RAINWATER HARVESTING

STRATEGY

Rainwater harvesting is the collection of rainwater from rooftops, balconies and/or other (above grade) surfaces during rainfall events. Collection is dependent on precipitation intensity, and by means of storage, collected rainwater can be used at a later point in time. Using rainwater for non-potable, even potable uses, results in drinking water savings. In off-grid locations, rainwater can be an important primary water source. Rainwater harvesting can be key to supporting urban blue-green infrastructure and is often included in sustainable building certification criteria. Rainwater harvesting can be part of a larger water saving and reuse strategy in combination with water efficient fixtures, and the reuse of greywater or mixed wastewater.

INPUT STREAMS

- Rainwater (from roofs, balconies)
- Rainwater from green roofs
- Stormwater (from lawns, pavement, roadways, etc.)

TARGET OUTPUTS

- Treated water for non-potable reuse (toilet flushing, irrigation, infiltration, laundry)
- Treated water for potable reuse

COLLECTION & STORAGE

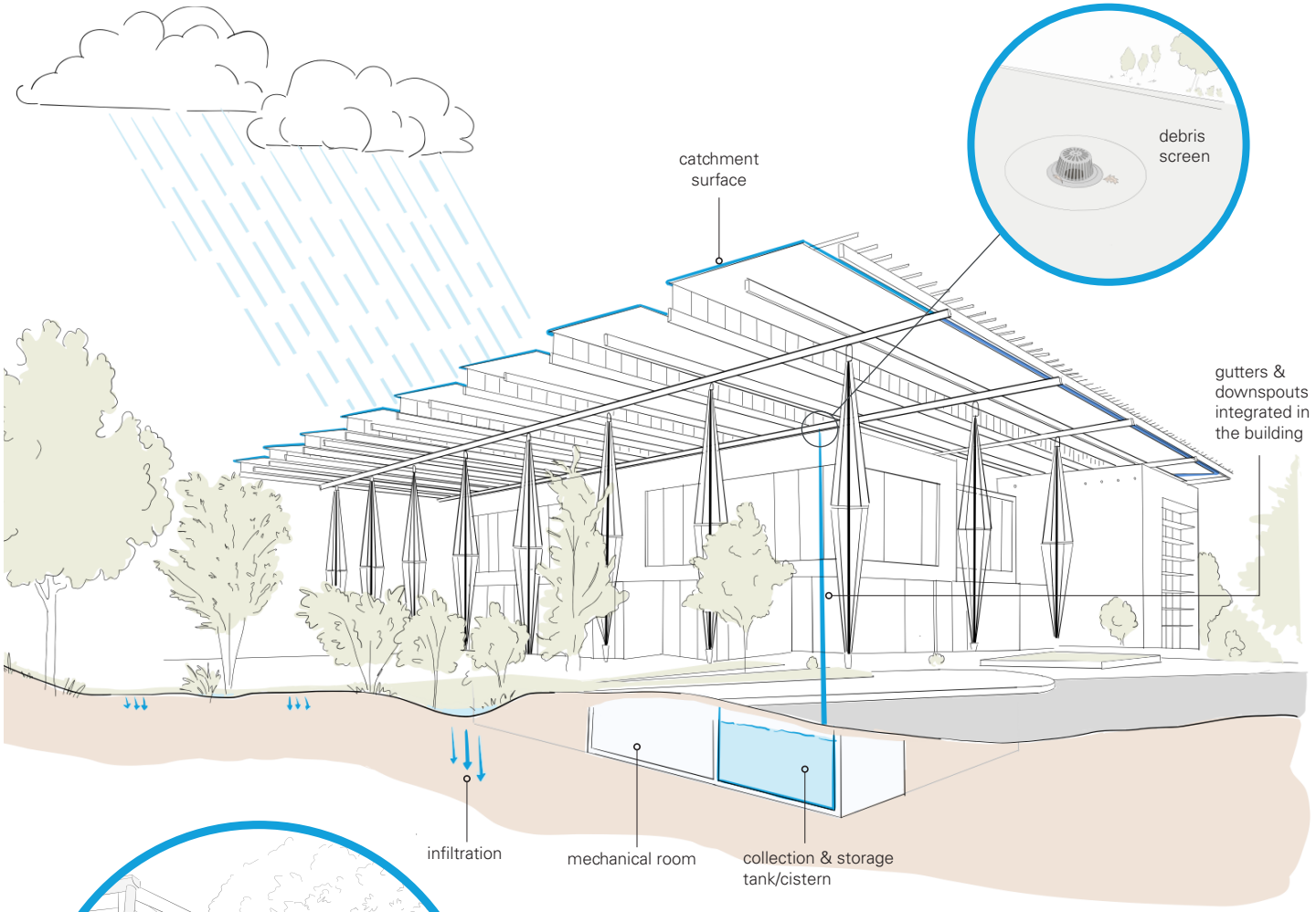
Gutters and downspouts direct rainwater from catchment surfaces to storage tanks or ponds. Ponds additionally support local biodiversity and cooling. Pre-storage measures include debris screens, filters, and first-flush diversion. Storage helps bridge the gap between wet and dry weather, and between collection, treatment, and reuse.

TREATMENT

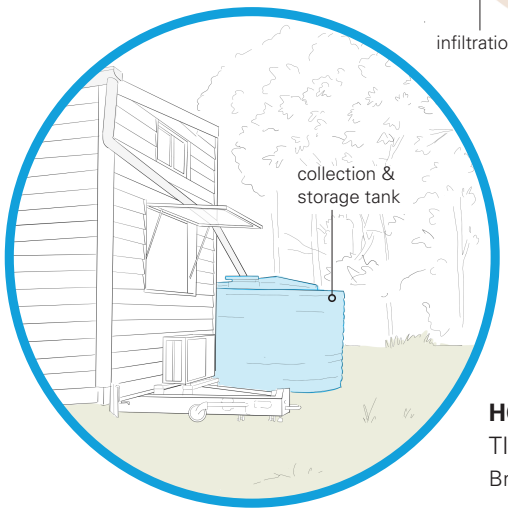
Rainwater can be directly reused for non-potable purposes like toilet flushing and irrigation, though treatment expands safe reuse, especially indoors. Treatment is typically done in a basement for building-scale projects or at a decentralized facility for neighborhood or district-scale systems.

PIPING & REUSE

A separate piping network distributes treated rainwater to reuse applications. For in-building non-potable reuse, precautions must prevent cross-connections and backflow between treated and drinking water pipes, and minimize microbial regrowth in tanks and pipes.



BUILDING SCALE
KENDEDA BUILDING
Atlanta, GA, USA | 2017



HOUSEHOLD SCALE
TINY HOUSE
Bryon Shire, Australia | 2019

TO CONSIDER

COLLECTED STREAM

Rainwater is a relatively clean stream, though its quality can be reduced by deposition and leaching of metals, nutrients and microbial pathogens from dust, debris, animal droppings and from collection surfaces themselves. The quantity of rainwater available for collection depends of local precipitation, and catchment surface area. Rainwater can also be collected (and treated) together with other water sources (see).

SPACE & PLACEMENT

Catchment surface area is an important determining factor in rainwater harvesting potential. Space requirement is most demanding for the storage tank(s), which can be located aboveground (e.g., rain barrels) or belowground (e.g., cisterns). Tank volume depends on rainwater supply and reuse demand balances. Water mass balance models and control units can help users monitor rainwater storage levels, automatically discharging water from the tank before a next rainfall event.

RESOURCE INTENSITY

Most buildings already account for initial material and installation costs for gutters and pipes. Above ground rain barrels are a cheaper add-on than underground storage tanks. Regular, though low, maintenance is required to clean filters. Energy is required to pump rainwater to place of reuse, when gravity-driven distribution is not feasible.

NEW BUILD VS. RETROFIT

Catchment surface materials need to be appropriate to prevent leaching of pollutants into the water (e.g., copper) in both existing and new build construction. Indoor reuse of rainwater requires an additional piping network, which lends itself better to new build construction.

HYBRID VS. DECENTRALIZED

In off-grid, decentralized settings, rainwater can be an important water source. In urban and suburban contexts, harvested rainwater can be used in parallel to other water sources (e.g., drinking water from distribution network), and the harvesting system can benefit from a sewer connection (e.g. to receive first-flush diversion water).

USER EXPERIENCE

Rainwater is generally accepted as a non-potable water source, and often also as a potable water source after sufficient treatment.

TREATMENT OPTIONS

Rainwater can be directly reused or treated for non-potable, and even potable, reuse. Treatment typically includes filtration and/or disinfection processes. Treatment of stormwater may require additional steps for pollutant removal (see Water Reuse).

DIRECT REUSE

Rainwater reuse without treatment is common at the household level, typically for garden irrigation, cleaning, and toilet flushing. The water may have a yellow tint due to tannin staining from organic material like leaves, seeds, and pollen.

TREATMENT BEFORE REUSE

Treatment technologies for rainwater reuse target the removal of heavy metal, nutrient and microbial pollutants. Treatment trains are typically more complex for high-quality reuse and less complex for non-potable applications.

STORAGE

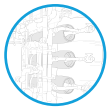
Storage tanks and cisterns store water before treatment and/or reuse.

T.41 WATER TANKS & CISTERNS

FILTRATION

Filtration is the removal of particles and colloids, as well as microbial and chemical contaminants, using membranes or granular media. Biological degradation also occurs where microorganisms in a biofilm are present.

T.44 CONSTRUCTED WETLANDS



T.48 MEMBRANE FILTERS

T.49 GRANULAR MEDIA FILTERS

DISINFECT. & ADV. OX.

Disinfection is the inactivation or removal of pathogens to ensure microbial safety for reuse. Advanced oxidation processes also provide targeted removal of micropollutants.

T.50 UV & CHLORINE DISINFECTION

T.51 OZONATION & ADVANCED OXIDATION

SAFE REUSE

POLLUTANTS

The removal of pollutants, originating from dust and debris, or from collection surfaces themselves, depends on treatment steps and sequence. User exposure to these pollutants is considered small for most non-potable applications but is a concern for potable applications. A treatment step for targeted micropollutant removal (e.g., activated carbon or advanced oxidation) can be included.

Stormwater, collected from roads and terraces, typically contains more pollutants (e.g., organic and chemical pollutants and heavy metals) than rooftop-collected rainwater. Treatment may require additional steps for pollutant removal (see Water Reuse).

SAFE STORAGE

Trace levels of pathogens (e.g., from animal feces), organic matter and nutrients can lead to microbial regrowth in storage tanks and pipes. Growth of opportunistic pathogenic microorganisms, like *Legionella pneumophila* or *Legionella spp.*, is a major concern for human health. Additionally, for potable reuse, tank liners and coatings need to be food grade.

Measures for safe storage include: 1) removing organics and nutrients from water before storage, 2) ensuring tanks are opaque to prevent algal growth, 3) including a disinfection step (e.g., with residual disinfection) 5) regular cleaning of tanks and pipes.

BLUE-GREEN INFRASTRUCTURE

Rainwater harvesting, treatment, and reuse can be combined with blue-green infrastructure (BGI) to support local biodiversity, increase urban cooling, irrigate green areas and add aesthetic value. Examples of synergies between rainwater harvesting and BGI include: collection via green roofs, treatment with constructed wetlands, water storage in open retention ponds, and irrigation of public areas.