

BMP 6.5.2: Runoff Capture & Reuse



Capture and Reuse encompasses a wide variety of water storage techniques designed to “capture” precipitation, hold it for a period of time, and reuse the water. Heavy rainfall may require slow release over time. A water budget must be developed to ensure that the water will be used to allow for more runoff capture

| | | | | | | | | | |
|--|--|-------------------|----------|-----------|------------|--------------------|--------|----------------|--|
| <p style="text-align: center;"><u>Key Design Elements</u></p> <ul style="list-style-type: none"> ▪ Storage techniques may include cisterns, underground tanks, above-ground vertical storage tanks, rain barrels or other systems ▪ Storage devices designed to capture a portion of the small, frequent storm events ▪ Most effective when designed to meet a specific water need for reuse ▪ Systems must for bypass or overflow of large storm events ▪ Water budget analysis incorporating anticipated water inflow and usage is required ▪ Collection and placement of storage elements up gradient of areas of reuse may reduce or eliminate pumping needs ▪ Maintenance - periodic tank and sump cleanout is required | <p style="text-align: center;"><u>Potential Applications</u></p> <p>Residential: Yes Commercial: Yes Ultra Urban: Yes Industrial: Yes Retrofit: Yes Highway/Road: Limited</p> <hr/> <p style="text-align: center;"><u>Stormwater Functions</u></p> <table> <tr> <td>Volume Reduction:</td><td>Med/High</td></tr> <tr> <td>Recharge:</td><td>Low Low</td></tr> <tr> <td>Peak Rate Control:</td><td>Medium</td></tr> <tr> <td>Water Quality:</td><td></td></tr> </table> <hr/> <p style="text-align: center;"><u>Water Quality Functions</u></p> <p>TSS: 100% TP: 100% NO3: 100%</p> | Volume Reduction: | Med/High | Recharge: | Low Low | Peak Rate Control: | Medium | Water Quality: | |
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| Water Quality: | | | | | | | | | |

Description

Cisterns, Rain Barrels, Vertical Storage, and similar devices have been used for centuries to capture storm water from the roofs of buildings, and in many parts of the world these systems serve as a primary water supply source. The reuse of stormwater for potable needs is not advised without water treatment, although many homes in the U.S. were storing water in cisterns for reuse as little as a century ago. These systems can reduce potable water needs for uses such as irrigation and fire protection while also reducing stormwater discharges.

Storage/reuse techniques range from small, residential systems such as Rain Barrels that are maintained by the homeowner to supplement garden needs, to large, “vertical storage” units that can provide firefighting needs. Storage/reuse techniques are useful in urban areas where there is little physical space to manage storm water.

Variations

Cisterns – large, underground or surface containers designed to hold large volumes of water (500 gallons or more). Cisterns may be comprised of fiberglass, concrete, plastic, brick or other materials.

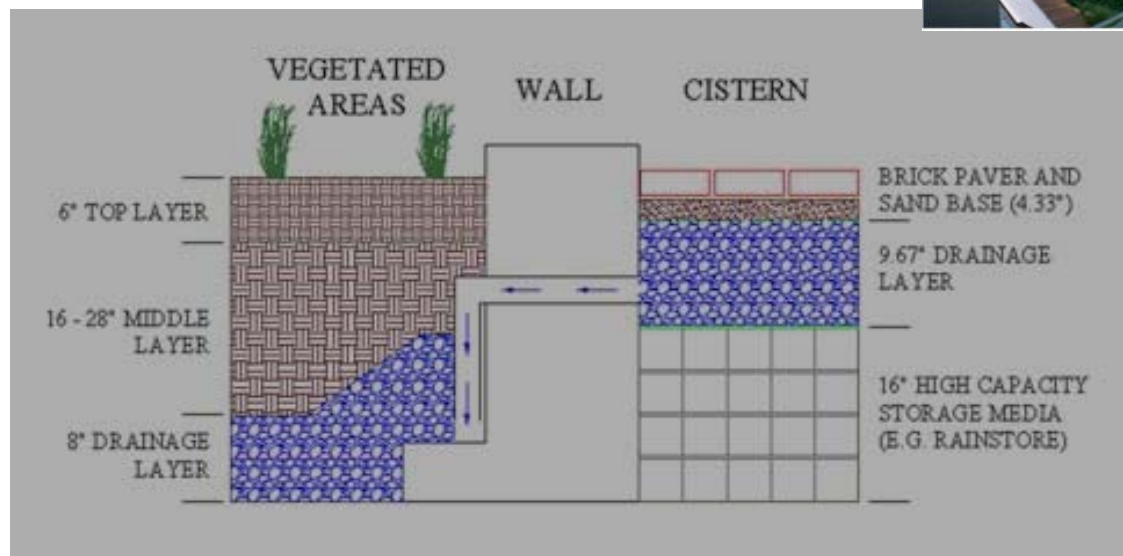


Rain barrels – barrel (or large container) that collect drainage from roof leaders and store water until needed for irrigation.



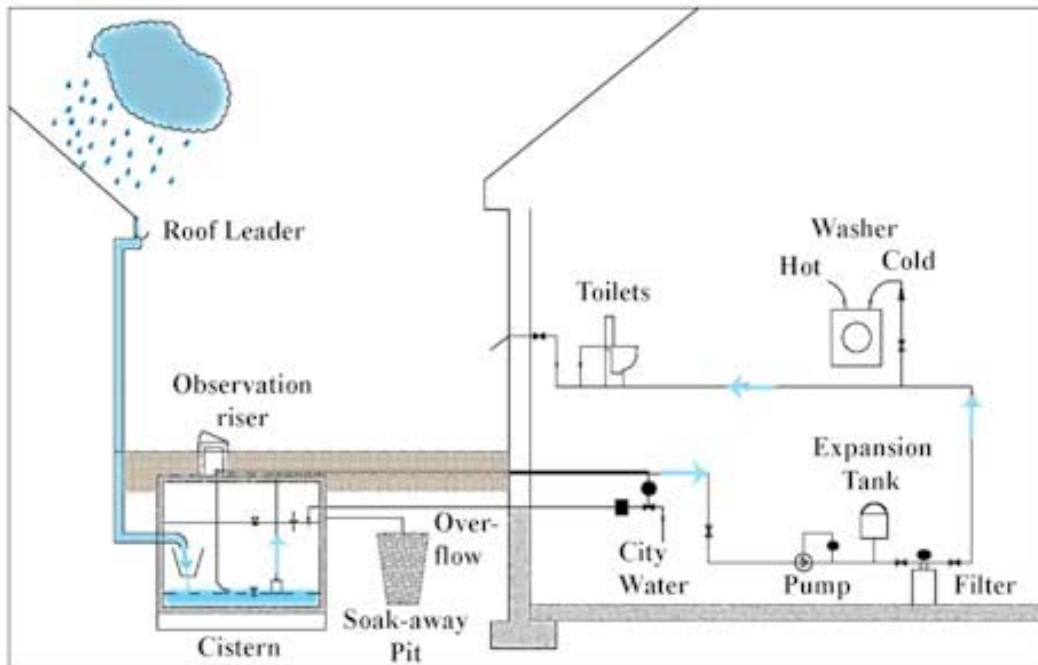
Vertical Storage – stand along “towers”, or “fat downspouts” that usually rest against a building performing the same capture, storage and release functions as cisterns and rain barrels.

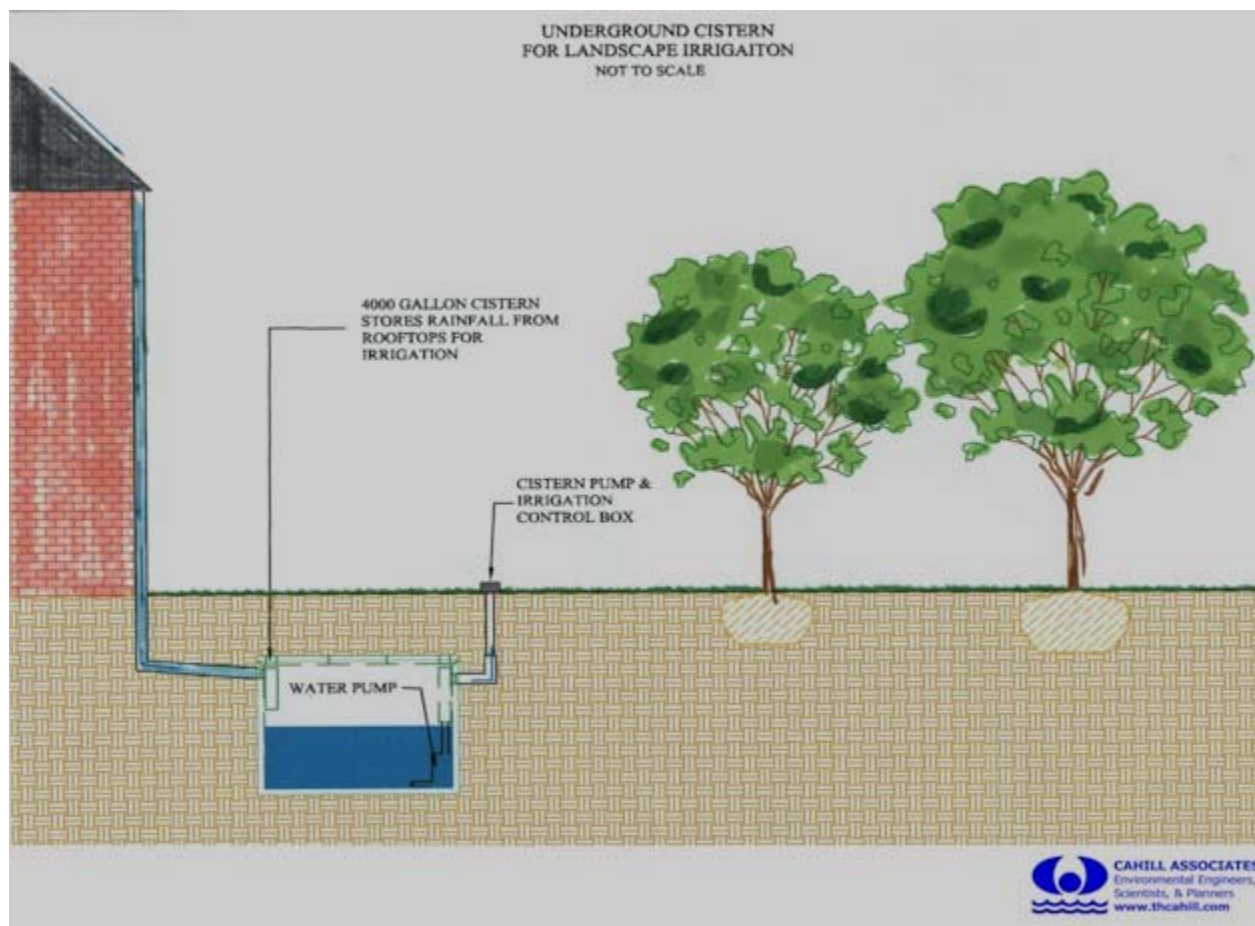
Storage Beneath Structure – Storage may be incorporated into elements such as paths and walkways to supplement irrigation with the use of structural plastic storage units



Applications

- Landscaped areas and gardens to meet irrigation needs
- Storage for firefighting needs
- Urban areas and Combined Sewer areas to reduce peak surcharges.
- Reuse for greywater needs such as flushing toilets.
- Reuse for athletic field irrigation





Design Considerations

1. The Designer should **calculate the water need** for the intended uses. For example, what will the collected water be used for and when will it be needed? If a 2,000 square foot area of lawn requires irrigation for 4 months in the summer at a rate of 1" per week, how much will be needed and how often will the storage unit be refilled? The usage requirements and the expected rainfall volume and frequency should be determined.
2. **Drawdown** – the Designer should provide for use or release of the stored water between storm events in order for the necessary stormwater storage volume to be available.
3. The **Catchment Area** on which the rain falls should be considered. The catchment area typically handles roof runoff.
4. The **Conveyance System** should keep reused stormwater or greywater from other potable water piping systems. Do not connect to domestic or commercial potable water system.
5. Pipes or storage units should be clearly marked "Caution: Reclaimed water, Do Not Drink".
6. Screens may be used to filter debris from storage units.

7. The **first flush** runoff may be diverted away from storage in order to minimize sediment and pollutant entry. However, rooftop runoff contains very low concentrations of pollutants.
8. Storage elements should be protected from direct sunlight by positioning and landscaping. (Limit light into devices to minimize algae growth.)
9. The proximity to building foundations should be considered for overflow conditions.
10. Climate is an important consideration, and capture/reuse systems should be designed to account for the potential of freezing.
11. Cisterns should be watertight (joints sealed with nontoxic waterproof material) with a smooth interior surface, and capable of receiving water from rainwater harvesting system.
12. Covers (lids) should have a tight fit to keep out surface water, animals, dust and light.
13. Positive outlet for overflow should be provided a few inches from the top of the cistern.
14. Observation risers should be at least 6" above grade for buried cisterns.
15. Reuse may require pressurization. Water stored has a pressure of 0.43 psi per foot of water elevation. A ten-foot tank would have a pressure of $0.43 \times 10 = 4.3$ psi. at the bottom of the tank. Most irrigation systems require at least 15 psi. To add pressure, a pump, pressure tank and fine mesh filter can be used, which adds to the cost of the system, but creates a more usable system.

| Capacities of Various sized Cisterns (cf) | | | | | | | |
|--|------------------------------|------|------|-------|-------|-------|-------|
| Depth (ft) | Diameter of Round Types (ft) | | | | | | |
| | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| 6 | 1266 | 2256 | 3522 | 5076 | 6906 | 9018 | 11412 |
| 8 | 1688 | 3008 | 4696 | 6768 | 9208 | 12024 | 15216 |
| 10 | 2110 | 3760 | 5870 | 8460 | 11510 | 15030 | 19020 |
| 12 | 2532 | 4512 | 7044 | 8532 | 13812 | 18036 | 22824 |
| 14 | 2954 | 5264 | 8218 | 11844 | 16114 | 21042 | 26628 |
| * Harvested Rainwater Guidelines, GreenBuilder.com | | | | | | | |

| Annual Rainfall Yield in Gallons for Various Impervious Surface Sizes and Rainfall Amounts | | | | | | | | | |
|--|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Impervious Surface Area sf | Rainfall (inches) | | | | | | | | |
| | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 |
| 1000 | 11844 | 14213 | 16582 | 18951 | 21319 | 23688 | 26057 | 28426 | 30795 |
| 1100 | 13029 | 15634 | 18240 | 20846 | 23451 | 26057 | 28663 | 31268 | 33874 |
| 1200 | 14213 | 17056 | 19898 | 22741 | 25583 | 28426 | 31268 | 34111 | 36954 |
| 1300 | 15397 | 18477 | 21556 | 24636 | 27715 | 30795 | 33874 | 36954 | 40033 |
| 1400 | 16582 | 19898 | 23214 | 26531 | 29847 | 33164 | 36480 | 39796 | 43113 |
| 1500 | 17766 | 21319 | 24873 | 28426 | 31979 | 35532 | 39086 | 42639 | 46192 |
| 1600 | 18951 | 22741 | 26531 | 30321 | 34111 | 37901 | 41691 | 45481 | 49272 |
| 1700 | 20135 | 24162 | 28189 | 32216 | 36243 | 40270 | 44297 | 48324 | 52351 |
| 1800 | 21319 | 25583 | 29847 | 34111 | 38375 | 42639 | 46903 | 51167 | 55431 |
| 1900 | 22504 | 27005 | 31505 | 36006 | 40507 | 45008 | 49508 | 54009 | 58510 |
| 2000 | 23688 | 28426 | 33164 | 37901 | 42639 | 47377 | 52114 | 56852 | 61589 |
| 2100 | 24873 | 29847 | 34822 | 39796 | 44771 | 49745 | 54720 | 59694 | 64669 |
| 2200 | 26057 | 31268 | 36480 | 41691 | 46903 | 52114 | 57326 | 62537 | 67748 |
| 2300 | 27241 | 32690 | 38138 | 43586 | 49035 | 54483 | 59931 | 65380 | 70828 |
| 2400 | 28426 | 34111 | 39796 | 45481 | 51167 | 56852 | 62537 | 68222 | 73907 |
| 2500 | 29610 | 35532 | 41454 | 47377 | 53299 | 59221 | 65143 | 71065 | 76987 |
| 2600 | 30795 | 36954 | 43113 | 49272 | 55431 | 61589 | 67748 | 73907 | 80066 |
| 2700 | 31979 | 38375 | 44771 | 51167 | 57562 | 63958 | 70354 | 76750 | 83146 |
| 2800 | 33164 | 39796 | 46429 | 53062 | 59694 | 66327 | 72960 | 79593 | 86225 |

* Values represent 95% of actual precipitation to account for any storage and/or losses.

Detailed Stormwater Functions

Volume Reduction Calculations

Volume reduction is the actual volume of the storage container, taking into consideration how many times it is emptied.

Peak Rate Mitigation Calculations:

Capture and reuse takes a volume of water out of site runoff. This reduction in volume will translate to a lower overall peak rate for the site.

Water Quality Improvement

Pollutant removal takes place through filtration of recycled primary storage, and/or natural filtration through soil and vegetation for overflow discharge. Quantifying pollutant removal will depend on design. Sediment removal will depend on area below outlet that is designed for sediment accumulation, time in storage, and maintenance frequency. Filtration through soil will depend on flow rate, the type of soil (infiltration capacity), and design specifics (stone bed, etc.).

Construction Sequence

Install per manufacturer's instructions.

Maintenance Issues

Flush cisterns to remove sediment. Brush the inside surfaces and thoroughly disinfect.

Winter concern: Do not allow water to freeze in devices. (Empty out before water freezes.)

Cost Issues

Rain Barrel: ranges from \$80 to \$200, average for residential use is \$150 (2005)

Cistern: varies, depending on material used (reinforced concrete, steel, plastic are common), size, and pump characteristics

Vertical Storage: ranges from \$88 for 64-gallon capacity to \$10,516 for 12,000-gallon capacity (for a plastic, manufactured product). Storage costs \$1.25/gallon (2005).

General: the reuse of water for irrigation or other uses saves money on water costs over time.

Specifications:

The following specifications are provided for informational purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

1. **Vertical Storage** All storage containers should meet FDA specifications for stored drinking water if potable water is the intended use. Follow Manufacturer's specifications for vertical storage containers.

References

City of Tucson, Water Harvesting Guidance Manual, March 2003 (edited by Ann Audrey Phillips, prepared for the City of Tucson, Department of Transportation, Stormwater Section)

“What are Rainwater Harvesting and Stormwater Recycling?” Heather Kinkade-Levario, ASLA and Hari Krishna Ph.D., P.E., Ann Phillips, Tim Pope

Sustainable Building Sourcebook, “Harvested Rainwater Guidelines”, sections 1.0, 2.0, 3.0
www.greenbuilder.com

“Rainwater Harvesting” www.ci.austin.tx.us/greenbuilder/fs_rainharvest.htm City of Austin, TX

Portland, OR’s Code Guide Office of Planning & Development Review “Rainwater Harvesting – ICC – RES/34/#1 & UPC/6/#2, March 2001

U.S. EPA National Pollutant Discharge Elimination System, “Post-Construction Storm Water Management in New Development & Redevelopment, On-Lot Treatment”

City of Vancouver, Engineering Services, Water and Sewers “Rain Barrel Program”

“Cisterns/Rainwater Harvesting Systems, www.advancedbuildings.org Technologies and Practices, Plumbing & Water Heating

CSIRO, Land and Water, “Urban Water Reuse – Frequently Asked Questions” (south Australia)

“Rain Barrels – Truth or Consequences” Karen Sands, AICP and Thomas Chapman, P.E., Milwaukee Metropolitan Sewerage District, Milwaukee, Wisconsin

“Hydrologic Processes at the Residential Scale” Qingfu Xiao, E. Gregory McPherson, James R. Simpson, Hydrologic Sciences Program, UC Davis, Center for Urban Forest Research, USDA Forest Service

“Black Vertical Storage Tanks by Norwesco” www.precisionpump.net/storagetanksystems.htm