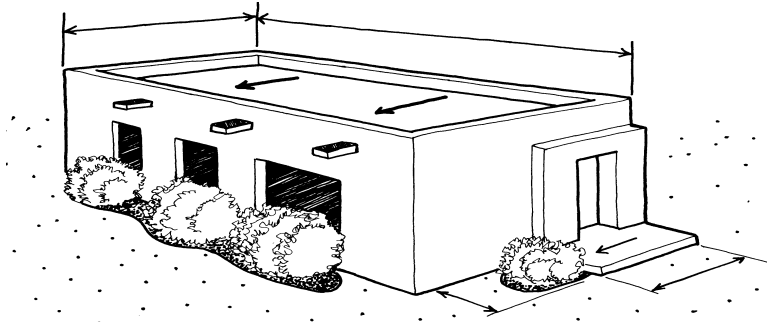


SILVERBELL NURSERY GUIDE TO WATER HARVESTING IN TUCSON

WE SELL TANKS AND INSTALL SYSTEMS
TO HARVEST RAINWATER FOR THE
LANDSCAPE, SWIMMING POOLS AND A
VARIETY OF OTHER USES.

This Guide borrows generously from a public document published by the
Pima County Cooperative Extension Agency, written by Patsy Waterfall,
Extension Agent.



Area of flat roof — Length x width.

For flat roofs measure the length and width of the building. The square footage of the catchment area is multiplied by the amount of rainfall in inches (**TABLE-3**) converted to gallons to get the volume of water.

$$\text{SUPPLY (in Gallons)} = \text{RAINFALL (inches)} \times 0.623 \times \text{CATCHMENT AREA (FT}^2\text{)} \times \text{RUNOFF COEFFICIENT}$$

**TABLE - 3
ANNUAL SUPPLY
FROM ROOF CATCHMENT**

Inches/Rainfall	Gallons/Square Foot
0	.0
1	.6
2	1.3
3	1.9
4	2.5
5	3.1
6	3.7
7	4.4
8	5.0
9	5.6
10	6.2
11	6.8
12	7.5
13	8.1
14	8.7
15	9.3

INCHES OF AVERAGE MONTHLY RAINFALL FOR ARIZONA CITIES AND TOWNS

	Scottsdale	Sierra Vista	Springerville	Tempe	Tuba City	Tucson	Willcox	Williams	Yuma
Jan	1.01	1.19	0.50	1.01	0.55	0.99	1.11	2.08	0.38
Feb	1.06	0.65	0.50	1.04	0.52	0.88	0.95	2.37	0.28
Mar	0.96	0.44	0.49	1.15	0.59	0.81	0.68	2.32	0.27
Apr	0.35	0.36	0.27	0.25	0.27	0.28	0.25	1.00	0.09
May	0.17	0.26	0.45	0.21	0.32	0.24	0.35	0.80	0.05
Jun	0.11	0.38	0.53	0.07	0.17	0.24	0.40	0.48	0.02
Jul	0.99	3.01	2.52	0.89	0.66	2.07	2.36	2.54	0.23
Aug	1.05	3.85	3.11	1.20	0.69	2.30	2.59	3.01	0.61
Sep	0.87	1.29	1.49	0.86	0.98	1.45	1.27	1.73	0.26
Oct	0.97	1.16	1.08	0.85	0.85	1.21	1.36	1.77	0.26
Nov	0.88	0.45	0.57	0.80	0.43	0.67	0.73	1.75	0.14
Dec	0.99	0.98	0.48	1.03	0.32	1.03	1.30	1.52	0.42
Annual	9.41	14.02	11.99	9.36	6.35	12.17	13.35	21.37	3.01

Precipitation

Normal for Period 1971 - 2000 (National Weather Service)

TABLE - 4
AVERAGE MONTHLY RAINFALL
Tucson and Phoenix

TUCSON, ARIZONA			PHOENIX, ARIZONA		
Month	Inches	Feet	Month	Inches	Feet
JAN	1.0	0.1	JAN	0.9	0.1
FEB	0.9	0.1	FEB	0.8	0.1
MAR	0.7	0.1	MAR	0.9	0.1
APR	0.3	0.0	APRIL	0.3	0.0
MAY	0.2	0.0	MAY	0.2	0.0
JUN	0.4	0.0	JUNE	0.1	0.0
JUL	2.0	0.2	JULY	0.9	0.1
AUG	2.3	0.2	AUG	1.0	0.1
SEPT	1.5	0.2	SEPT	0.7	0.1
OCT	1.2	0.1	OCT	0.8	0.1
NOV	0.8	0.1	NOV	0.8	0.1
DEC	1.0	0.1	DEC	0.9	0.1
TOTAL	12.3	1.0		8.3	0.9

To assist you in calculating your landscape supply and demand, blank worksheets have been provided in Appendices E and F. A sample supply worksheet using Tucson rainfall has been provided (page 22) to show how monthly rainfall amounts are calculated based on 1,000 SF of roof area.

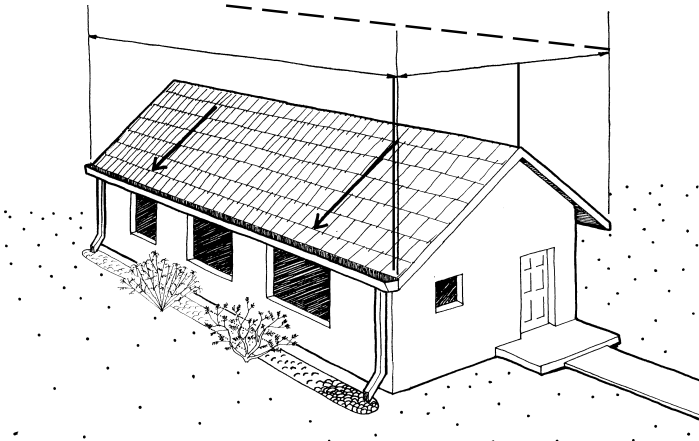
Calculating demand. The demand equation tells you how much water is required for a given landscaped area. There are two methods you can use — **Method 1** is used for new or established landscapes, **Method 2** can only be used for established landscapes.

METHOD 1: The equation for calculating demand for new or established landscapes is based on monthly evapotranspiration (ET_o) information.

ET_o is an estimate of the water lost when a plant transpires or “sweats” through its leaves plus the water evaporated from the soil surface. ET_o provides a useful reference point when determining plant irrigation need. This value is always a percent of ET_o and varies according to the plant species.

Calculate supply. First calculate the monthly supply (rainfall harvest potential) and the monthly demand (plant water requirement) for a year. If you are designing a more complex system you will also need to calculate your monthly storage requirement.

The runoff coefficient tells what percent of the rainfall can be harvested from specific surfaces (**TABLE-2**). The higher numbers represent a smoother, less absorbent surface, therefore, greater rainwater collection potential than the lower numbers.



Area of sloped roof — (both sides) Length x width.

The equation for calculating supply measures the amount of water (in gallons) capable of being harvested from a catchment area. The area of the catchment is expressed in square feet, for example a 20' x 50' catchment area equals 1,000 square feet (SF). Measure a sloped roof by measuring the area that is covered by the roof, (both sides).

Water Harvesting Techniques: Water Tanks

Goal

Store rooftop runoff for use at a later time.

Appropriate siting, water volume and slope

Water tanks (sometimes called cisterns) come in all shapes, materials and sizes. Determine appropriate tank volume based on roof area, rainfall, downspout location, available space, water uses and site-specific conditions. Tanks need to be placed on level pads in areas not vulnerable to settling, erosion or slope failure. Tanks should be located at least 10 feet from a building to avoid foundation damage in case the tank leaks. In addition to storing water, tanks can serve multiple functions such as shading, providing visual screens, and moderating hot and cold temperature extremes. The higher on the site above-ground tanks are located, the more gravity-feed pressure will be available. Water can be distributed by gravity flow or by a booster pump via hoses, irrigation systems, channels, or perforated pipes.

Construction

Prefabricated tanks of plastic, metal, or concrete can be purchased and installed professionally. Securely cap tanks with opaque material to prevent evaporation, mosquito breeding, and algae growth. Lock all caps and entry ports for safety. The interior of tanks should be accessible for periodic inspection and maintenance. Downspouts, inlets and outlets **must** be screened to keep mosquitoes (Appendix E), animals and debris out of the tank. Gutters must be cleaned regularly. Position outlet pipes several inches above the bottom of the tank to allow sediment to settle in the bottom. All tanks need an overflow pipe of equal or greater capacity than the fill pipe.

Overflow pipes should be able to operate passively (i.e. not dependent on a pump). Route overflow water into a water harvesting basin, adjacent tank, French drain, or other useful location away from buildings. Water in above-ground tanks can be delivered by gravity flow alone to low-pressure uses nearby. Below-ground tanks save land area, but require substantially more construction. A booster pump can be added to hook tanks into an irrigation system. Tank water should be filtered as it enters irrigation lines to keep debris from plugging the irrigation system. Calculations for sizing tanks are shown in Appendix C and discussed in some references listed in Appendix G.

Vegetation

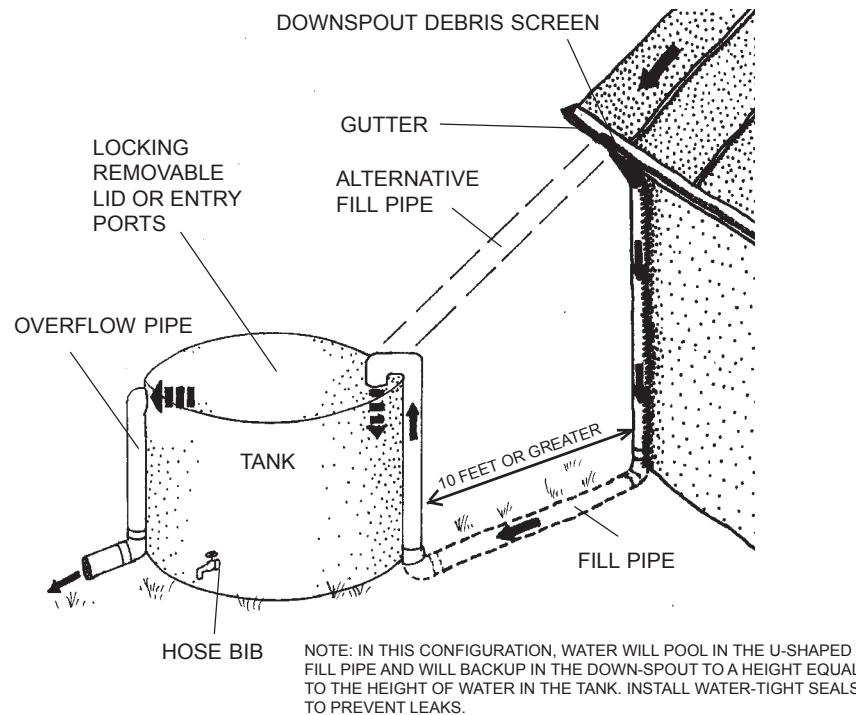
Areas around above-ground tanks can provide beneficial microclimates for heat- and cold-sensitive plants. Avoid placing plants with intrusive roots around below-ground tanks. Vegetation can be used to visually screen above-ground tanks to improve site aesthetics.

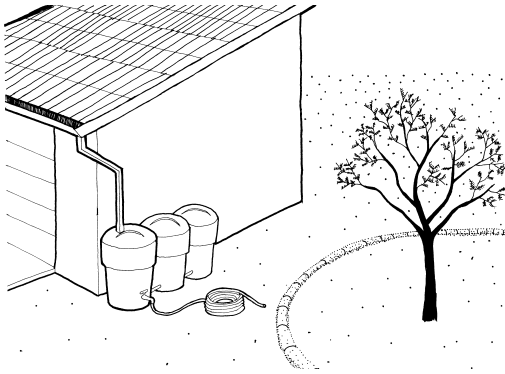
Maintenance

Periodically inspect all screens, gutters and tanks to remove accumulated debris. Check tanks following major rainfall events to verify that overflow system is working correctly. Periodically inspect and maintain the interior of tanks.

Variations

Tanks can be constructed individually or in a series with the overflow from one tank filling the adjoining tank, or connected at the bottom to maintain the same water level in all tanks.





Roof catchment with multiple storage cans connected to a hose adjacent to a landscape holding area.

If the landscaped area is extensive, several tanks can be connected to increase storage capacity. In the case that all storage tanks become full and rainfall continues, alternative storage for the extra water must be found. A concave lawn area would be ideal as a overflow holding area allowing the rain water to slowly percolate into the soil.

Estimates for the cost of storage ranges from \$100 to \$3,500 depending on the system, degree of filtration, and the distance between the storage and the place of use. Underground containers are a more expensive choice because of the cost of soil excavation and removal. Pumping the water out of the container adds an additional cost. *Source: California Department of Water Resources, Captured Rainfall: Small-Scale Water Supply Systems, Bulletin 213. May 1981.*

The distribution system. The distribution device can be a hose, constructed channels, pipes, perforated pipes, or a manual drip system that directs the water from the storage containers to landscaped areas. Gates and diverters can be used to control flow rate and flow direction. A manual valve or motorized ball valve located near the bottom of the storage container can assist gravity fed irrigation.

If gravity flow is not possible, an in-line electric pump hooked to a hose can be used. The distribution of water through an automatic drip irrigation system requires extra effort to work effectively. A small submersible pump will be required to provide enough pressure to activate the remote control valve (minimum 20 psi). To avoid burning the pump out, it should have the capability of turning off when there is no water in the tank.

Elements of a Complex Water Harvesting System

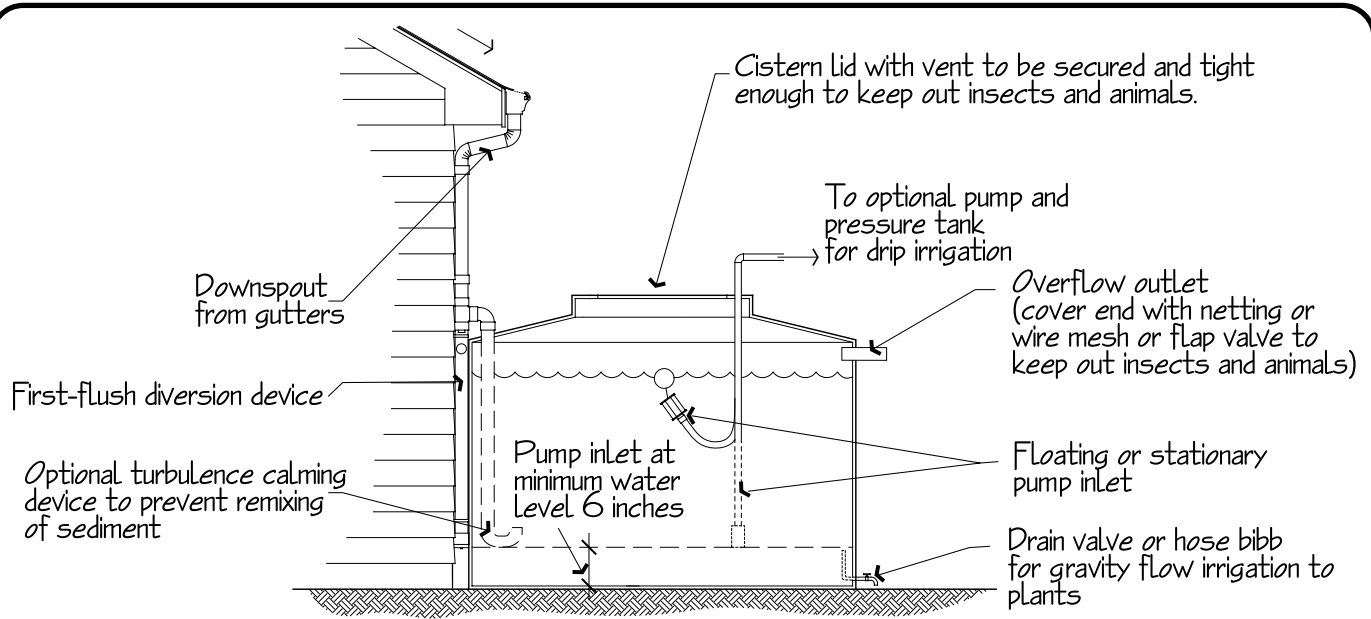
Components of complex systems that utilize storage include *catchment areas*, usually a roof, *conveyance systems*, *storage*, and *distribution systems* to control where the water goes. The amount of water or “*yield*” that the catchment area will provide depends on the size of the catchment area and its surface texture. Catchment areas made of concrete, asphalt, or brick paving and smooth-surfaced roofing materials provide high yields. Bare soil surfaces provide harvests of medium yield. Of all the soil types, compacted clayey soils have the highest yield. Planted areas, such as grass or groundcover areas offer the lowest yields because the plants hold the water longer allowing it to infiltrate into the soil. This is not necessarily a problem, depending whether you want to use collected water immediately in planted areas, or store it for later use.

TABLE - 2
RUNOFF COEFFICIENTS

	HIGH	LOW
ROOF		
Metal, gravel, asphalt, shingle, fiber glass, mineral paper	0.95	0.90
PAVING		
Concrete, asphalt	1.00	0.90
GRAVEL	0.70	0.25
SOIL		
Flat, bare	0.75	0.20
Flat, with vegetation	0.60	0.10
LAWNS		
Flat, sandy soil	0.10	0.05
Flat, heavy soil	0.17	0.13

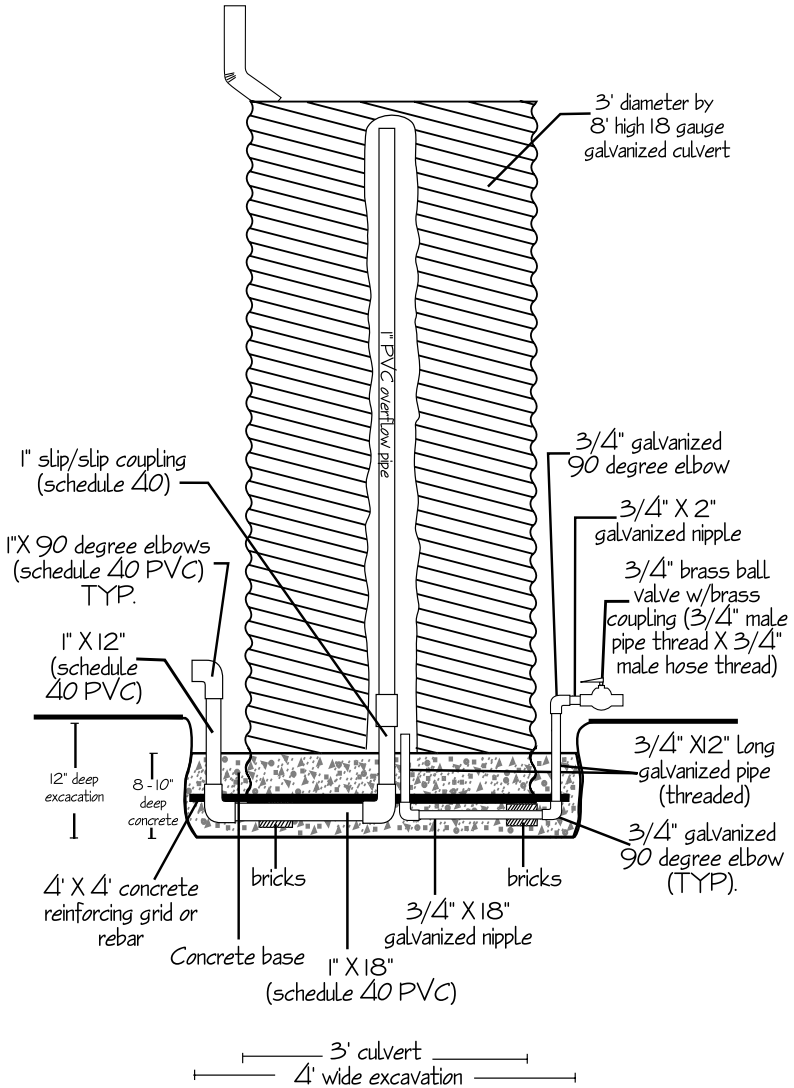
Conveyance systems. With a roof catchment system the gutter and downspouts are the means of conveyance that direct the water from the catchment area to the storage container. Gutters and downspouts are either concealed inside the walls of buildings or attached to the exterior of buildings. They can be added to the outside of a building at any time. Proper sizing of gutters is important to collect as much rainfall as possible. (See Guidelines, Appendix A)

APPENDIX C - RESIDENTIAL CISTERN DETAIL



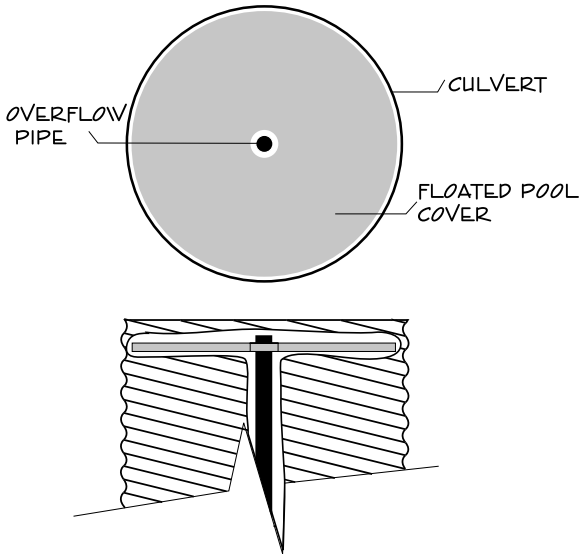
Source: *Forgotten Rain - Rediscovering Rainwater Harvesting*, 2003.
Original diagram was simplified for this publication

APPENDIX D CULVERT CISTERN DETAIL



Source: Scott Calhoun, ACNP and Josephine Thomason

Culvert Top Directions:



OPTION 1

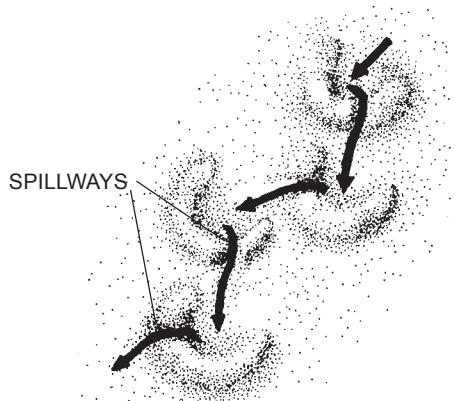
Option 1 : Floating Cover - cut a piece of floated pool cover material to fit the inside diameter of the culvert. Place the cover inside the top of the culvert cutting a hole for the overflow pipe to pass through. The hole should be slightly larger than the overflow pipe to allow the cover to raise and lower easily, depending on the water level inside the cistern.

Option 2 : Screen Cover - cut a piece of window screening or shade cloth approximately two feet wider than the diameter of the cistern, center the screening or shade cloth on the cistern top and fold edges down along the outside of the cistern and secure it by wrapping a length of wire around the outside of the cistern, catching all the edges of the screen or shade cloth and twist the ends of the wire together to assure a tight fit.

Water Harvesting Techniques: Microbasins

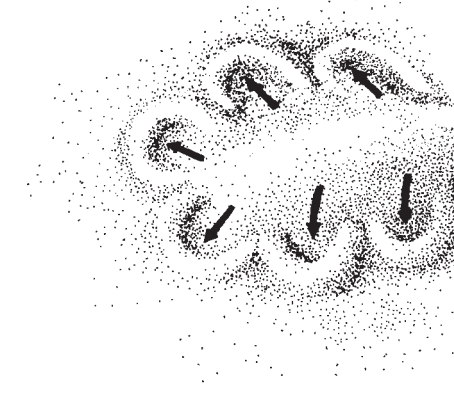
A. Microbasins in a series.

Offset the spillways on microbasins to create a longer water flow path to encourage more infiltration into the soil. These are appropriate for moderate flows. May need more erosion control measures for overflow areas.



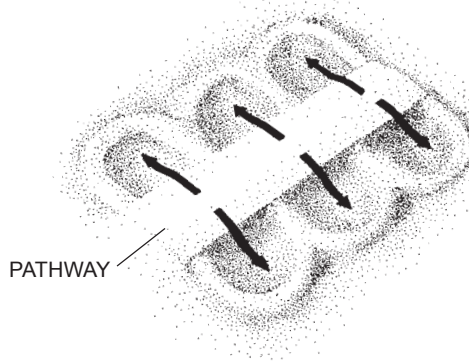
B. Microbasins on-contour.

Arrange microbasins to intercept water running off a ridge. Microbasins will follow the shape of the contour line around a ridge with the upslope ends of basins at the same elevation.



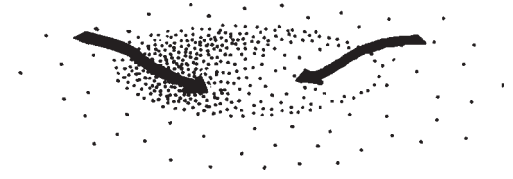
C. Build microbasins in association with pathways, driveways, etc.

Raise pathways and other hard surfaces relative to microbasins so the surfaces drain toward basins and water does not pool where people walk or drive. Avoid a steep drop off at the pathway edge.



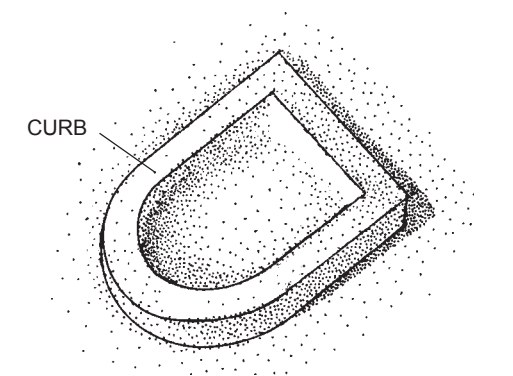
D. Localized depressions.

Construct gentle localized depressions without constructing associated berms.



E. Lower soil level inside curbed areas.

Use a concrete header as the berm for a microbasin and lower the soil level inside the header. This allows retention of all the rainwater that falls into the basin, though it does not intercept additional stormwater flowing in the area. This is a good way to retrofit existing parking lot planting areas. If multiple plants are present, multiple internal basins can be shaped to further focus the water.



F. Direct parking lot runoff toward microbasins.

Slope parking lot surfaces to direct stormwater runoff toward depressed microbasins positioned so that trees planted in them will shade cars and people. Use curb-stop sections or formed curb with curb openings to stop car tires, while allowing water to flow into the microbasin planting areas.

