota	Ironwood
Prosopis spp.	Mesquite

2. Cacti

BOTANICAL NAME	COMMON NAME
Carnegia gigantea	Saguaro
Ferocactus spp.	Barrel
Fouquieria splendens	Ocotillo
Peniocereus greggii	Desert Night-Blooming Cereus

No protected plant material (as defined above) may be relocated, removed, or destroyed without approval of a Native Plant Preservation Plan. No native plant certification shall be issued unless an application is submitted in conjunction with an existing or proposed development for approval.

B. Incorporation of Plants in a Project

Incorporation of plant material into site design takes into consideration the following:

1. Conditions where protected plants remain in place:
   a. Along natural washes where exposed roots, erosive soils, and steep slopes often make relocating plants difficult.
   b. Where dense massing of plant materials provides an aesthetic setting, but individual plants may be unsalvageable.
   c. In boulder outcroppings where digging out the root ball would be impractical.
   d. Where unstable soils decrease the ability of the root ball to hold together.
   e. When large specimen material does not lend itself to relocation.
   f. When seasonal conditions reduce the salvageability rate to the point of making relocation undesirable.
   g. When plants occur in a unique grouping or form.
   h. When plants are located within designated scenic and vista corridors.
   i. Within land use buffers such as scenic corridor or NAOS easements.
2. Conditions where protected plants may be salvaged:
   a. When retention of protected plant material is impractical due to reasonable construction, physical conditions are good, and plant material falls within the construction boundaries.
3. Conditions where protected plants may be removed from the site:
   a. When the allowable site density is high and there are minimal areas for replacing plant material.
   b. When conditions yield more plant materials than can be relocated on the project.
4. Protected plant materials may be destroyed:
   a. When the physical condition of a protected plant is poor due to disease, infestation, mutilation, age, or poor natural conditions; and is located within the construction boundaries.
   b. If a protected plant is involved in a safety issue and cannot be relocated, removed, or protected in place.

Native Plants in Retention and Detention Basins and Drainage Channels

The following is a guide in the use of native plants within retention and detention basins and improved drainage channels:

1. Plants that can be placed on the bottom of a basin:

BOTANICAL NAME	COMMON NAME
Prosopis velutina	Velvet Mesquite
Atriplex canescens	Four-wing Saltbush
Celtis pallida	Desert Hackberry
* Acacia greggii	Catclaw
Justicia californica	Chuparosa
Ambrosia ambrosioides	Canyon Ragweed

2. Plants that may be placed on the sides of a basin (including all plants listed above):

BOTANICAL NAME	COMMON NAME
Olneya tesota	Ironwood
Cercidium floridum	Blue Palo Verde
Chilopsis linearis	Desert Willow
Lycium Species.	Wolfberry
Hyptis emoryi	Desert Lavender
Calliandra eriophylla	Fairy Duster
Larrea tridentata	Creosote
* Simmondsia chinensis	Jojoba
* Dodonaea viscosa	Hopbush
* Ephedra trifurca	Mormon Tea
Hymenoclea monogyra	Cheese Bush
* Lotus rigida	Deer-Vetch

3. Plants that should not be used in any part of a basin:

BOTANICAL NAME	COMMON NAME
Cercidium microphylla	Foothills Palo Verde
Opuntia Species.	Chollas and Pricklypears
Ferocactus Species.	Barrel Cacti
Ambrosia deltoidea	Bursage
Agave Species.	Century plants
Encelia farinosa	Brittlebush
Eriogonum fasciculatum var. poliofolium	Buckwheat
Fouquieria splendens	Ocotillo

Slope Revegetation with Native Plants

1. Restore all exposed slopes created by grading to a natural condition and stabilize them to minimize erosion and slope collapse or wasting.
2. Restoration shall include revegetation with native species as found on similar natural slopes in the area.
3. Treat cuts into rock or caliche with artificial weathering techniques.
4. Irrigate all revegetated areas for at least 3 years or until the vegetation has become established.
5. Do not use imported decomposed-granite soil-cover/mulch in revegetated areas or in any place within open space areas.
6. Complete all site restoration for any type of development within 90 days of the completion of

work or prior to the issuance of a certificate of occupancy, whichever occurs first.

10-8 LANDSCAPE MAINTENANCE

Most native and desert adapted plants need little or no water and fertilization once they are established. Fertilizer and pesticides should not be used in or around stormwater management areas as the materials can contaminate downstream water courses. Plants should be inspected annually to determine the need for pruning or replacement. Most desert native and adapted plants can maintain their natural form without much pruning. Prune plants properly as recommend by a certified arborist when at least one of the following conditions is present:

1. Need to remove dead diseased or weakened branches or plants
2. Keep flow channels and lines of sight clear for inspection and maintenance of channels and washes.
3. Need to control or direct growth

After major storm events, and at least annually, inspect grading, ground coverings/mulch, irrigation systems and other site improvements for signs of damage or erosion. Repair or restore immediately to minimize additional damage.

Refer to Paradise Valley Landscape Guidelines and the Town Code Section 5-8-4 for more information.

Appendix 6A

DRAINAGE REPORTS AND PLANS

A. For all Drainage Reports and Plans, provide as required for the level of detail for each type of drainage report and plan:
   1. Analysis based on:
      a. HEC-1, HEC-HMS, HEC-2 or HEC-RAS, Flowmaster, HY-8, Culvert Master and/or DDMSW; or
      b. Nonstandard software, if approved by town staff, and if working nonstandard software is provided.
   2. Two bound copies (3 ring, GBC or Coil wire, no staples), with card stock front and back covers.
   3. Information for the entire project site and off-site at least fifty feet from site.
   4. Topography, based on current surveys, as follows:
      a. For topography on site and 25 feet beyond the property line, as well as any area subject to a hydraulic model, show existing and proposed topography with minimum 1-foot contours, with 5-foot contour lines distinguished for readability. Exceptions may be considered on a case-by-case basis for substantial areas of undisturbed ground not subject to inundation in a base flood.
      b. For off-site topography necessary to delineate watershed boundaries, show existing topography with minimum 2-foot contours. Subject to town staff approval, show spot elevations in lieu of 1-foot contours for development that does not have enough relief to use 1-foot contours.
      c. All proposed contours must align with all existing contours.
      d. Showing how topography influences stormwater runoff from the development and off-site watersheds.
      e. Provide cross sections as necessary to adequately demonstrate how the proposed site grading will not adversely affect other property.
   5. Current color aerial photographs:
      a. On-site, minimum 400 scale aerial photos, clearly identifying project site.
      b. Off-site, minimum 800 scale aerial photos, showing project site in context.
   6. On-site photographs to support parameter selection.
   7. Drainage Plans: show 1-foot contours, 24” x 36”.
      a. Scales of Drainage Plans are shown below; alternate scales are subject to town staff approval.
      b. All plans shall label substantial cut and fill areas with a directional arrow, with the slope expressed as horizontal to vertical (H:V).
      c. All plans shall provide a legend for all line types, symbols and abbreviations used on the plan.

   d. All plans shall be clearly readable even if reduced by 50%, as determined by city staff.
8. Sufficient detail to allow thorough review.
9. Plan Check Number and/or Case Number on the right margin of cover and each page.
10. FEMA blocks, information and certification as required in Chapter 1.
11. Full size plans/maps, folded, contained in pockets and listed in the Table of Contents.
12. The Drainage Report and Plan, including all Chapters, Figures, Attachments, Plans, Maps and Appendices as a PDF file.
13. A compact disk (CD) or digital video disk (DVD) containing the entire Drainage Report and Plan, including all Chapters, Figures, Attachments, Plans, Maps and Appendices with data files of analysis required above, all in PDF format. The CD and DVD shall be labeled and include the engineer's name, firm name, project name, date, and Plan Check Number and/or Case Number. The CD or DVD shall be in a case and placed in the separate folder in the Drainage Report and Plan. This CD or DVD shall also contain all hydrologic and hydraulic input and output files such as HEC-1 and HEC-RAS.
14. Completed and signed Warning and Disclaimer of Liability. See App. 6B in this chapter.

B. For all Drainage Reports and Plans, provide:
   1. Title Page:
      a. Type of Report (Conceptual, Preliminary, Final or Master Plan).
      b. Project Name.
      c. Location.
      d. Plan Check Number and/or Case Number.
      e. Benchmark datum of NAVD 1988, or subject to town staff approval, a local benchmark with an elevation equation related to NAVD 1988, to nearest hundredth of a foot in the format LF88 = X,XXX.XX.
      f. Engineer's seal, signature, and date, in accordance with AZBTR requirements.
   2. Table of Contents:
      a. List of All Chapters, Figures, Attachments, Plans, Maps and Appendices.
      b. Engineer's seal, signature, and date.
   3. Introduction:
      a. Project Name, location, size and brief description (including scope of project).
      b. Vicinity map.
      c. Purpose and objectives of Drainage Plan.
      d. Executive summary of findings, conclusions and proposals.
      e. Special Conditions, if applicable, including project stipulations; erosion issues; 401 and 404 Permits; ADEQ Permits; AZPDES Permits; and stormwater storage waiver, wash modification and phasing proposals.

4. Data Analysis Methods: Provide a narrative of, pre- and post-development, for on-site and off-site conditions:
   a. Hydrologic procedures, parameter selection and assumptions.
   b. Hydraulic procedures, methods, parameter selection, design criteria and assumptions.
   c. Stormwater storage calculation methods and assumptions, including accounting for sediment.
   d. Basis for setting lowest floor elevations relative to designated floodplains and adjacent washes; or outside a floodplain, relative to highest adjacent grade.
5. Conclusions.
   a. Summarize the data analysis methods used.
   b. State how the conclusions are reached.
6. References and Appendices: Provide the following technical data to support the conclusions, based on the level of detail required for each type of grading report and plan described in section 6.2.
   a. Data and calculations
   b. Peak flow calculations (e.g. Rational Method or HEC-1 printouts)
   c. Channel design calculations including toe-down protection and drop structure design
   d. Culvert design calculations
   e. Floodplain calculations (e.g. Manning's and/or HEC-RAS printouts)
   f. Stormwater runoff calculations
   g. Storage volume calculations
   h. Retention/detention basin inflow outflow analysis and design calculations
   i. Street capacity calculations
   j. Curb opening, catch basin calculations
   k. Storm drain calculations
   l. Sediment and scour calculations
   m. Rip-rap sizing
   n. Erosion/sediment control plan
   o. Soils and or geologic analyses
   p. Hydrologic and hydraulic data and calculations
7. Different information and format:
   a. Town staff may require additional information, or information in a different form from that required above, to address unique situations or assist town staff in thorough review of the Drainage Report and Plan.

c. Additional information must conform to generally accepted engineering principles and practices to allow town staff to assess whether the Drainage Report and Plan meets town standards.

C. For Conceptual Drainage Reports and Plans, provide the documents required in A and B above with further specifications below:
   1. Plans to a minimum scale of 1" = 40'
   2. The Report must include the phasing information, including:
      a. Graphic of areas to be phased, with labels of phases.
      b. Justification for phasing.
   3. The Plan must show and label, on separate pages, (1) pre-development, on-site and off-site, and (2) post-development, on-site and off-site:
      a. Watershed and floodplain boundaries.
      b. FEMA floodplain designations.
      c. Dimensions and calculation of disturbed area.
      d. Flow lines and flow rates; with dashed lines for flow line of watercourse bottoms.
      e. Historical flow path entry and exit locations.
      f. 100-year peak discharge rates at key concentration points.
      g. Land use, building footprints, utilities and development conditions.
      h. Existing watershed and drainage characteristics, network and patterns.
      i. Location, description and purpose of existing and proposed drainage infrastructure; conveyance of off-site flows; connections to and probable effect on upstream and downstream drainage systems.
      j. Existing drainage easements and rights-of-way, with the Maricopa County Recorder's number.

D. For Preliminary Drainage Reports and Plans, provide the documents required in A., B. and C. above with further information and specifications below:
   1. Plans to a minimum scale of 1" = 30'.
   2. FIRMs.
   3. Proposed waiver of any stormwater storage requirement.
   4. Topographic plan resulting from proposed on-site grading.
   5. The Report must include the following descriptions and analysis:
      a. Existing land use in the watershed area, and proposed land use resulting from development.
      b. Explanation of parameters of analysis used.
      c. Basis of selection of lowest floor elevations.
      d. In AO Zones, the lowest floor elevations and highest adjacent grade (HAG), calculated as follows: Determine the Regulatory Flood Elevation (RFE) to set the LF88

for residential structures. The RFE = the HAG Elev + AO depth No.+ 1 foot of freeboard.

e. In local floodplains and special flood hazard areas, for all structures, show the lowest floor elevations, BFE, highest adjacent grade, and, in addition, for commercial structures, floodproofing elevations. If the lowest floor is below the base flood elevation, the design for protecting the interior of the structure. For calculating the BFE, see FEMA Publication 265: Managing Floodplain Development in Approximate Zone A Areas – A Guide for Obtaining and Developing Base (100-year) Flood Elevations at http://www.fema.gov/library/viewRecord.do?id=1526.
f. For all mechanical equipment and attendant utilities, in local floodplains and special flood hazard areas, show the lowest floor elevations, BFE, highest adjacent grade, and, in addition, for commercial structures, floodproofing elevations, if applicable.
g. Existing walls and provide top of wall elevations.
h. Wash cross-sections to show that the wash has adequate capacity and freeboard to convey runoff through the site.
i. Scour effects.
j. Proposed drainage infrastructure, including storage facilities design criteria, volume required (VR = XXX ft3), volume provided (VP = XXX ft3), and basin locations.
k. Management plans for operating and maintaining all drainage infrastructure.
l. Consistency with applicable ordinance requirements, standards, approved stipulations, General Plan (Land Use Element), Conceptual Drainage Report and Plan, Master Drainage Report and Plan, and other proposed developments affecting the site, including capital improvement projects.
m. Phasing information, including detailed graphic of areas to be phased, with labels of phases, and descriptions and analysis of all drainage Improvements to be constructed in each phase, timetables for each phase, impact of phased construction, and required interim drainage infrastructure. Each phase shall provide drainage infrastructure to serve that phase, and create no adverse impact off-site.

6. The Plan must show and label, pre- and post-development, on-site and off-site:
   a. Topographic or other physical discontinuities relative to adjacent properties.
   b. Existing and proposed property lines and, for existing properties, assessor's parcel numbers.
   c. Plan Check Number and/or Case Number for adjacent development that has occurred in the last 5 years.
   d. 100-year peak discharge rate at all entry and exit locations, and flow concentration points.

e. Runoff from a base flood, and consideration of storm events more frequent than the base flood. Development shall not increase peak discharge rates above the historic peak discharge rate for any event up to and including the base flood.
f. Modeling results of flow amounts, velocities and routes.
g. Location of proposed drainage infrastructure, including storage facilities (with volume required, volume provided and drain times), and related to adjacent properties, regional drainage plans and existing drainage infrastructure.
h. Wash cross-sections, including flow rate, water surface elevation, velocity and top width.
i. Size, capacity and nature of off-site drainage infrastructure entering and exiting the project site.
j. Impact of development on project site and future development within fifty feet of project site.
k. Proposed drainage easements, including easements over watercourses with a 100-year peak discharge rate of 25 cfs or greater, showing the limits of the easement.
l. Upon town staff request, spot elevations.

E. For Final Drainage Reports and Improvement Plans, provide the documents required in A, B, C and D above with further specifications below:
1. Plans to a minimum scale of 1" = 20' showing grade breaks and flow arrows.
2. One-foot topographic contours based on a current survey for the entire development site to 25 feet beyond the property line and for off-site areas where a hydraulic model is necessary.
3. Certification that all applicable local, state and federal permits have been obtained.
4. Notice of Intent, Stormwater Pollution Prevention Plan and ADEQ checklist, as approved by ADEQ, as applicable.
5. Proposed drainage easement agreements, including legal descriptions, title commitments and confirmation of easements signed by lienholders.
6. Certification:
   a. The plan relies on accurate figures and analysis.
   b. The plan meets all applicable requirements and standards.
   c. The plan reflects all elevations based on the city's benchmark of NAVD 1988, or subject to town staff approval, based on a local benchmark with an elevation equation related to NAVD 1988.
   d. The plan is consistent with approved stipulations and the Preliminary Drainage Report and Plan.
   e. All structures are safe from flooding.

f. The development shall have no adverse impact on-site or off-site.

7. The Report must include the following descriptions and analysis:
   a. Location of all on-site and off-site culverts, with number, material, size of pipes, and upstream and downstream invert elevation labels.
   b. How topographic changes from the project affect drainage characteristics, including time of concentration.
   c. Whether model was developed with subcritical, supercritical or mixed flow analysis.
   d. Methods to address any erosion issues consistent with DSPM requirements.
   e. Existing land use and Green Ampt soil characteristics for the site, including USDA NRCS soil survey maps.
   f. Phasing information, including detailed timetables for each phase, and demonstrated compliance with applicable stipulations.
   g. An appendix addressing town review comments, with cross-references to the revised Plan.
8. The Plan must meet standards for improvement plans, complete with detailed engineering and construction notes. The Plan must show and label, pre- and post-development, on-site and off-site:
   a. On-site drainage sub-basins.
   b. Limits of inundation for all watercourses with a 100-year peak discharge rate greater than 50 cfs.
   c. 10-year and 100-year peak discharge rates for all washes entering and exiting the site, with intermediate locations of 10-year and 100-year peak discharge rates within the site at least 1 time per sheet per wash, at confluences and points of interest such as culverts, storm drains, utility crossings, and channel improvements, shown with a directional arrow in the following format: Q10/Q100 = xx cfs.
   d. All existing and proposed walls, and top and base wall elevations at wall ends, changes in elevation, and as required by town staff.
   e. Utilities labeled by type.
   f. Easements labeled by type, such as drainage, water, sewer, access, public utility, sidewalk and natural area open space.
   g. Dimensions, capacities, materials, cross-sections and typical details of proposed drainage infrastructure.

F. For Master Drainage Reports and Plans, provide the documents required in A, B and C above with further specifications below:
   1. Plans to a minimum scale of 1” = 100’.

2. The Report must include the descriptions and analysis of all drainage Improvements to be constructed in each phase, the impact of phased construction, and required interim drainage infrastructure.
3. The Plan must show and label, pre- and post-development, on-site and off-site:
   a. Existing land use in the watershed area, and modified land use resulting from proposed development.
   b. Size, capacity and nature of off-site drainage infrastructure entering and exiting the project site.
   c. All drainage improvements to be constructed in each phase and required interim drainage infrastructure.

Appendix 6B

WARNING AND DISCLAIMER OF LIABILITY

The Town's Stormwater and Floodplain Management Ordinance is intended to minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare which might result from flooding.

The Stormwater and Floodplain Management Ordinance identifies floodplains, floodways, flood fringes and special flood hazard areas. However, a property outside these areas could be inundated by floods. Also, much of the Town is a dynamic flood area; floodways, floodplains, flood fringes and special flood hazard areas may shift from one location to another, over time, due to natural processes.

WARNING AND DISCLAIMER OF LIABILITY
The flood protection provided by the Stormwater and Floodplain Management Ordinance is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Floods larger than the base flood can and will occur on rare occasions. Floodwater heights may be increased by constructed or natural causes. The Stormwater and Floodplain Management Ordinance does not create liability on the part of the Town, any officer or employee thereof, or the federal, state or county government for any flood damages that result from reliance on the Ordinance or any administrative decision lawfully made thereunder.

Compliance with the Stormwater and Floodplain Management Ordinance does not ensure complete protection from flooding. Flood-related problems such as natural erosion, streambed meander, or constructed obstructions and diversions may occur and have an adverse effect in the event of a flood. You are advised to consult your own engineer or other expert regarding these considerations.

I have read and understand the above.

_____	_____	_____
Plan Check #	Owner	Date