Harvest and Use TC-12

Design Considerations

- Soil for Infiltration
- Area Required
- Slope
- Environmental Side-effects

Targeted Constituent	Removal
Sediment	Med
Nutrients	Med
Trash	High
Metals	Med
Bacteria	Low
Oil and Grease	High
Organics	Low
Flow Control	Med

Description

Harvest and Use refers to the capture of stormwater runoff in a tank and subsequent use of the captured volume (e.g. irrigation, indoor use). Capture of stormwater can be accomplished with above or below-ground cisterns or rain barrels to drain an entire roof or a partial area. For increased effectiveness, real-time controls (RTC) can be installed to integrate precipitation forecasts into the decision process. RTC allows the tank to be drawn down to ensure the anticipated storm volume can be held; what would have been overflow of the tank is drained in advance of the storm, and infiltrated (Tetra Tech, 2016).

California Experience

The RTC analysis cited above installed five residential cistern across LA County. Each residence was equipped with RTC and their implementation and efficacy was monitored (Figure 1). Installation of these systems validated their ability to be integrated into residential irrigation as well as the construction, permitting and implementation aspects of harvest and use. A water harvesting system at the San Diego Zoo is used to offset potable water use in irrigating the exhibits (Figure 2).

Additionally, the Water Boards have determined that harvest and use can qualify as a ”Full Capture System (FCS)[1]” for trash. Accordingly, in addition to providing general specifications, this fact sheet includes trash-specific information to assist with upgrading either an existing

[1] Full Capture System (FCS): A treatment control, or series of treatment controls, including but not limited to, a multi-benefit project or a low impact development control that traps all particles that are 5 mm or greater, and has a design treatment capacity that is either: a) of not less than the peak flow rate, Q, resulting from a one-year, one-hour, storm in the subdrainage area, or b) appropriately sized to, and designed to carry at least the same flows as, the corresponding storm drain.

BMP or the design of a planned BMP to meet the FCS definition. See the "Full Trash Capture Compliance" section and "Trash FCS" subsections in this fact sheet for more information.

Advantages

- Pollutant removal rates are assumed 100% in the captured and used stormwater volume.
- When RTC is integrated, stormwater can be drained across a regional network of intelligently controlled conveyances to a downstream regional BMPs or water reclamation facility.

Figure 1. Water harvesting at a private residence in Los Angeles.

Figure 2. Water harvesting demonstration at the San Diego Zoo.

Limitations

- Harvest and Use can be a relatively expensive technology due primarily to mechanical systems, power requirements, and high frequency maintenance needs.
- Stormwater from Harvest and Use may be accessible to mosquitoes and other vectors for breeding.

Performance

Generally, pollutant removal for cisterns is provided by a downstream BMP, although stormwater volume reduction can reduce total pollutant loads if rainwater is used. When equipped with RTC there is significant potential for harvest and use to improve water quality and augment the water supply (e.g. infiltrating stormwater, potable offset, and stormwater routed to a reclamation facility) (Tetra Tech, 2016). The cost-effectiveness of harvest and use

can vary broadly depending on geologic and climatologic considerations of their location as well as RTC subscription costs (when applicable, Table 1).

Table 1. Cost efficiencies for Zinc removal and supply augmented in LA County

RWH scheme	$/lb of zinc removal	$/ac-ft of water augmented
RWH + standalone RTC license	$68,479	$36,119
RWH + enterprise RTC license (100,000+ subscribers)	$23,348	$11,826

While the majority of water quality benefits gained from harvest and use is due to infiltration, there are some water quality benefits that can be garnered from the storage tank. Sedimentation as well as sorption, precipitation, and chemical process can be attributed to reduce pollutant concentration in storage tanks (Despins et al., 2009). Percent change in pollutant concentrations between entrance and exit of four RWH systems from 2011 to 2012 with 100+ water quality samples are shown in Table 2 (Debusk and Hunt, 2014).

Table 2. Median reduction roof runoff concentration for sediment and nutrients

	TSS	Total Phosphorus	Total Nitrogen	TKN	$NO_2 + NO_3$
Median reduction in runoff concentration	44.8%	15.4%	50.0%	47.9%	62.1%

Trash FCS

The Trash Amendments adopted by the State Water Board in April 2015 provide a performance standard for treatment of stormwater for trash in the form of the definition of FCS, which Harvest and Use meets (see Section 5.6.1 for FCS details).

Suitability and Design

Cisterns should be placed near a roof downspout, and the outlet (overflow and low-flow) should be directed to a pervious surface capable of infiltrating the water quality volume within 48 hours (e.g., bioretention cell). Infiltration requirements must follow those outlined in the Bioretention Fact sheet (TC-32). Fundamental harvest and use design components are as follows:

- Design of the runoff storage facility should be consistent with local regulatory guidelines.
- All inlets and outlets must be covered with a 1-millimeter mesh to prevent mosquito entry.
- Irrigation should not begin within 12 hours of the end of rainfall so that direct storm runoff has ceased and soils are not saturated.
- Can offset non-potable water supplies such as toilet flushing, car washing, street sweeping, and other uses.

Table 3. Cost of design components and associated considerations

Component	Cost	Design Consideration
Tanks/Cisterns	$0.60–$2.25/gal	Tanks should typically be opaque to prevent algal growth. Runoff should be conveyed to the cistern such that no backwater onto roofs occurs during the 100-yr event.
Rain Gutter and Gutter Guard	$23/ft	If feasible direct all roof runoff to cistern with new or additional gutters and gutter guard. Downspout pipes should be sized to convey the 100-year discharge without causing any backwater on the roof.
Irrigation Pump, Controller and Piping	$400-$800	Pump apparatus applicable when hydraulic head from tank is insufficient to irrigate. All pipes conveying harvested rainwater should be Pantone color #512 and be labeled as "reclaimed water."
Filter	$40.00–$400.00	Self-cleaning inlet flow-through filter to strain out large debris on conveyance configuration. A first-flush diverter to capture the first wash-off of sediment, debris, and pollen during a rainfall event. If drainage area greater than 1,500 ft^2, use bypass capable filter
Foundation No. 57 gravel (assume 6-in. depth) Concrete (assume 6-in. depth)	 $0.75/$ft^2$ $13.50/$ft^2$	Gravel foundation if weight of the cistern at capacity is less than 2000 pounds, otherwise a concrete foundation is required.
Sign		Signage indicating: "Caution: Reclaimed Water, Do Not Drink" (preferably in English and Spanish) must be provided anywhere cistern water is piped or outlets.

Many municipalities across California offer rebates to residences for rain barrels ($75) and cisterns (up to $350) to incentivize their implementation (MWD).

Indoor and Potable Use

Significant treatment, including filtration and UV treatment, will be necessary for potable use. Local building codes and health standards should be consulted for indoor and potable use.

Full Trash Capture Compliance

This section provides trash-specific information to assist with upgrading either an existing BMP or the design of a planned BMP to meet the FCS definition. In addition to developing and adopting the Trash Amendments, the State Water Board provides implementation information on its Trash Implementation web page: https://www.waterboards.ca.gov/water_issues/programs/stormwater/trash_implementation.html.

The web page includes information on best management practices or Full Capture Systems, including lists of State-certified Multi-Benefit Trash Treatment Systems. So, when selecting

BMPs for trash control, fact sheet users should refer to both this BMP fact sheet and the State Water Board's Trash Implementation web page.

Design Modifications to Prevent Trash Migration, Sustain Capacity, and Prevent Reduced Functionality

The harvest and use system must be configured to allow trash to enter the system and for trash to remain in the cistern until it can be collected and removed. To meet the requirement, inlets must be designed to pass the peak flow produced by the one-year, one-hour design storm or the same flows as the capacity of the inlet storm drain and solids that would be retained by a 5 mm screen or mesh, must remain in the system. A screen is not required if the capture system has capacity to treat either of the design flows through media filtration or infiltration into native or amended soils.

Trash Containment

Once trash has been captured in the harvest and use system it must be contained so trash does not escape the bioretention area. Containment may be provided by one or more of these features:

- an external design feature or up-gradient structure designed to bypass flows exceeding the region-specific one-year, one-hour storm event; or
- the BMP having sufficient capacity to trap particles from flows exceeding those generated by the one-year, one-hour storm event; or
- the BMP having sufficient capacity to treat either the design flows or volumes through media filtration or infiltration into native or amended soils; or
- use of a maximum 5 mm mesh screen on all outlets.

Maintenance

Relatively frequent inspection and maintenance is necessary to verify proper operation of these facilities. For Multi-Benefit Treatment Systems to be qualified as Full Capture Systems, the State Water Board requires regular maintenance to maintain adequate trash capture capacity and to ensure that trapped trash does not migrate offsite. Additionally, the State Water Board requires the BMP owner to establish a maintenance schedule based on site-specific factors, including the design trash capacity of the Harvest and Use Multi-Benefit Trash Treatment System, storm frequency, and estimated or measured trash loading from the drainage area. Below-ground cisterns may not provide complete dewatering, which increases the chances of water standing for over 72 hours and becoming a breeding place for vectors. Table 4 provides maintenance activity details, frequency, and costs.

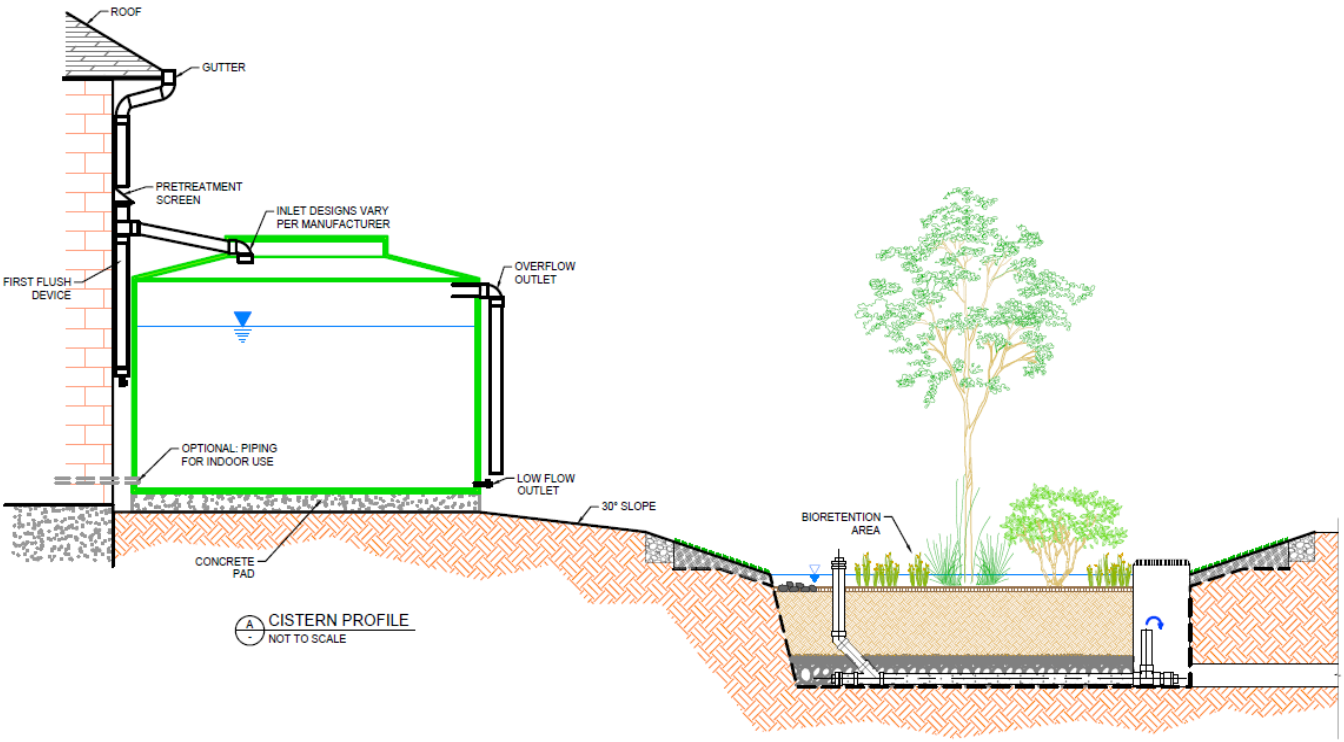
Table 4. Typical maintenance activities and associated costs and frequency

Frequency	Cost	Activity
Routine Maintenance (required monthly to every 2 years)		Clean gutters, debris screen, and roof of debris that have accumulated. Check pipe, valve connections, and backflow preventers for leaks.
Routine (small)	$2.85/ft^2	
Routine (medium)	$0.92/ft^2	

Frequency	Cost	Activity
Routine (large)	$0.52/ft^2	Check cistern for stability, anchor system if necessary.
End of Life Replacement (service life of 20 years)		
Replacement (small)	$0.6-2.25/gal	
Replacement (medium)	$0.6-2.25/gal	
Replacement (large)	$0.6-2.25/gal	
Note: Small System = 200 gal; Medium System = 600 gal; Large System = 1000 gal		

O&M costs for harvest and use systems are high because of the need for frequent inspections, and the reliance on mechanical equipment. When RTC is utilized an annual subscription is required that ranges from $1000 for a single residence but could be reduced by greater than 80% if 100,000's of residences subscribe in a regional program.

Schematic



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