Rainwater Harvesting for Beneficial Use

April 29, 2009

What is Water Harvesting?

Water harvesting is the capture and storage of water for beneficial use. It can be accomplished anywhere water supply is available for collection and a water source is desired or required. To understand the process fully, it is important to understand water harvesting terms.

Rainwater harvesting is the capture and storage of rainwater and is considered the cleanest form of harvested water.

Greywater harvesting is the capture and storage of water that has already been used for non-sewage purposes — from baths and showers to washing machines, sinks and vehicle washing run-off. Reuse of greywater triggers more code requirements and design regulations than the use of rainwater. Some applications are restricted by local code.

Reclaimed water is wastewater treated to levels that allow it to be used for non-drinking water purposes. Reuse of reclaimed water triggers more code requirements and design regulations than reuse of rainwater.

Potable water is clean water — satisfactory for drinking, culinary and domestic purposes, and meets the drinking water standards established by the Washington State Department of Health.

The Cascade People's Center uses rainwater collected from the roof and stores it in a cistern for toilet flushing.

What are the goals and benefits of rainwater harvesting?

Rainwater harvesting provides a host of design benefits that range from reducing owner utility rates and improving landscape health, to reducing combined sewer overflows into Seattle's water supply and reducing demand on the city's potable water systems.

- **Financial benefits**: City of Seattle residents are charged for both the potable water they use and the related sanitary sewer treatment they need to treat used water. Use of collected rainwater helps residents save on potable water use fees and on sanitary sewer use fees.
- **Plant health**: Landscape plants flourish with irrigation from collected rainwater. Rainwater does not contain chlorine (an important additive that keeps potable water safe for drinking), benefiting many ecologically sensitive plants.
- **Water quality**: When it rains, it pours — and during extreme rain events, some of our combined sewers fill to overflowing, pouring into the Puget Sound and contributing water bodies without full water quality treatment. Removing rainwater from the combined sewer systems and redirecting it to cisterns has

Building a Better Seattle

The green series is just one of many resources designed to help you build green and create value for your project from initial concept planning to permitting, construction and operation. To learn more, please visit www.seattle.gov/sdci.

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the potential to lower peak flows and reduce the amount of pollutants that find their way into our natural water bodies

- **Water supply**: Combine a rapidly increasing population with lower annual rainfall and higher temperatures, and the demand for potable water increases dramatically — putting greater pressure on municipal water supplies. Rainwater harvesting reduces this demand.
- **Green building credits**: Many green building systems offer credits for rainwater harvest systems, helping your project reach certification goals.

Rainwater Harvest System Components, Requirements and Design Considerations

A rainwater harvesting system begins at the point of collection and ends at the supply to approved plumbing fixtures and other outlets. Systems typically consist of the following components:

- **Harvest sources**: Unless otherwise approved by the City, only runoff from roof surfaces is allowed for rainwater harvesting collection. To protect the water quality of the rainwater harvested, avoid roofing materials such as copper or zinc that may release contaminants into your system, as well as roofing materials treated with fungicides or herbicides. Consult Seattle Public Utilities to understand any water rights issues that may apply to your project. See the "Regulations, Guidelines, and Design Resources" section of this document for contact information.
- **Collection systems**: Collection systems include gutters and downspouts, as well as the piping and any other conveyance needed to route harvested water from harvest sources to the cistern. All portions of the collection system should be constructed in accordance with Chapter 11 of the *2006 Uniform Plumbing Code* (UPC). See the "Regulations, Guidelines, and Design Resources" section of this Tip.
- **Initial water quality treatment/debris excluders**: Pre-storage treatment must be used to divert debris and/or “first flows” prior to entering the storage system, and to keep leaves and other larger debris from entering and clogging the system. “First flows” are defined as the initial rain that falls during a typical rain shower. These waters convey any sediment that has built up on the roof surface. They typically contain the greatest concentration of pollutants in harvested rainwater. Leaf screens and self cleaning bug screens are a typical choice for initial water quality treatment in the Pacific Northwest.

LEED™ Benefits for Water Harvesting

LEED™ (Leadership in Energy and Environmental Design) is a national green building standard created by the U.S. Green Building Council. LEED has programs for commercial and residential construction. Rainwater harvesting can contribute towards the following credits:

- Stormwater Design: Quantity Control
- Water Efficient Landscaping: Reduce by 50 Percent
- Water Efficient Landscaping: No Potable Water Use or No Irrigation
- Innovative Wastewater Technologies
- Water Use Reduction: 20 Percent Reduction
- Water Use Reduction: 30 Percent Reduction
- Innovation in Design: Potable Reduction for Process Water
- Innovation in Design: Education Credit

For more information visit **www.usgbc.org**.

Built Green™ Benefits for Water Harvesting

Built Green™ is a green building program developed by the Master Builders Association of King and Snohomish Counties in partnership with local governments including the City of Seattle. Built Green has programs for single family, multifamily and communities. Rainwater harvesting can contribute to the following credits:

- Install Rainwater Collection System (Cistern) for Reuse
- Prepare a Roof Water Management Plan Showing Best Practices for the Site Soils and Storm Water Infrastructure
- Stub-In Plumbing to Use Greywater Water for Toilet Flushing
- Use Greywater Water for Toilet Flushing
- Plumb for Greywater Irrigation
- Install Irrigation System using Recycled Water

For more information visit **www.builtgreen.net**.

- **Cistern/storage system**: Cisterns can be constructed from a variety of materials and placed in various locations. They can include tanks, pipes, and enclosed portions of buildings — above or below ground level. Construction materials include underground concrete and fiberglass, partial and above ground plastic, and enclosed basement structures. All cistern systems must meet the following criteria:
  - All cisterns must be installed in accordance with manufacturer's installation instructions and the building code.
  - If a foundation is required for installation, then the foundation must be flat and capable of supporting the cistern weight when full with water (in accordance with the building code).
  - Cistern/storage systems that are capable of being filled from both the rainwater harvesting systems and a public or private water system must be protected from cross contamination in accordance with the UPC.
  - Cistern/storage systems must have both access points and drains to allow inspection and cleaning.
  - Cistern/storage systems that are buried below ground level must have a manhole riser that sticks out a minimum of eight inches above the surrounding ground. Manhole covers must be secured and locked to prevent tampering.
  - Any cistern/storage system opening that could allow the entry of personnel must be marked: "danger — confined space."
  - Cleaning of any accumulated sediment on the bottom of the cistern must be possible by flushing through a drain, vacuuming or another approved method.
  - The cistern must have a designated overflow when the volume of the tank meets capacity. The cross section of the overflow must have an area equal to or greater than all of the areas of the devices delivering water to the cistern. The minimum overflow is four inches in diameter. The overflow must be protected with a screen with openings no greater than one-quarter inch.
  - The discharge location for the emergency overflow must be approved by the local authority.

From top to bottom: Cistern inlets, pipe labels, potable water bypass, King Street Station, Seattle, Wash. Images courtesy of MayFly Engineering and Design, Pllc.

  - Cisterns should be designed to prevent mosquitoes and other life forms from entering the cistern system. This can be done with appropriate screening at any opening to the cistern.

While not required, locating the cistern in an area that allows access for replacement in case of failure may be desirable. Consider using opaque containers for an above ground location to minimize algae growth.

- **Delivery/distribution system**: Delivery may be accomplished by a gravity system or include the pumps and pipes needed to move water from the storage system to the end use area. Consider designing a potable water back-up that can operate without electricity in emergency conditions.

  - All distribution system components must be sized and installed to meet the requirements of the UPC.
  - As specified in the Seattle and King County Public Health Rainwater Harvesting Policy included in the "Regulations, Guidelines, and Design Resources" section of this document, all pipes, irrigation hose bibs, irrigation outlets and related equipment rooms must include appropriated labeling of the rain water harvesting system.
  - Any connection to the domestic potable water system must be protected from cross contamination per the UPC.
  - Water must be drawn from at least four inches above the bottom of the tank.
- **Final water quality treatment**: The extent of water quality treatment is dependent on both the quality of the water entering the storage system and the desired reuse. Systems must protect the functions of delivery valves and fixtures and range from simple screens to cartridge filters, UV light, and chlorination. Screen systems and/or basic mechanical filtration are typically adequate for irrigation and toilet flushing reuse.
- **Operations and maintenance manual**: This document should include all operations and maintenance information needed to ensure proper function for the life of the rainwater harvest system. Information should include timing on replacing and/or cleaning filters, removing sediment and other pollutants from storage systems, backflow prevention inspections, valve schedules and operation, backup and cross connection, and seasonal startup and shutdown and freeze protection. It is the property owner's responsibility to maintain the system until abandoned per guidelines.
- **Education program**: Written documentation of this program can be included in the Operations and Maintenance Manual. All users and system operators need to understand how to operate and maintain the system in order to ensure proper function. This can be done with training and/or signage. User behavior to minimize the wasting of water should be encouraged.
- **Public information materials**: Additional information to inform the public of the system benefits and operation can be included in a project through signage. An education program can also be developed to allow non-users (the public) to learn about the benefits and operation of a rainwater harvest system.

Design Process

Rainwater harvesting systems used in structures must be engineered for site specific conditions. This requirement can be waived by the permitting authority for very simple systems. Rainwater systems are required to be submitted for plan review for building and plumbing permit. The UPC, Seattle and King County Public Health procedures title, *Rainwater Harvesting and Connection to Plumbing Fixtures*, and any manufacturer's installation instructions must be followed.

Permits, Inspections and Review Requirements

Rainwater harvesting systems must comply with permitting, planning and zoning requirements, this may include one or more of the following:

- design review
- building permits for cistern footings, foundations, enclosures and roof structures, and may include:
  - zoning review for location and setback
  - grading permits and erosion control plans for underground tanks
  - critical area determinations
- plumbing permits for all systems from the collection area to the final point of rainwater reuse

Structural Support

Consider the weight of a storage system full of water when initially considering a rainwater storage location. What supports or foundations, if any, will be necessary? If a storage system is located within a building, then its full mass must be integrated into any seismic and structural engineering studies. If a storage system is buried underground or located outside of the building, analyze soils in that location and construct foundations as needed. Consult with SDCI or the project structural engineer to understand structural requirements for your rainwater harvesting system.

- electrical permits for pump and electrical controls
- possible water rights from the Department of Ecology regional office

Before beginning construction check with each authority to determine if permit and inspection is required for your specific project. Before submitting for a permit or plan review, it is important to clarify submittal requirements. Typical submittal requirements include site plans, elevations, isometric drawings of the harvest system and specifications along with manufacturer's installation instructions for cistern, pump and filtration or disinfection components.

Top to bottom: Seattle cistern art, Beckoning Hand Scene, Rain Garden and Overflow, Vine Street, Seattle, Wash. Images courtesy of Mayfly Engineering and Design, Pllc.

Vegetated Roofs

Vegetated roofs "sponge" up a large percentage of the rain that falls on them. This percentage is based on vegetated roof depth and planting materials. In smaller rainfall events, some vegetated roofs will sponge up all rain that falls on them. When figuring rainwater harvest volumes, integrate absorption into design calculations. Depending on the planting materials and roof construction, vegetated roofs may also discolor or contribute a high amount of particulates into your harvest system — this can be managed with appropriate system filters. Consider water uses when selecting rainwater filters. For example, you may desire clearer water for washing clothes or when the water is visible in toilets.

After considering the reduced rainfall volume that comes off of a vegetated roof and the need for additional filtering, determine the cost / benefit of harvesting rainfall runoff from vegetated roof areas.

Rainwater Use Applications

Currently, harvested rainwater may only be used for toilets, urinals, hose bibs, some industrial applications, domestic clothes washing, irrigation and water features. Any other use must be first approved by the permitting authority.

Commercial and Residential System Design Teams

From the earliest stage of design it is important to have all team members participating in the design process. This will allow for identification of team member roles and responsibilities — an important facet of the process, as some design responsibilities will be new to team members who have not previously participated in the design of water harvest systems.

Many simple or residential projects will not require all of the team members that follow. If your design team does not already have a thorough understanding of the process, then adding a sustainability consultant who specializes in rainwater harvesting to your existing team may meet your rainwater harvesting system design needs.

However, in a more complicated project, it is typical for team members participating in the design process to include the following roles in their design scope:

- **Architect:** Leads and coordinates the design process.
- **Civil engineer:** Calculates rain flow volumes and integrates any other water sources and uses into a water balance to size the cistern volume. The civil engineer designs connections to rainwater and greywater mechanical systems outside of the building footprint and provides direction about overflow to storm systems, ensuring that overflow meets any local design criteria for stormwater quality and/or quantity. The civil engineer will also design potable water connections outside of the building envelope.
- **Landscape designer:** Consults on water harvest projects where harvested water is to be used for irrigation, providing irrigation volumes for water balance calculations and specifying appropriate irrigation systems that work with the water harvest system.
- **Mechanical engineer:** Provides greywater and in-building reuse volumes to be used for water balance calculations, designs roof drainage systems and interior potable water delivery and sewage piping systems, identifies filter and water quality systems to meet reuse requirements, and designs pump and delivery systems for water reuse. Pump and delivery systems may be located outside of the building envelope.
- **Electrical engineer:** Provides power to system elements as needed.
- **Geotechnical engineer:** Provides soil information used to determine if storage system foundations or supports are needed.
- **Structural engineer:** Integrates full storage system loads into seismic calculations and building structural design, and/or determines the need for foundations or supports outside of building.
- **Sustainability consultant** (optional): Consults and collaborates with the design team to ensure LEED or Built Green credit criteria are being met. A sustainability consultant may also facilitate design charrettes to identify commonalities with other sustainable design systems.

Design Collaboration

Early design integration can save in construction costs as the system can be integrated with other building systems and layout. Efforts to reduce water consumption throughout the project support a cost-effective water harvest design solution. Educational and interpretive materials can help encourage water conservation.

When considering site irrigation, a focus on soil health, and the use of drought tolerant and native species planted in an appropriate environment will reduce the amount of water needed for irrigation. Advanced irrigation controllers can further enhance irrigation efficiency. The design of the irrigation system also impacts water usage; for example, drip irrigation systems instead of spray systems will minimize water lost through evaporation.

Indoors, consider using toilet fixtures and urinals with minimal or no water needed for sewage conveyance and clothes washers that require minimal water volumes for operation.

Storage System Sizing

The first step in a water harvest design process is to determine both the owner's annual water reuse goals and the volume of water available for annual harvest. Reuse goals may be directly related to obtaining credits as part of LEED or Built Green certification processes or to meet other owner goals.

A potable water supply should be designed into all systems even if harvest volume is estimated to be greater than reuse volumes. A potable water supply will supplement any water needs not met with the water harvested and will also supply water for maintenance when the storage system is emptied.

Once you have a feel for the size and potable water make-up needs of your system and a location is chosen, it is crucial to communicate and collaborate with your design team on the details of the system. Make sure that the entire system from harvest source to reuse is included in plans and specifications in all phases of the design process.

Regulations, Guidelines and Design Resources

When designing a rainwater harvest system, the following publications may be of use:

Code Resources:

- Seattle and King County Department of Public Health has prepared a Policies and Procedures Title, *Rainwater Harvesting and Connection to Plumbing Fixtures*, with an effective date of January 30, 2007, and a Document Code No. Product/Method #07-001. The purpose of this document is to accommodate rainwater harvesting for certain types of reuse while protecting public health and encouraging the conservation of valuable water resources. This document may be found at **https://www.kingcounty.gov/depts/health/environmental-health/piping/plumbing/guidelines.aspx**.

- The UPC, as enforced by the Seattle and King County Public Health provides guidance on rainwater and greywater harvesting. UPC Chapter 6, "Water Supply and Distribution" covers potable, non-potable, and reclaimed water use, including "backflow prevention." UPC Appendix J covers reclaimed water for non-residential buildings. This document may be ordered from the Seattle Public Library at **www.spl.org**.

Design Resources:

- The Washington State Department of Ecology provides *Ecology Criteria for Sewage Works Design*, also known as the Orange Book. Chapter E1 on reclaimed water includes discussion on various classes of reclaimed water and their possible reuses. This document can be found at **https://fortress.wa.gov/ecy/publications/summarypages/9837.html**.

- The Washington State Department of Health published, *Water Conserving On-Site Wastewater Treatment Systems*, dated July 2012. This publication is divided into sections on waterless toilets, greywater systems and subsurface drip dispersal systems for greywater use in irrigation. This publication can be found at **www.doh.wa.gov/CommunityandEnvironment/Wastewater-Management/FormsPublications**.

Pumps, filters and backflow prevention, King Street Station, Seattle, Wash. Images courtesy of Mayfly Engineering and Design, Pllc.

- SDCI has a rainwater harvesting tool posted on their Green Factor website. This tool analyzes 10 years of historical rainfall data while incorporating seasonal evaporation to determine collection areas, tank size and irrigation areas for projects based on user input. The Rainwater Harvesting Tool can be found at **www.seattle.gov/sdci/codes/codes-we-enforce-(a-z)/seattle-green-factor**.

- National Sanitation Foundation International is an independent testing and certification organization that provides information on the performance of various filters. Visit their website at **www.nsf.org** to obtain product information on specific water quality system components.

Design Process

For optimal results, the rainwater harvest system design process should be active, adaptive and thorough. At each stage of the construction document design process, harvest system design assumptions should be verified by all contributing team members. It is common for design assumptions to change — contributing roof areas, irrigation demands and fixture counts, for instance — and it is important that the harvest system design reflects this. At each stage of the construction document process harvest, system design assumptions should be verified by all contributing team members.

Design Challenges

- Current water and sewer rates are low. Lifecycle costs can be analyzed to validate first costs.

- Maintenance is increased compared to traditional potable water systems—the design team should specify system specific maintenance needs in the Operations and Maintenance Manual.

- Increased coordination to address during design process.

- Increase space needed to site system components compared to traditional city water supply systems.

- The American Rainwater Catchment Systems Association provides guidance on water harvesting. Available on their website is *The Texas Manual on Rainwater Harvesting*. This document as well as other design documents can be found at **www.arcsa.org/resources.html**.

Commercial Case Study Fire Station 10

The City of Seattle's Fire Station 10 facility, located at 105 Fifth Avenue South, houses three critical facilities for Seattle's emergency and disaster response: Fire Station 10 Operations, the Emergency Operations Center and the Fire Alarm Center. The facility was designed to achieve a LEED Silver rating in accordance with the City's sustainable building policy.

Water Conservation Goals

Fire Station 10 employs a water harvest system that will reuse the majority of the fire drill water used as well as the rainwater that falls on non-driving surfaces on the site. The design team estimates that nearly 130,000 gallons of harvested water are projected to be used annually for site landscaping and washing fire facility vehicles.

Fire Station 10 was designed to achieve LEED Silver rating in accordance with the City's sustainable building policy.

In addition to capturing rainwater and drill water, conservation goals will be met by installing low-flow fixtures. Water closets have dual-flush (1.1/1.6 GPF) valves. Ultra-low-flow lavatories (0.5 GPM) and low-flow kitchen faucets (1.8 GPM) are specified for the building. In addition, 1.8 GPM showerheads will also be used. Overall, these water-saving fixtures are projected to reduce potable water use by more than 156,000 gallons per year.

Water Rights

Seattle Public Utilities (SPU) received a water right permit from the Department of Ecology so they can capture and put to use the rainwater that falls on rooftops of structures in the combined and partially separated sewer basins of the City of Seattle. By removing the legal uncertainty regarding rainwater harvesting, SPU hopes to encourage and hasten adoption of this practice.

For a map of combined and partially separated sewer neighborhoods and additional information regarding the water rights program visit **www.seattle.gov/util/About_SPU/Water_System/Projects/RainwaterPermit/.** Contact Paul Fleming at **paul.fleming@seattle.gov** or at (206) 684-7626 for information regarding project permit requirements related to water rights.

Incentives: Seattle Public Utilities

Lower drainage fees: Property owners can apply for a 10 percent credit on their drainage fee. For more information about savings on drainage fees, please visit **www.seattle.gov/util/natural-systems**.

Seattle Green Factor bonus: The Seattle Green Factor requires new development in neighborhood business districts to meet a landscaping target using a menu of landscaping strategies. When used for landscape irrigation, rainwater harvesting can provide bonus credits for the Green Factor landscaping requirement. For the Green Factor Worksheet, Planting Area Calculation worksheet, and Rainwater Harvesting Calculation tool, visit **www.seattle.gov/sdci/codes/codes-we-enforce-(a-z)/seattle-green-factor**.

Approximately three-quarters of the facility will be covered with a vegetated or green roof, further reducing the stormwater impacts. LEED credits being pursued that the rainwater harvesting system will contribute to include:

- Sustainable Sites Credit 6.1 Stormwater Design: Quantity Control.
- Water Efficiency Credit 1.1 Water Efficient Landscaping: Reduce by 50 percent.
- Water Efficiency Credit 1.2 Water Efficient Landscaping: No Potable Water Use or No irrigation.
- Innovation in Design: Potable reduction for Process Water.
- Innovation in Design: Education Credit.

Water Harvest System

The Fire Station 10 water harvest system captures fire drill water and rainwater that falls on non-driving surfaces that will be used for site landscaping and washing fire facility vehicles. The water captured in the cistern system will undergo a modest level of treatment and will be the sole source of water for plant irrigation. Water from the harvest system will also be available through a hose bib connection for fire personnel to use for vehicle washing purposes. The system was sized in order to meet 100 percent of the demand for both irrigation and vehicle washing. Water reuse for vehicle washing contributes to a LEED Innovation and Design Credit for Process Water Savings.

Design System Components

- **Harvest sources**: Rainwater is collected from the portions of the roof that are not green roofs. Both rainwater and fire drill practice water are captured from non-driving surfaces.
- **Collection systems**: A rain leader system within the building collects roof drainage from contributing areas. A trench drain system collects drill water runoff outside of the building. Both of these systems are conveyed to the storage system with conventional storm drainage conveyance.
- **Initial water quality treatment**: A StormFilter system located in a 48-inch manhole provides initial water quality treatment.
- **Storage system**: A buried 1,500 cubic foot corrugated metal pipe cistern provides storage volume. An overflow from the cistern is connected to the site's detention system in order to meet stormwater flow control requirements.
- **Delivery system**: A pump, located in a vault outside of the building, pressurizes the delivery system. A potable water feed is connected to the pump vault to provide make-up water when the cistern is empty.
- **Final water quality treatment**: The planned uses for the reclaimed water did not require secondary treatment.
- **Operation and maintenance manual**: The design team provided information regarding design intent and operations to be included in the facility operation and maintenance manual.
- **Education program**: Information on the water harvest system was included in the education program developed to meet the LEED Innovation in Design Credit for Education. The city's facility maintenance department is working on a measurement and verification program to incorporate the water use projections made during design and react if resource consumption is outside of the baseline conditions.

Design Team Members

Architect
Weinstein AU Architects & Urban Designers

Civil and Structural Consultant
Magnusson Klemencic Associates

Mechanical Consultant
Notkin Engineers

Electrical and Technology Consultant
Sparling

Landscape Architect
Gustafson Guthrie Nichol, Ltd.

Sustainability Consultant
Paladino & Company

Residential Case Study
The Sensible House Project

The Sensible House, a residential home completed in April 2004, was the first house in Seattle to achieve a Built Green™ Five Star designation — the highest level available. This building consists of an 1,800 square foot main residence and a 650 square foot accessory dwelling unit.

Green Building Elements

Sustainable building features for The Sensible House include:

- Salvaged materials from the original house.
- A super insulated shell resulting in a heating system about one-sixth as powerful as the average home in this climate.
- Solar powered hot water heater and photovoltaic panels for on-site renewable energy generation.

The Sensible House, image from **www.sensiblehouse.org**.

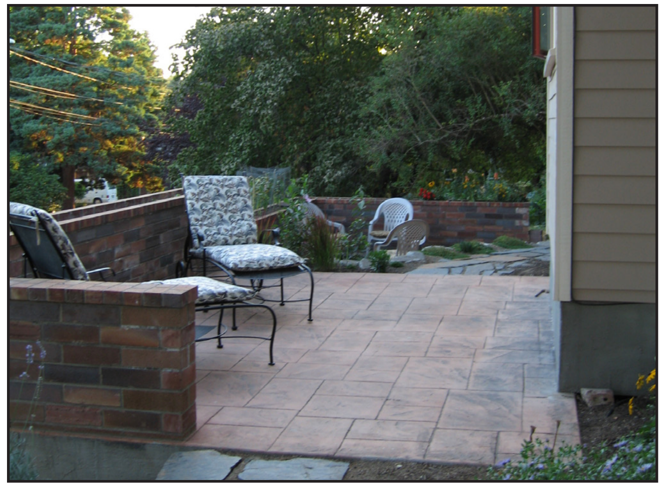
- An advanced plumbing system that reduces the amount of hot water wasted.
- Improved interior air quality through the use of low-toxic paints, finishes, caulks, and adhesives, as well as avoidance of materials containing urea-formaldehyde.
- Rainwater harvest system.

It is reported that The Sensible House will save over 10,000 pounds of carbon emissions and 115,340 gallons of water each year compared to a typical house.

Rainwater Harvest System

The design elements consist of:

- Rainwater is collected from the roof with a conventional downspout system.



The rainwater cistern is a waterproofed concrete vault that also serves as a patio in the backyard. Image courtesy of Bob Scheulen.

- The downspouts direct the water through a drain pipe capped with a standard window screen to divert debris. The filtered water travels through the drain pipe to the cistern.
- The cistern is a waterproofed concrete vault that was built by the house contractor. The top of the tank is used as a patio in the backyard.
- Water from the tank inlet is diffused at entry into the tank in order to minimize stirring up of sediment that has settled to the bottom.
- The intake from the pump floats to collect the cleanest water from about six inches below the water surface.
- The tank overflow is connected to the city storm sewer.

The delivery system corresponds with the following design elements:

1. The intake for the pump with a floating screen filter to keep sediment from entering the pump.
2. A check valve to help the pump function correctly.
3. A shutoff valve to control cistern water from the tank.
4. A 240V variable speed motor that keeps the output line pressurized as set by the motor controller.
5. A filter system to keep sediments from the irrigation system.
6. A small pressure relief tank that keeps the system stable when the pump starts up and shuts off.
7. Shutoff valve for cistern water supply to toilets.

8. Shutoff valve for potable water supply to toilets.
9. Reduced pressure backflow prevention to keep cistern water from contaminating potable water supply.

Design Team Members

Water harvest system design team members included:

Owners
Bob Scheulen and Kim Wells

Architect
Ted Granger

Contractor
Jon Alexander, Sunshine Construction

Cistern Redesign Consultant
Mike Broili, Living Systems Design

To Learn More

Buildings located in the City of Seattle that have integrated water harvesting systems include:

- **Northgate Civic Center**
- **King Street Center**
- **Seattle Central Library**
- **Seattle City Hall**
- **Carkeek Park Environmental Learning Center**

Additional rainwater harvesting resources:

- **Seattle Rainwater Harvesting Information**
- **King County Rain Barrel Information**
- **City of Portland**
- **The Texas Manual on Rainwater Harvesting July 2005**
- **Texas A&M Extension Rainwater Harvesting Services**
- **International Rainwater Catchment Systems Association**

Access to Information

Links to electronic versions of SDCI Tips, codes and forms are available on our website at **www.seattle.gov/sdci**. Paper copies of these documents are available from our Public Resource Center, located on the 20th floor of Seattle Municipal Tower at 700 Fifth Ave. in downtown Seattle, (206) 684-8467.