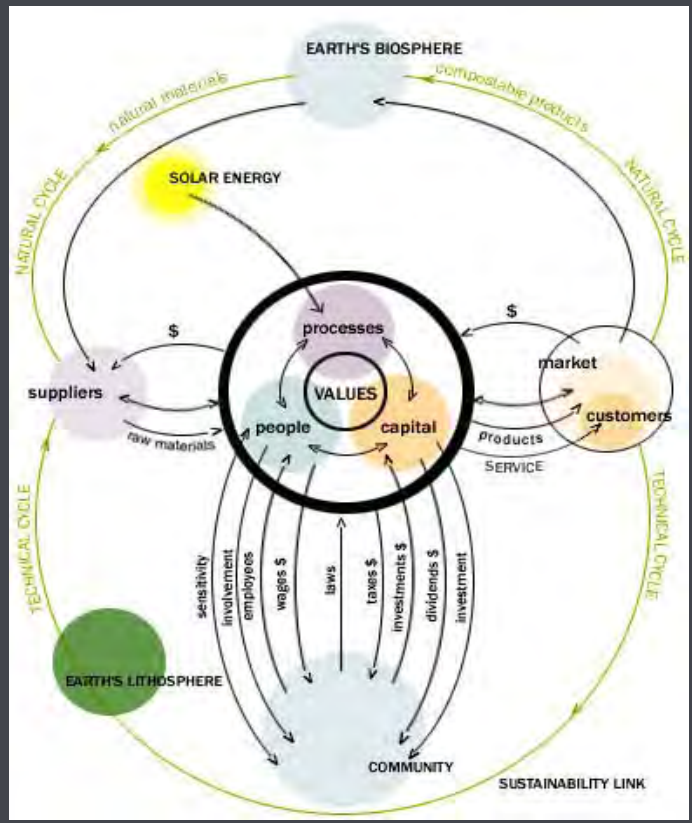
Rainwater as a Campus Resource

Margaret Robertson, ASLA

Lane Community College – Eugene, Oregon

What is ‘Sustainable?’

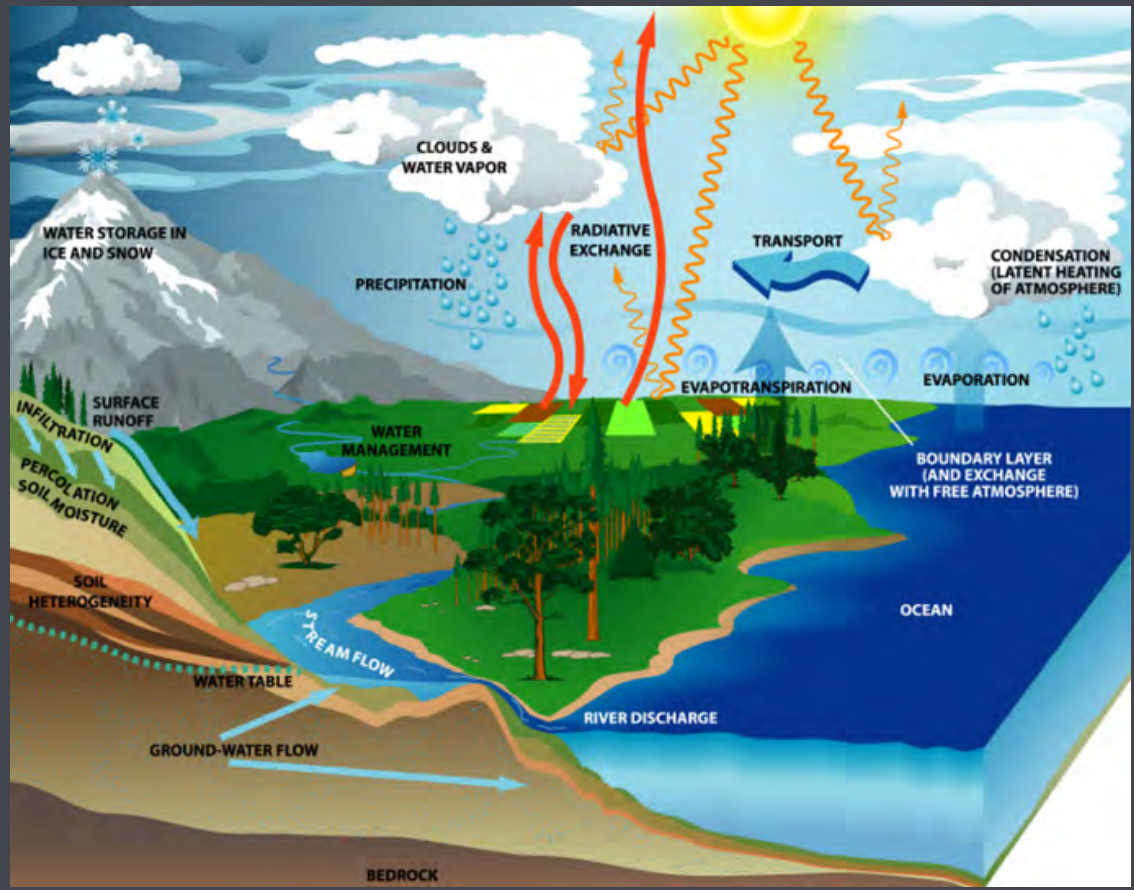
- Being “less bad” is not enough
- Sustainable:
  - Systems that support themselves over very long periods of time
  - Closed loop
  - Restorative
- “Waste” is a human construct
  - . . . and a symptom of poor design.



From www.interfacesustainability.com/model.html

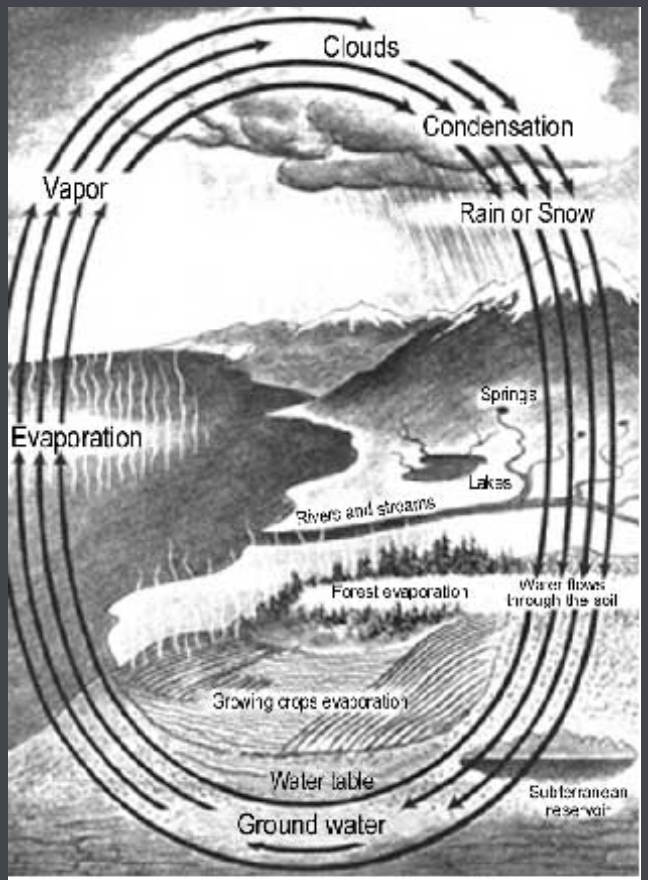
The Hydrologic Cycle

- The same water, cycling round and round.
- Powered by
  - Sun
  - Gravity



U.S. Global Climate Research Panel

Sources of water



The water cycle - a critical ecosystem service.

- Rain — PRIMARY

“blue water”

- Rivers
- Lakes
- Groundwater
- Aquifers

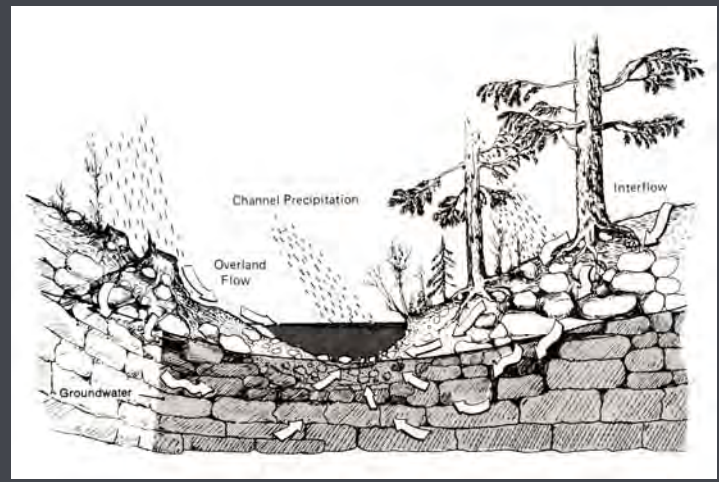
“green water”

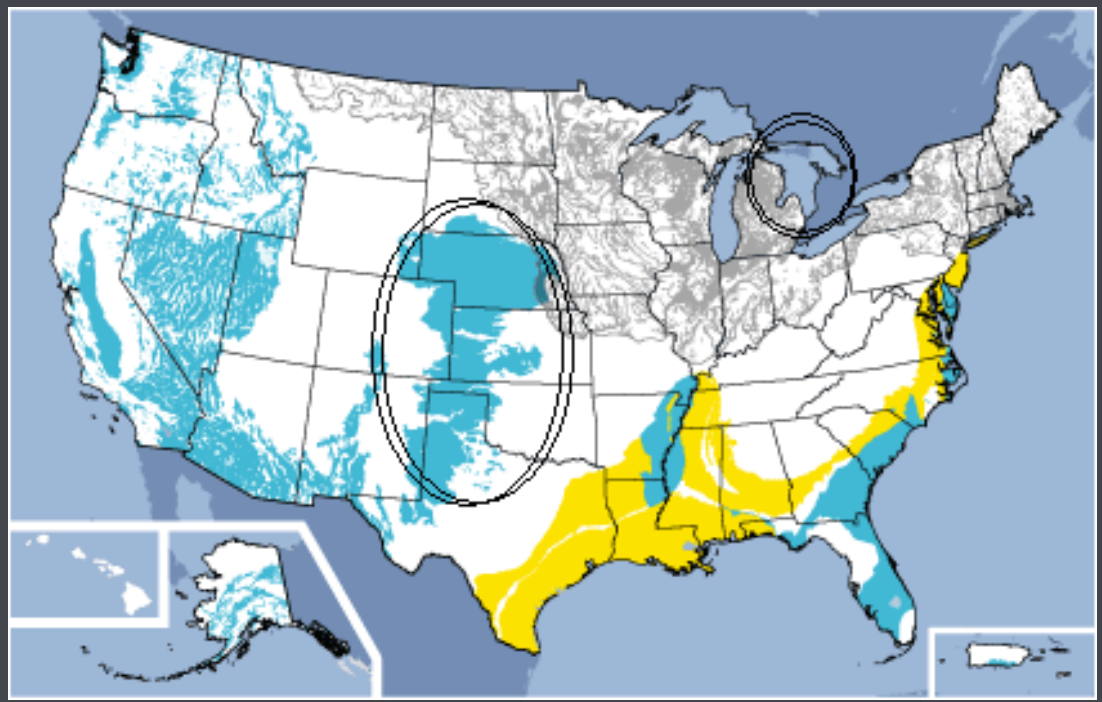
- Soil

SECONDARY

The Hydrologic Cycle

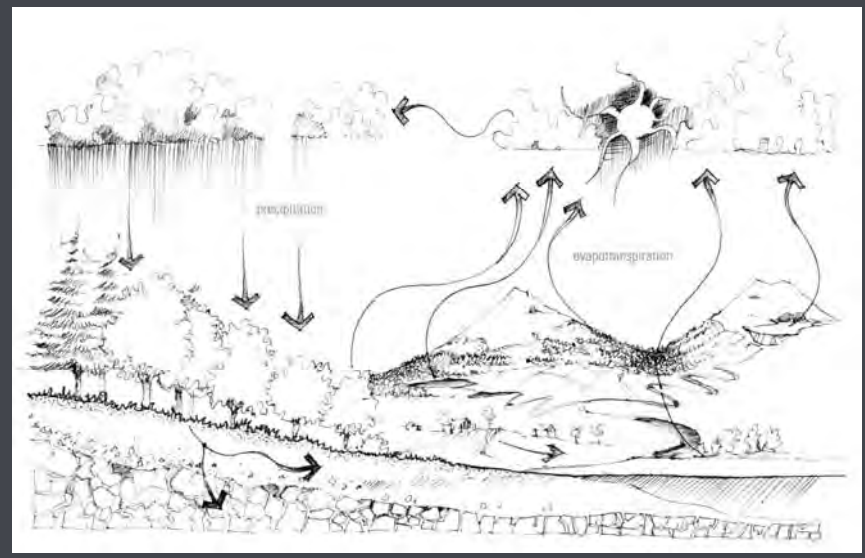
- Groundwater:
  - zone of completely saturated subsoil and bedrock
- Aquifer:
  - relatively large quantity of groundwater

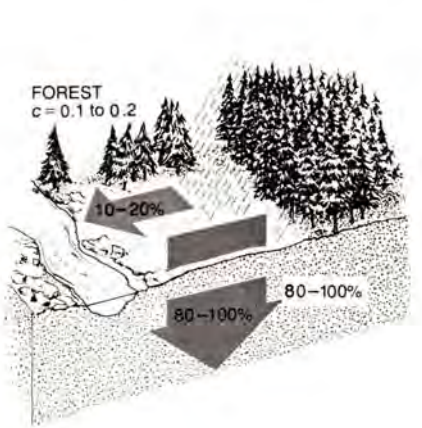


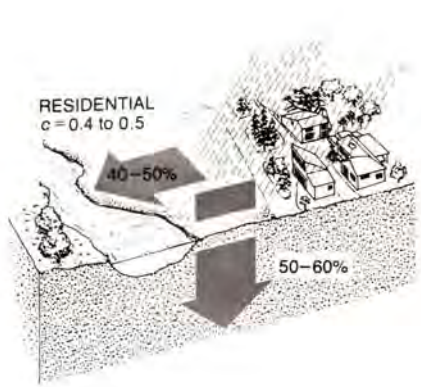


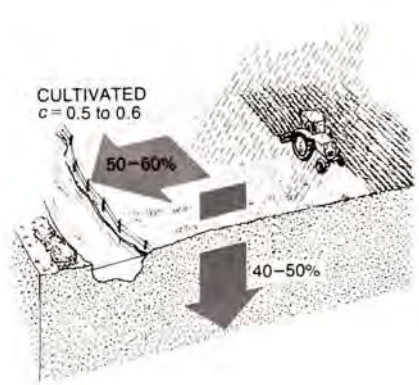
The Hydrologic Cycle
The Issues

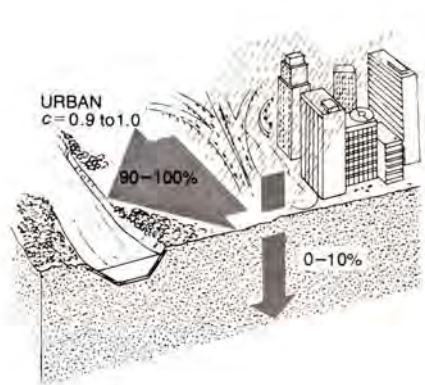
- Groundwater depletion
  - We use a lot of water
  - Buildings and paving keep water from recharging groundwater
  - “Get-rid-of-the-water” approach
- Pollution → rivers











Adapted from William Marsh: ***Landscape Planning***

The Hydrologic Cycle
Some Solutions

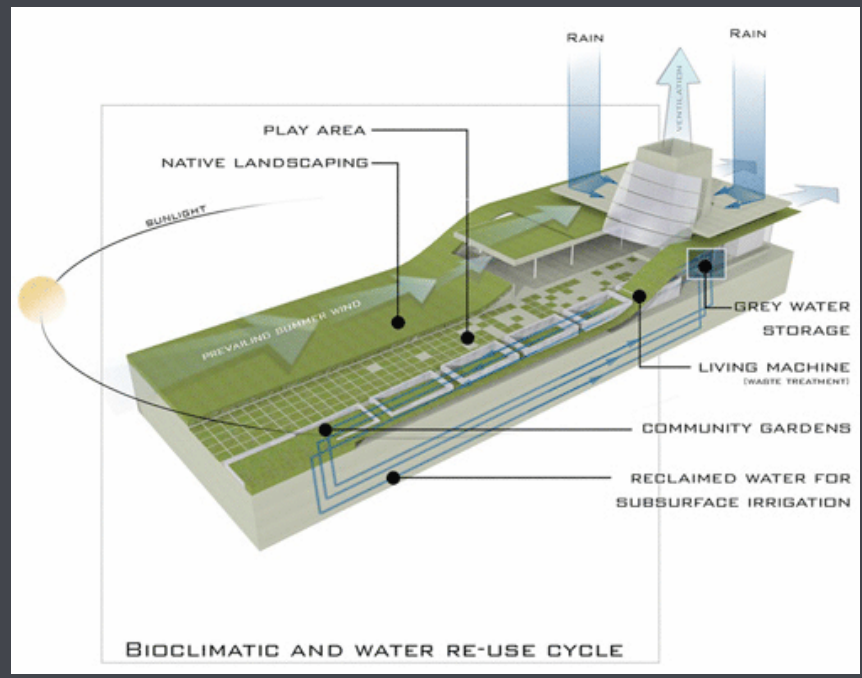
"The challenge for the future is not a water supply problem, but a water management problem."

--Mithun, Seattle architectural firm

- Stormwater infiltration
- Rainwater systems for buildings
- Greywater and other alternate water sources

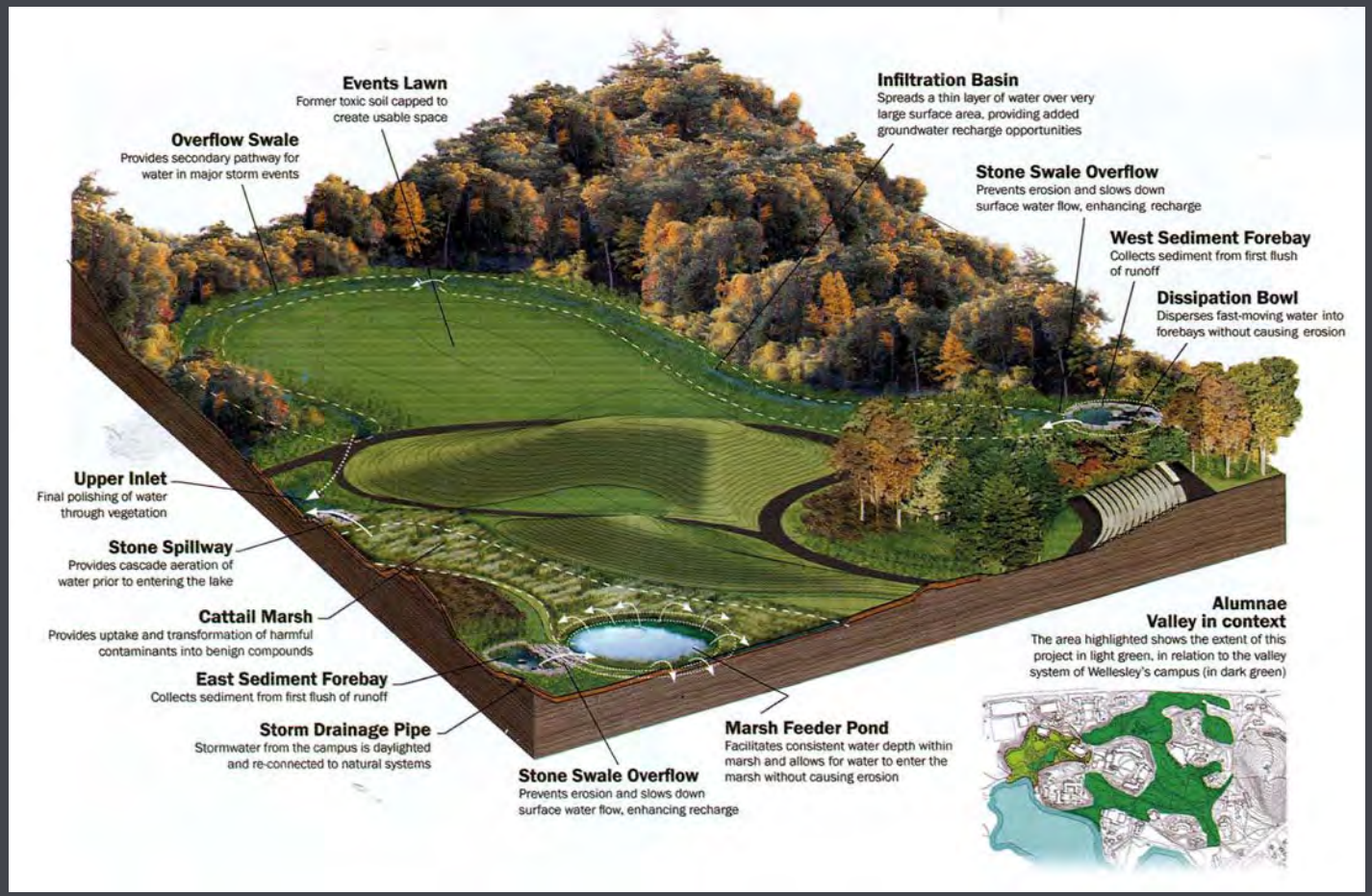
What they do:

- Reduce amount of water taken from aquifers
- Replenish groundwater
- Reduce pollution in rivers and streams
- Reduce costs for drainage infrastructure

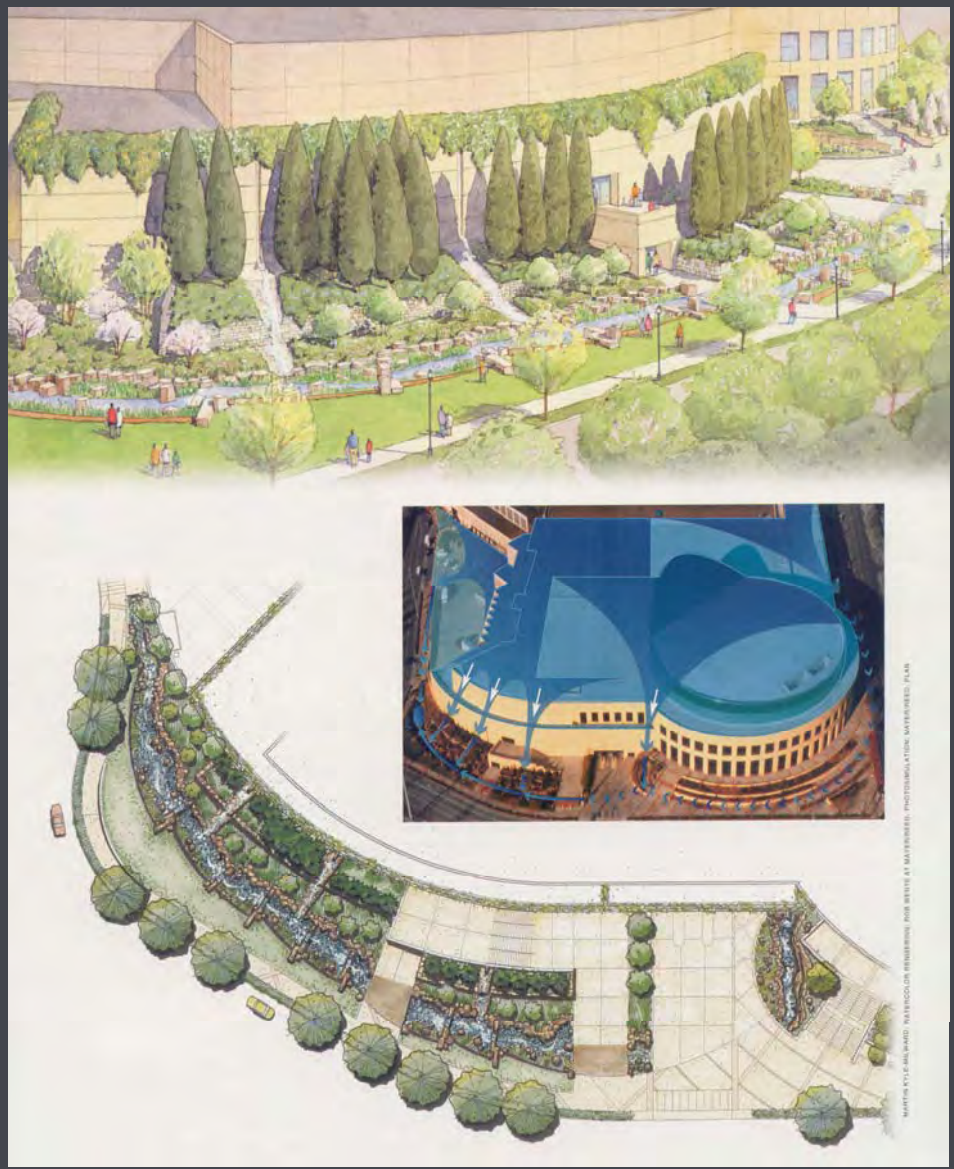


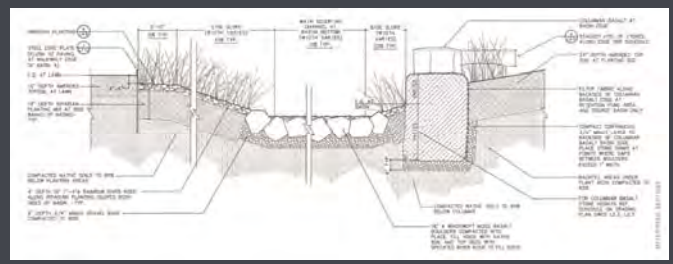
Water reuse cycle – Buckminster Fuller Institute

Stormwater Infiltration



Wellesley College – former parking lot





Portland Convention Center Rain Garden

The Rain Garden

Creating Clean Water In A Beautiful Setting

The Rain Garden is a celebration of the bounty of rainfall in the Pacific Northwest as roof runoff jettisons from steel scuppers connected to concealed downspouts on the convention center's south facade. During the wet season (late October through May), water courses down spillways into a series of sedimentation basins contained by stone weirs (small dams with spillways). The mood of the garden changes vastly during the dry season (June through September) when the focus of the garden shifts to the rich compositions of flowering plants and basalt stone quarried from geologic volcanic formations of the northwest.

The Rain Garden is also a demonstration project for the on-site management of stormwater in an urban environment illustrating how natural sustainable practices can be integrated into public gardens. Functionally, the garden collects and cleanses stormwater before it is released into the Willamette River. The sustainable methodologies incorporated in the garden's design mimic natural ecosystem processes and help reduce the impact on the combined stormwater/sanitary sewer system.

Questions About The Garden

The garden's water supply is gravity-fed, untreated stormwater collected from the 5.5-acre roof.

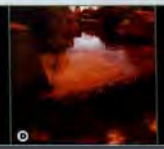
Steel pond edges were fabricated from marine steel that oxidized to a reddish-brown patina.

Herbaceous plants such as sedges, rushes, and water iris along with woody riparian shrubs flower in the urban streamside environment.

During rainstorms, the garden becomes animated when large volumes of water from the roof rush from the steel scuppers and splash down the spillways.

Many of the plants used in the garden are drought tolerant reducing the need for irrigation during dry summer months.

The Rain Garden was designed by Mayer/Reed and received a 2003 BEST Award for Water Conservation from the City of Portland Office of Sustainability.

The Rain Garden Features

A. Four spillways carry stormwater from the roof drain system into the garden.

B. Piped stormwater collected from the east side of the building enters the garden.

C. Water flows beneath the parking garage driveway to the lower garden.

D. Stone weirs control water levels and rate of flow from basin to basin. They also introduce some aeration.

E. Seven terraced retention basins allow polluted sediments to be trapped by plants and cobbles. Sediments are absorbed into the ground and cleansed by microorganisms.

F. Naturally filtered stormwater processed in The Rain Garden, and not absorbed into the ground, is diverted to the Willamette River.

G. Root systems of plants absorb undesirable nutrients, metals and oils.

H. Water collected at the lower pond is piped directly to the Willamette River.

For More Information on sustainability go to www.oregonmc.org
Photography courtesy of Bruce Forster

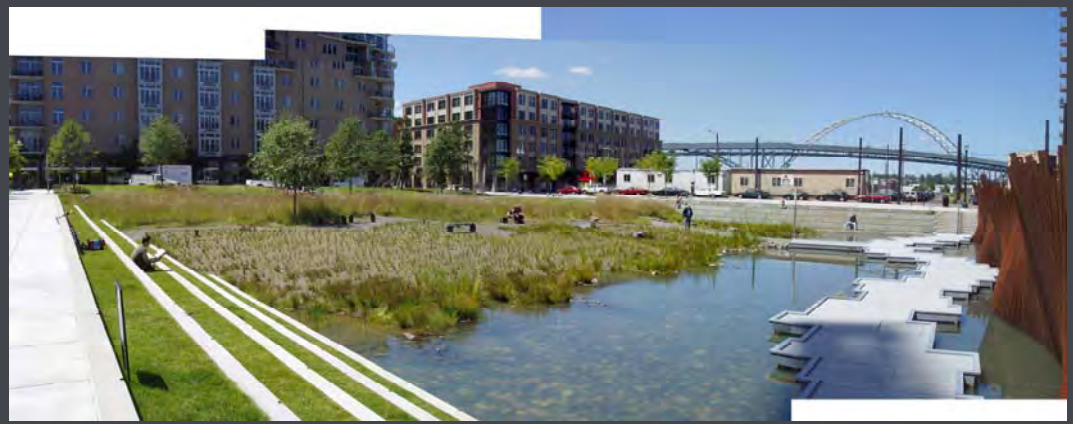
Portland Convention Center Rain Garden

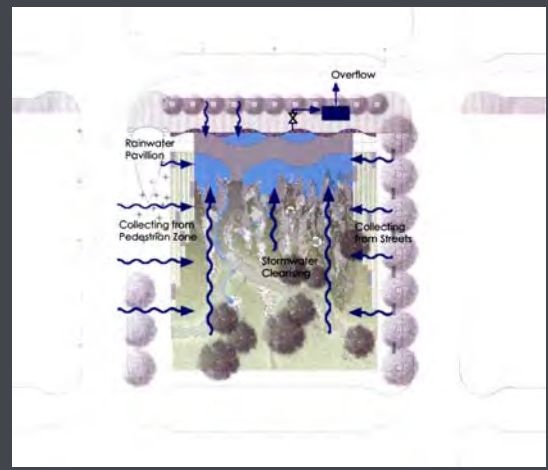
Stormwater Infiltration

Water Pollution Control Laboratory
Portland, Oregon

Stormwater Infiltration

Herbert Dreiseitl

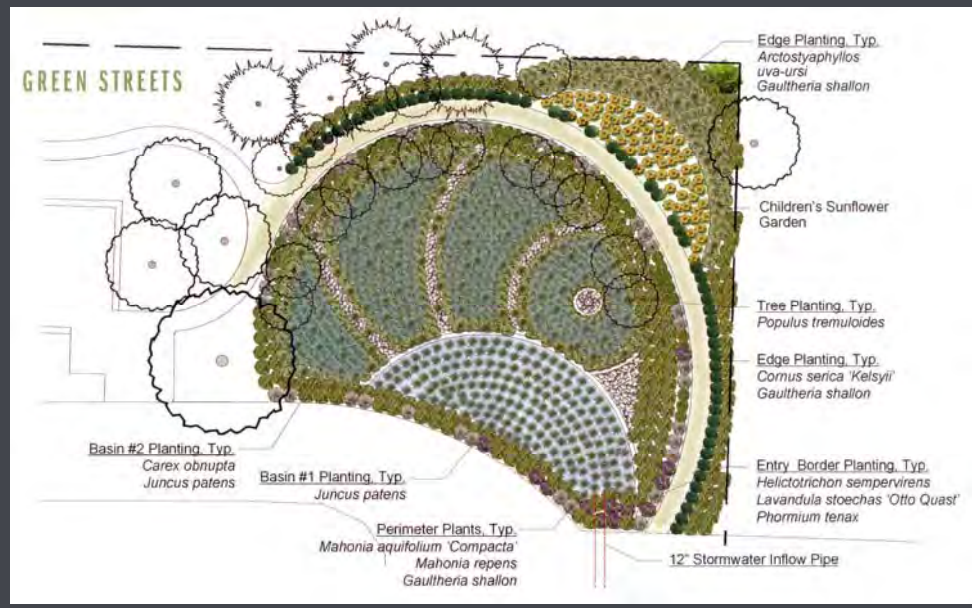




Tanner Creek – Portland, Oregon

Stormwater
Rain Gardens and Microbasins

Stormwater
Rain Gardens and Microbasins



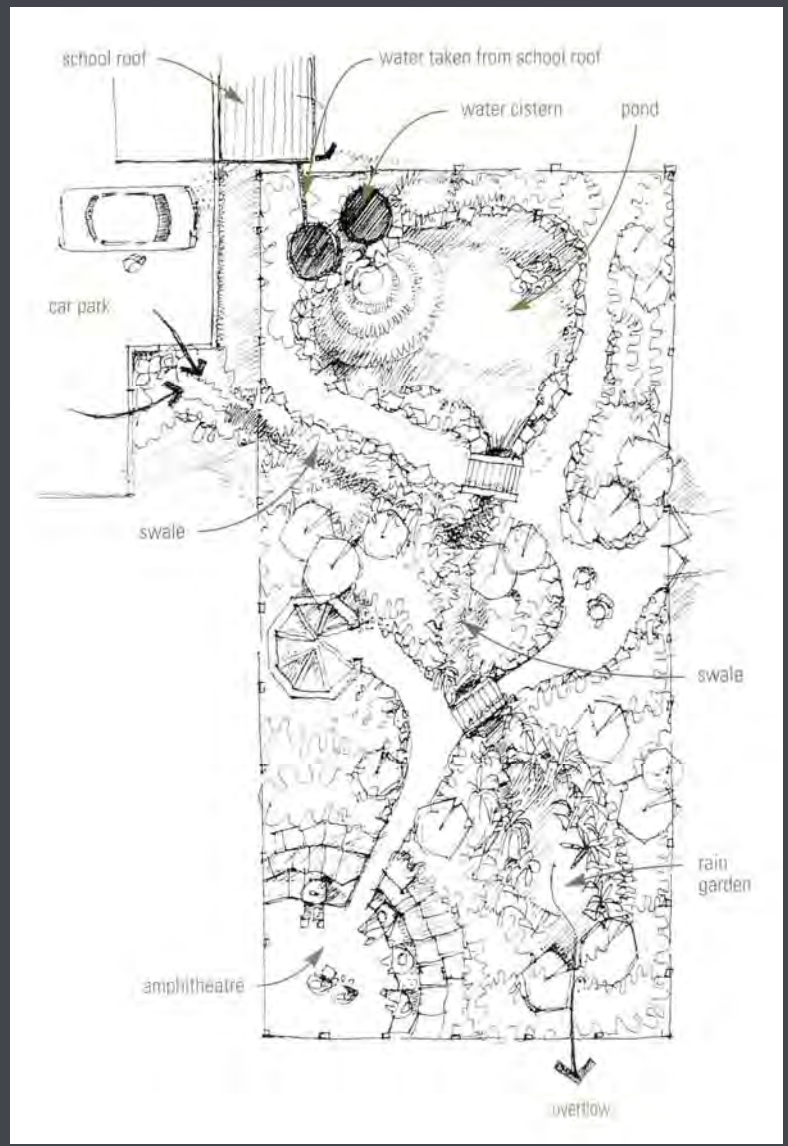
Kevin Perry

Glencoe Elementary School – Portland, Oregon

Stormwater
Rain Gardens and Microbasins

Glencoe Elementary School – Portland, Oregon

Stormwater
Rain Gardens and Microbasins



DaVinci Arts Middle School – Portland, Oregon

Stormwater
Rain Gardens and Microbasins

Mt. Tabor Middle School – Portland, Oregon

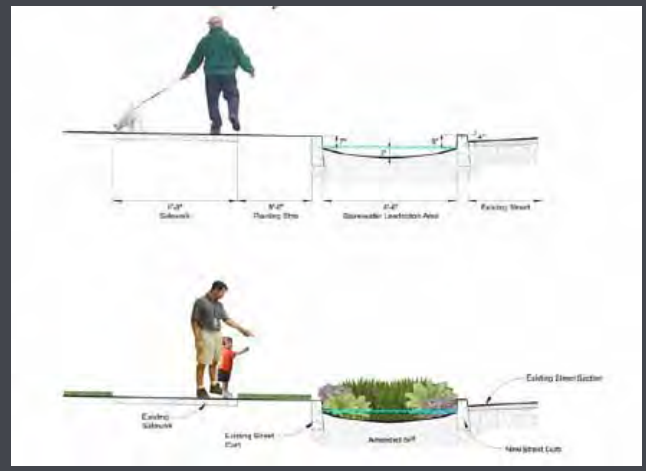
Stormwater Swales

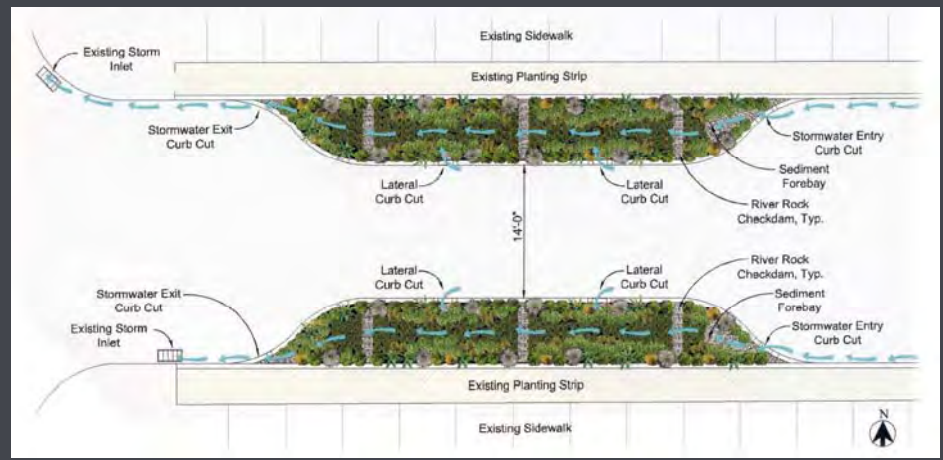
- Swale –
  - Ditch, with plants
  - Linear rain garden
- Function:
  - Infiltration
  - Reduce water velocity
  - Remove particulate pollutants (plants)
  - Break down petroleum-based pollutants (bacteria)
  - Store hydrocarbons, heavy metals.
- Plants
  - Store water.
  - Hold particles.
  - Take up pollutants.
- Bacteria
  - Break down pollutants.

University of British Columbia

University of Oregon

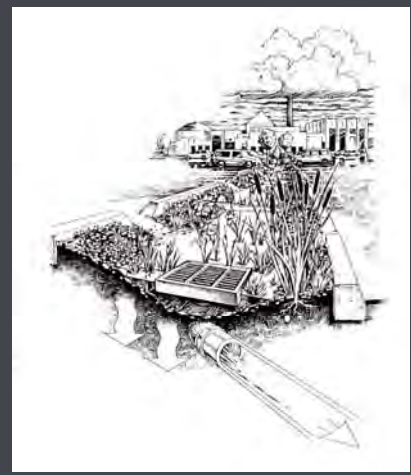
Stormwater Swales



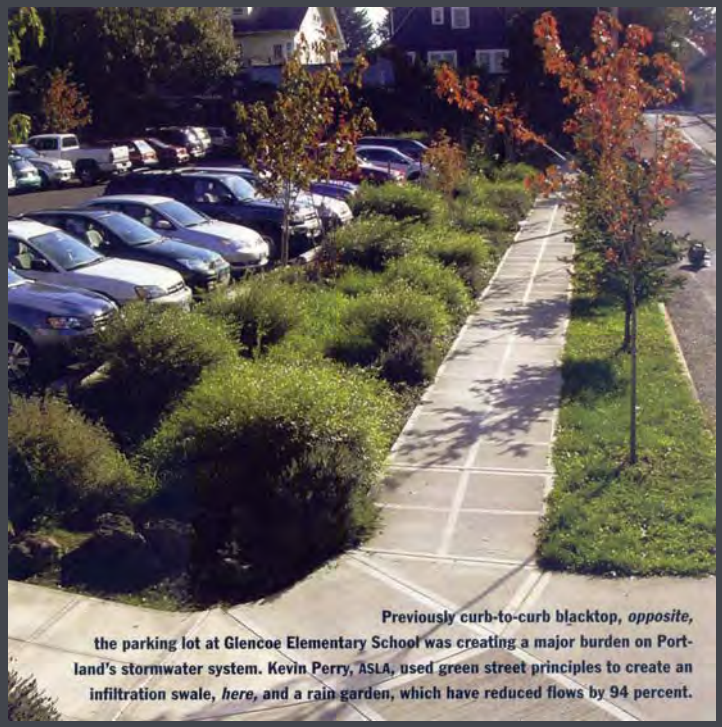


NE Siskyou Green Street – City of Portland, Oregon

Stormwater Swales

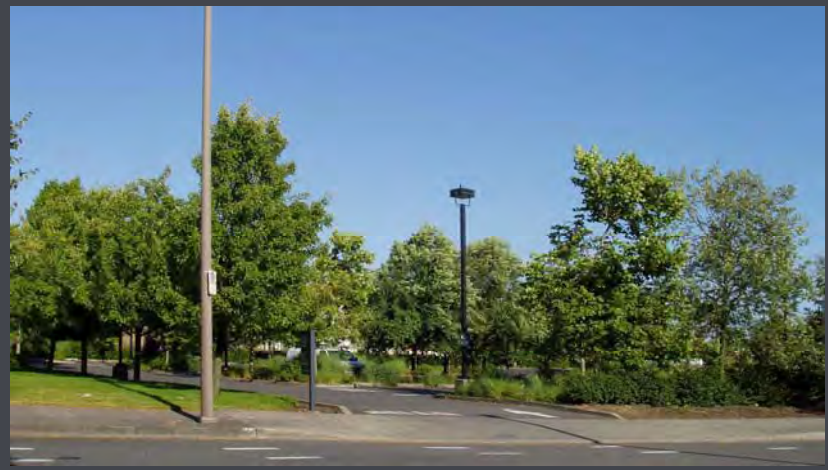


Oregon Museum of Science and Industry
Portland, Oregon



Previously curb-to-curb blacktop, *opposite*, the parking lot at Glencoe Elementary School was creating a major burden on Portland's stormwater system. Kevin Perry, ASLA, used green street principles to create an infiltration swale, *here*, and a rain garden, which have reduced flows by 94 percent.

Glencoe Elementary School, Portland
Parking lot, before and after



Portland Community College
Parking lot

Stormwater
Porous Paving

- Structure:
  - Reservoir of rocks – 40% voids
  - Paving layer – lets water through
    - Lots of choices
- Function:
  - Removes pollutants
    - digested by bacteria
  - Infiltration – recharge groundwater

Ecotrust Building, Portland

Scientific American

Stormwater
Porous Paving

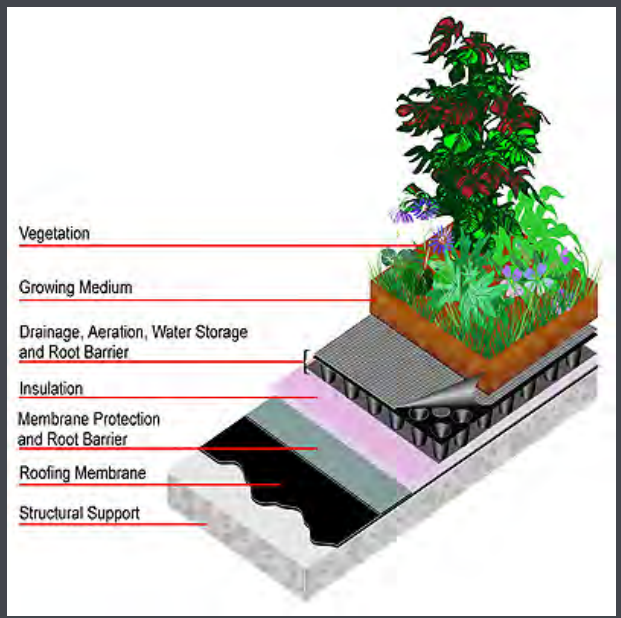
Ford Visitors Center
Rainwater from roof → 12,500 gal cistern

Ford Rouge Factory
Dearborn, Michigan

19-acre parking lot
Stores 3.6 million gallons

Green Roof

- A kind of roof covering
- Made of layers
  - Waterproof layer
  - Growing medium
  - Plants

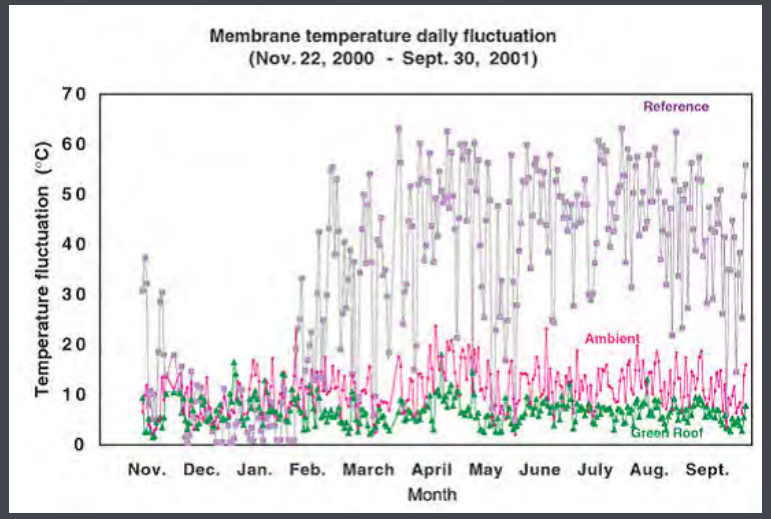


Chicago
City Hall

York University,
Toronto, Ontario

Green Roof Benefits

- Energy savings (heating, cooling)
- Stormwater quality and quantity
- Pollution removal – particulates
- Reduction of urban heat island effect
- Habitat creation; biodiversity
- Increased membrane life expectancy
  - 10-year membranes last 20 years+
  - Protects from UV, heat stress, temperature fluctuations



conventional

green

Conventional roof vs. green roof temperatures
National Research Council, Ottawa, Canada

Rockefeller Center, New York
Green roof installed 1930.

Green Roofs Types

Extensive

- 6” deep or less
- Low weight
- Low cost
- Minimal maintenance

Gap Headquarters,
San Bruno, California

Ford truck plant,
Dearborn, Michigan

Semi-intensive

- Depth varies
- Cost and maintenance vary

Intensive

- More than 6” deep
- Heavy weight
- Greatest plant diversity
- Highest cost
- Highest maintenance

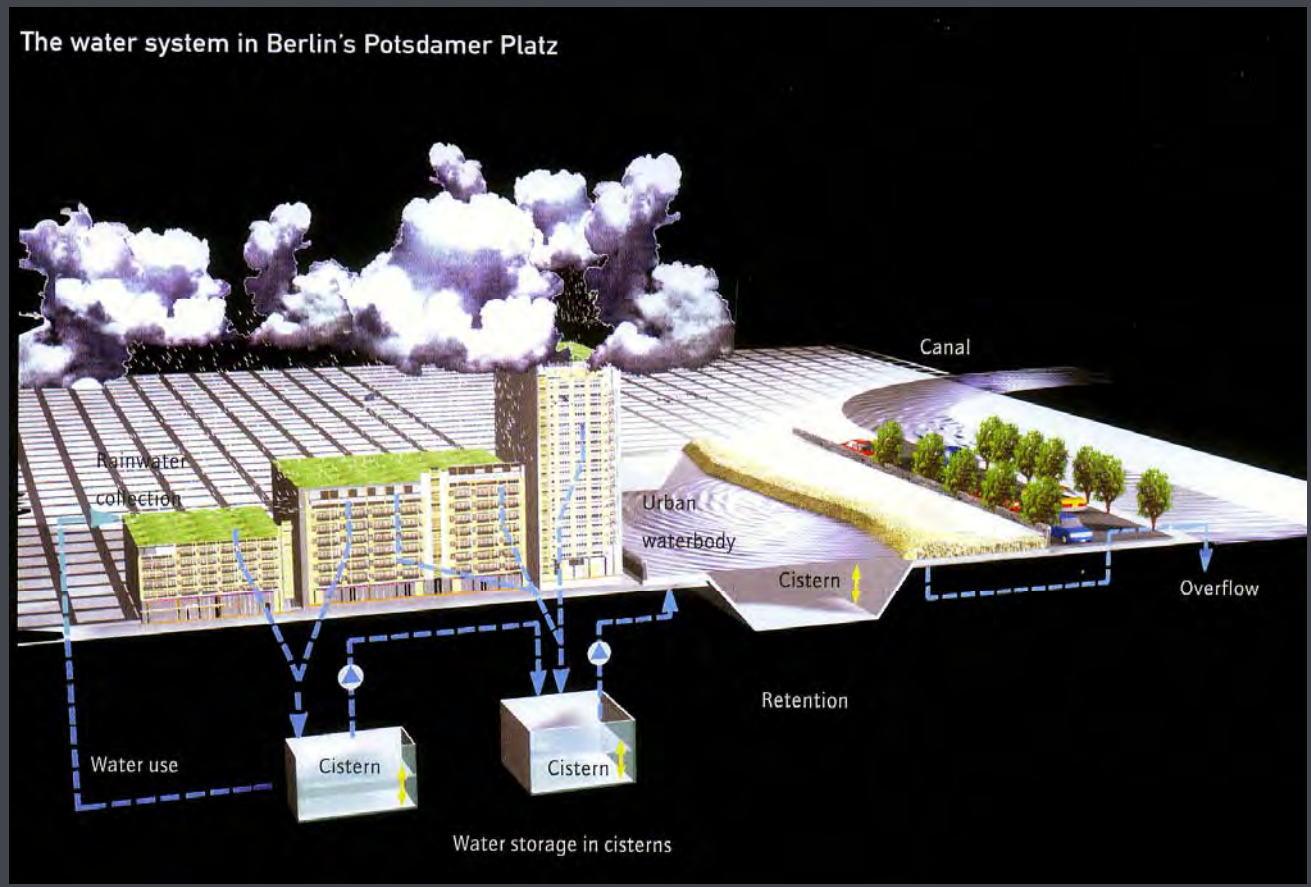
Millennium Park, Chicago

Key Bank, Portland

Active Rainwater Harvesting

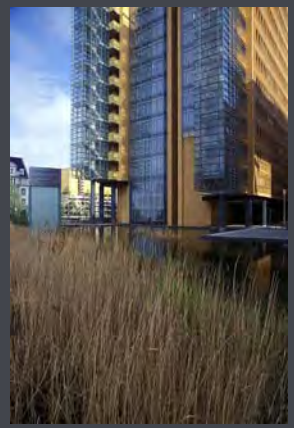
- Rainwater collection + storage → rainwater harvesting
- Store for later use.
- Use, treat water, infiltrate

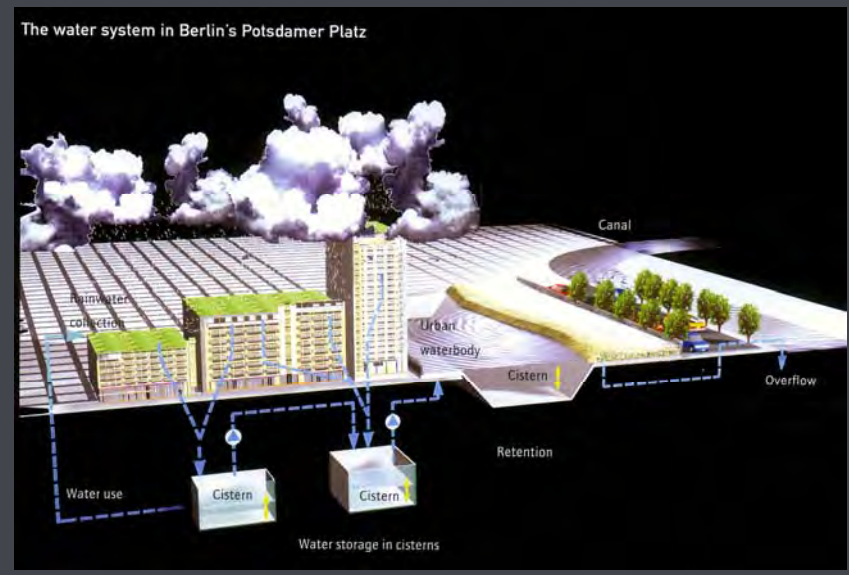
- → Hydrologic cycle



Herbert Dreiseitl

Active Rainwater Harvesting



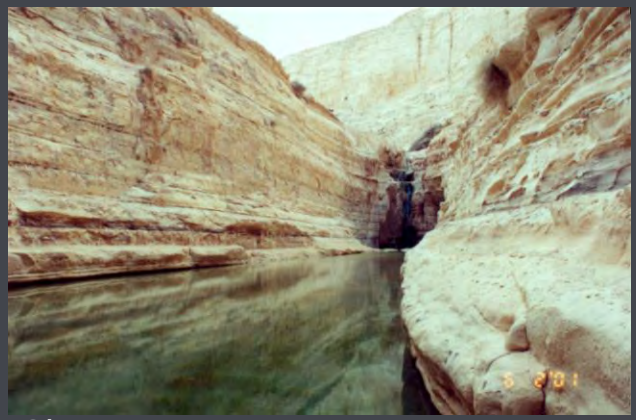


Daimler headquarters at Potsdamer Platz, Berlin

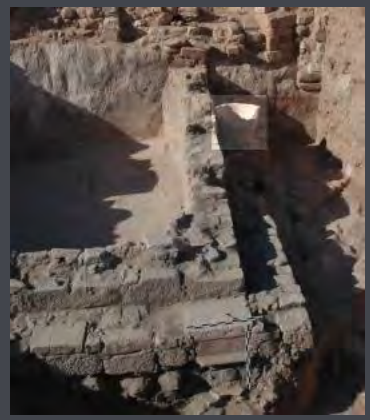
Irrigation of the land with seawater desalinated by fusion power is ancient.

It is called Rain.

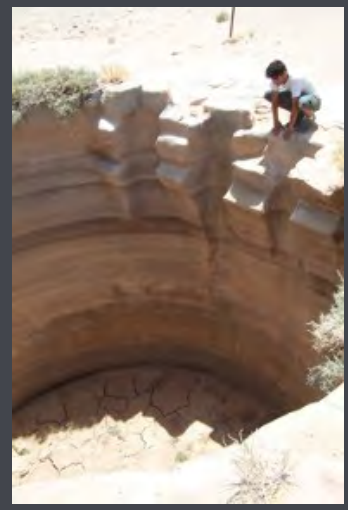
Michael McClary



Cistern, Negev Desert, 2000 BCE



Nabataean cistern, Upper Temenos, Petra

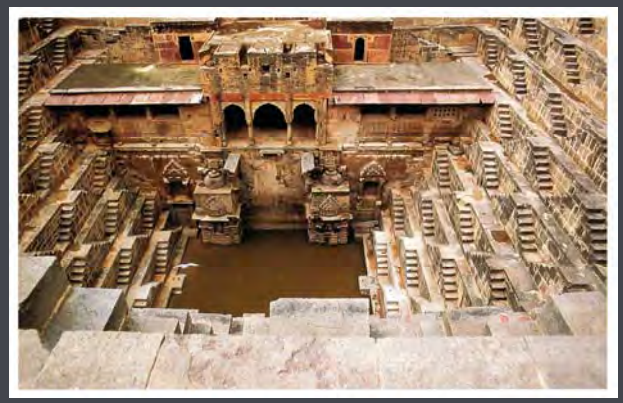


Nabataean cistern, Humeima

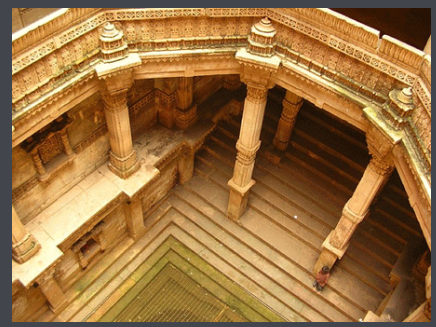
Nabataean cistern, Humeima

Cistern at Citadel, Amman, Jordan

Collecting rainwater is not a new idea.



Chand Baori Stepwell

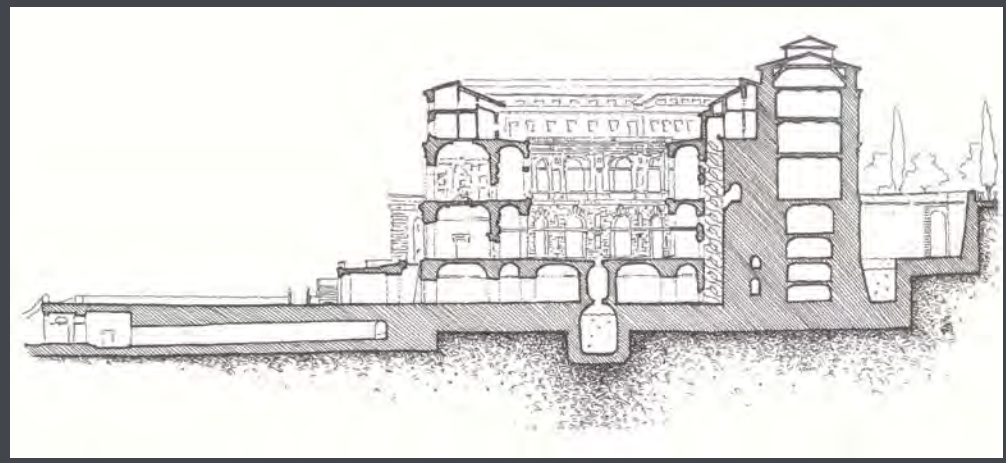


Adalaj Stepwell, Gujarat

Queen's Stepwell – 11th century CE
Patan, Gujarat

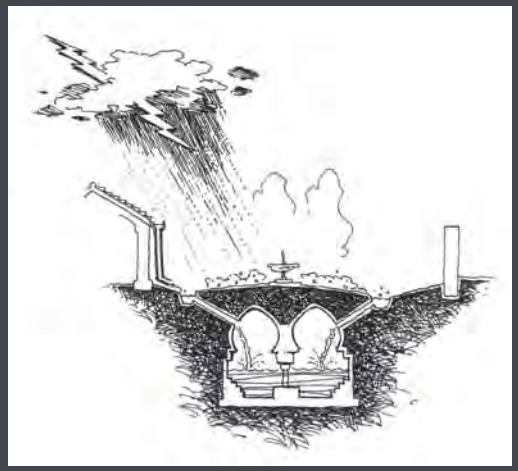
Cistern at Nahagarh Fort

Manueline cistern, El Jadida Portuguese fortress
Early 16th century

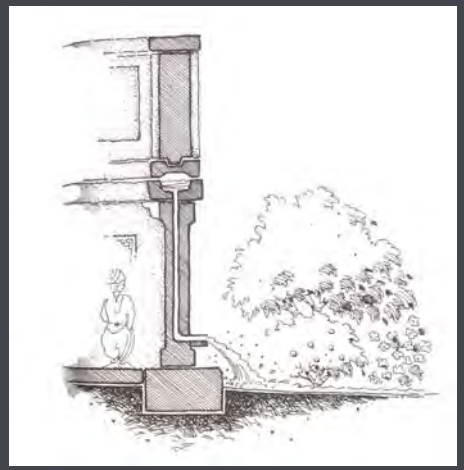


Villa Farnese
Caprarola, Italy

Renaissance architect Vignola designed the palace around the rainwater cistern.



Persian cistern

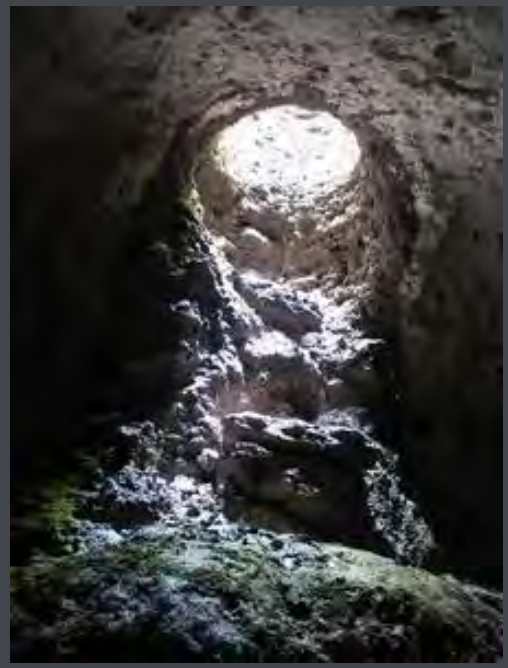


Distribution channel in Mughal palace walls

Drawings by Chip Sullivan

Mughal rainwater cistern at Fatehpur Sikri, India

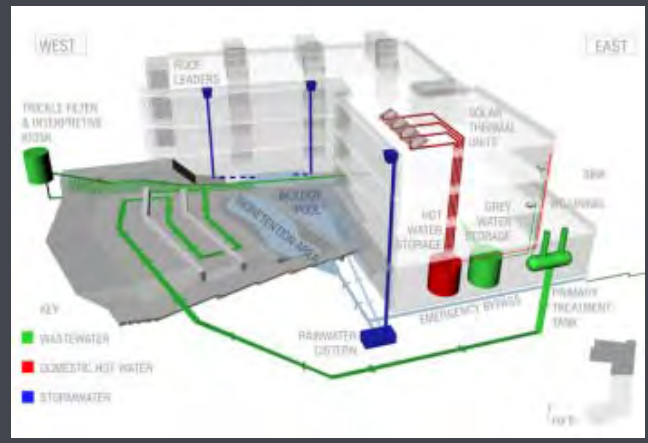
Frederick Catherwood painting, 1842



Cenote of Bolenchen Chultun
Yucatan Peninsula, 300 CE

Active Rainwater Collection

- “Potable water:” Water purified to drinking-water quality
- Less than half the domestic water use in buildings requires potable water.

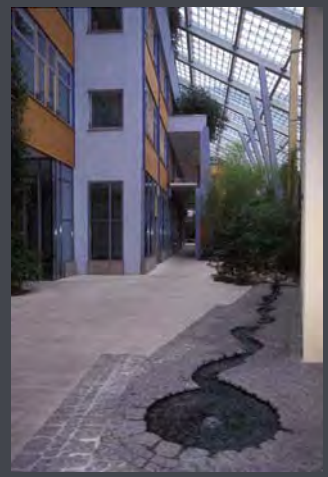


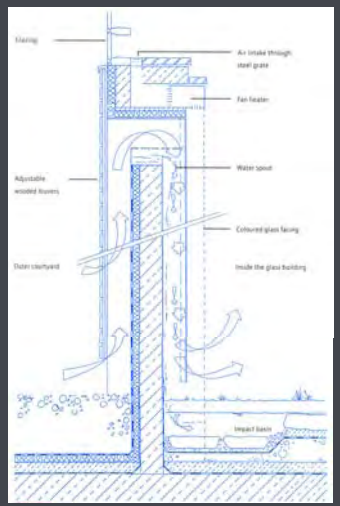
Andropogon, Landscape Architects

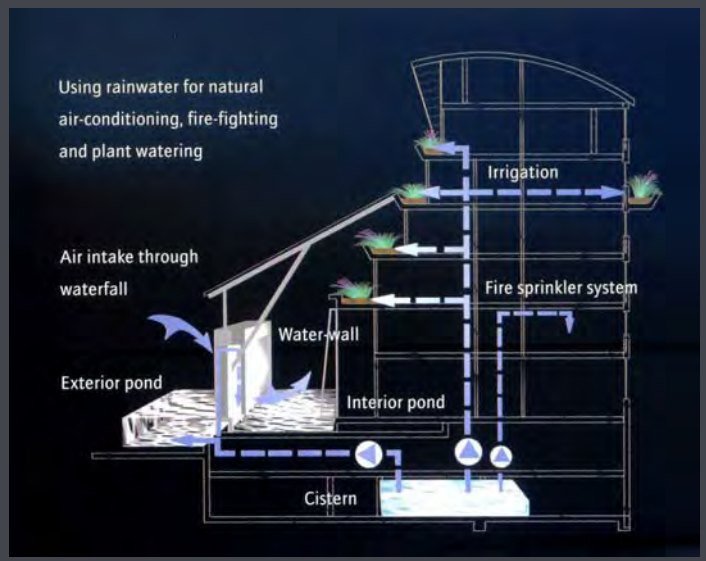
Sidwell Friends Middle School
Washington, D.C.

Active Rainwater Collection

- Rainwater used for cooling, fire sprinklers, plant irrigation





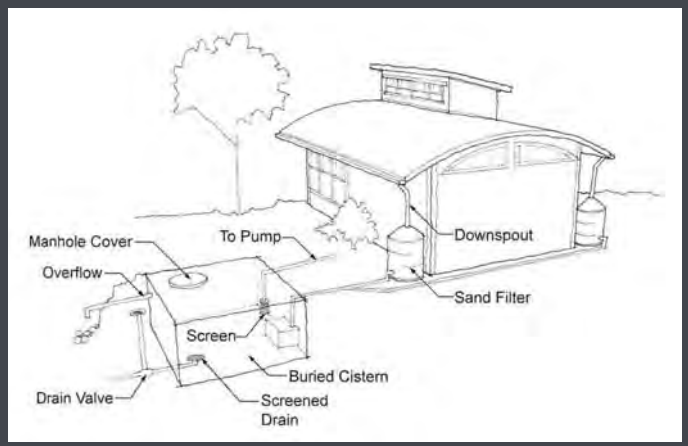


Herbert Dreiseitl

Prism Building, Nurenburg

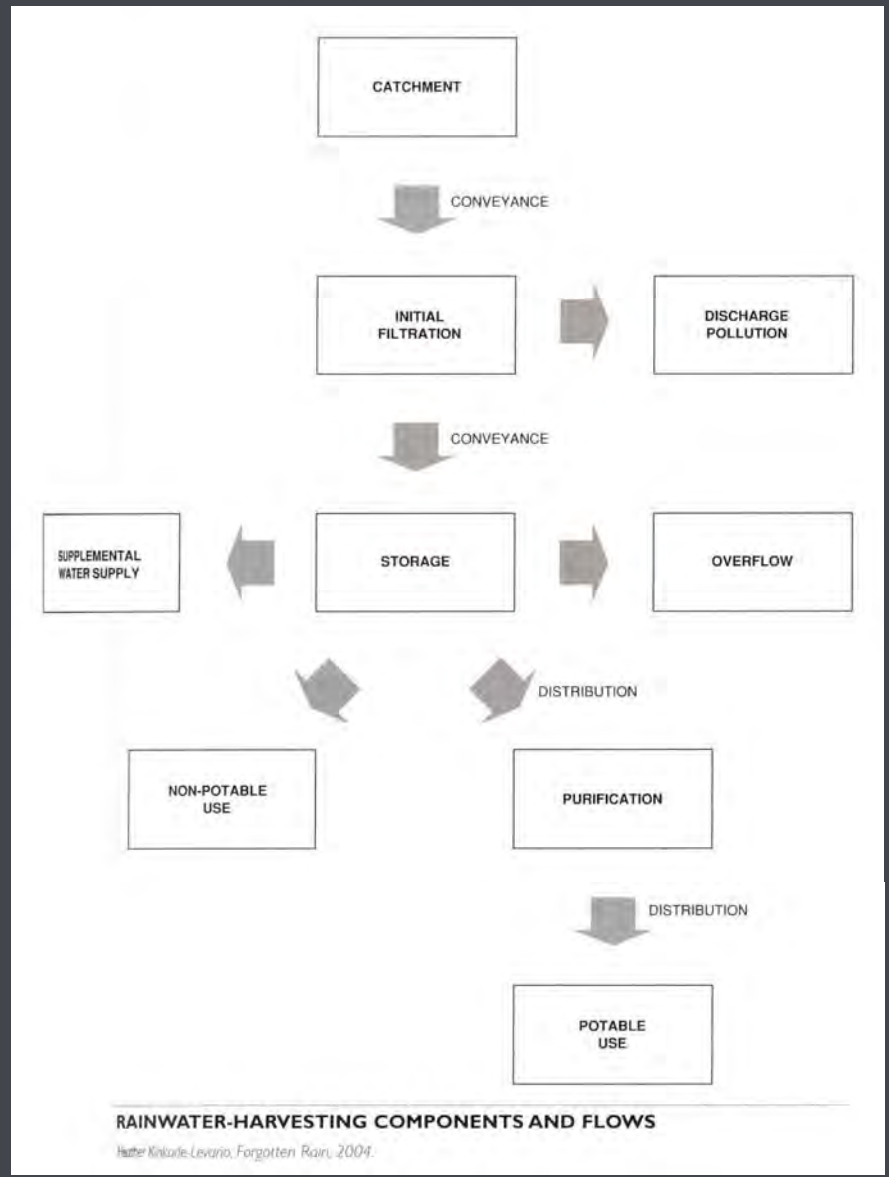
Six basic components:

- Catchment area
- Conveyance
- Filtration
- Storage
- Distribution
- Purification, if for potable use



Residential scale

Drawings by HOK Architects



Rainwater System Components

Catchment Area - Residential scale

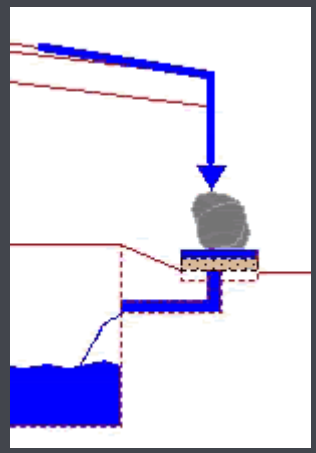
- Catchment: surface on which rain falls

Green Building pilot project
Eugene, Oregon

Residence by Glenn Murcutt, architect
South Australia

Rainwater System Components

Catchment Area - Residential scale

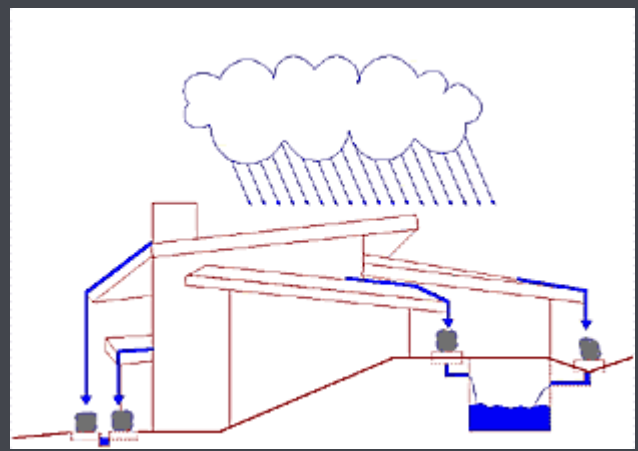


The Making of
Rainwater

Natives of the Netherlands, Anita Van Asperdt and Eimar Boesjes have built a Eugene house that celebrates their new homeland's most unique attribute: the rain.

BY TED KATAUSKAS
PHOTOGRAPHY BY DAVID BAZAZIAN

Eleven years ago, Eimar Boesjes quit his job as head of the computer-aided-design department at an architecture school in Amsterdam and moved to Oregon, ostensibly to establish an architectural software business. Ostensibly, because from the beginning, Boesjes intended to use the proceeds from his company to design and build a very special home.
His home.



Residence by Anita Van Asperdt and Eimar Boesjes
Eugene, Oregon

Rainwater System Components

Catchment Area

Ladybird Johnson Wildflower Center
Austin, Texas

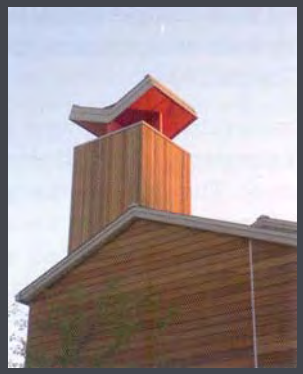
Rainwater System Components

Catchment Area

Winrock International Global Headquarters
Little Rock, Arkansas

Rainwater System Components

Catchment Area – Rainwater Supply for Cooling Towers



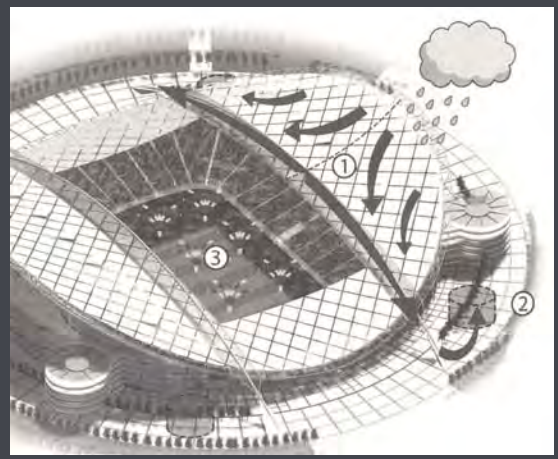
Global Ecology Research Center
Stanford University

Habitat Research and
Development Center – Namibia

Rainwater System Components

Catchment Area

Lewis Center, Oberlin College

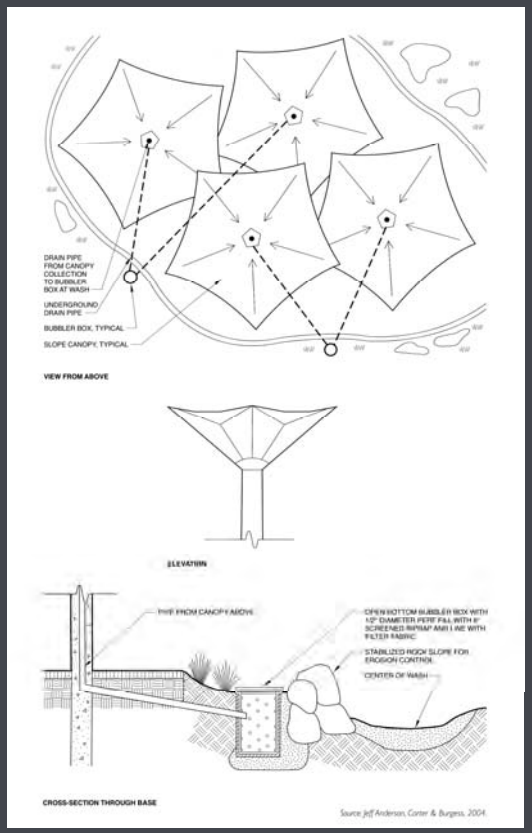


Telstra Stadium, Australia

Rainwater System Components

Catchment Area

Shade structure / rainwater catchment area
UC-Berkeley, California



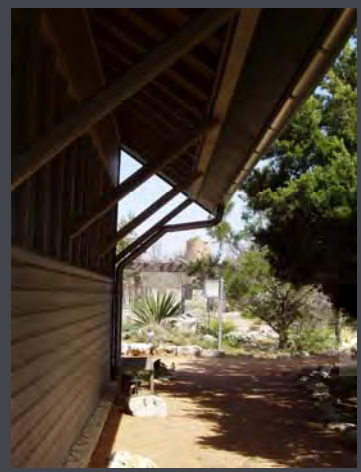
Shade structures / rainwater catchment areas
Papago Buttes Corporate Center
Phoenix, Arizona

Rainwater System Components

Conveyance

- Pipes or channels
- From catchment to storage

Ladybird Johnson Wildflower Center
Austin, Texas

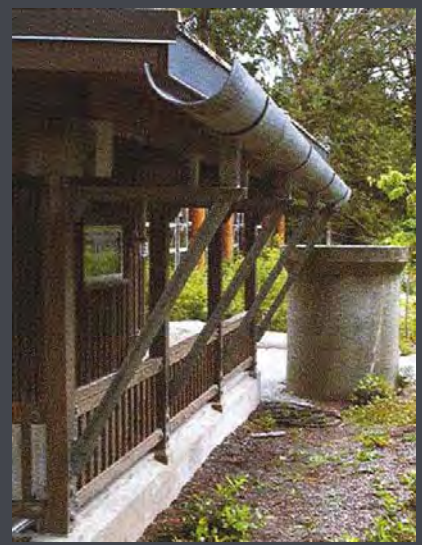


Rainwater System Components

Conveyance

Environmental Services Building
Pierce County, Washington

Newton Public Library
Surrey, B.C.



IslandWood Education Center,
Bainbridge Island, Washington

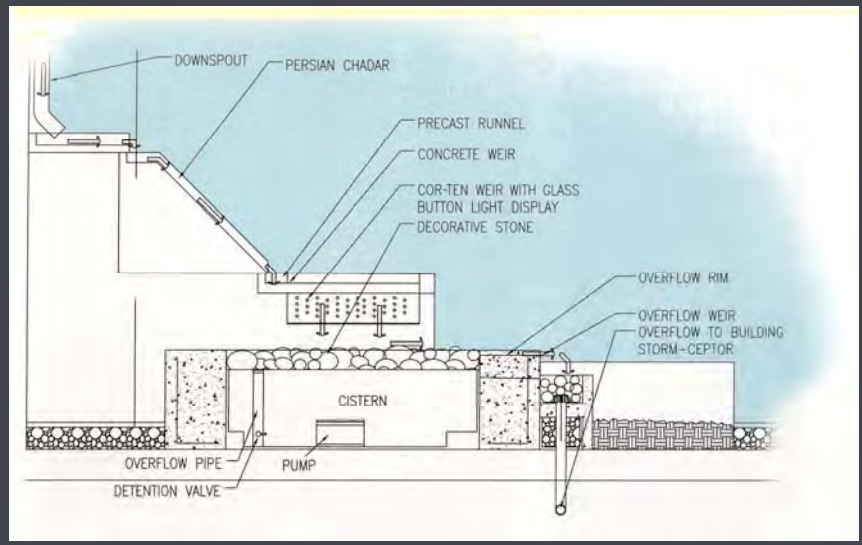
Rainwater System Components

Conveyance

Flanders Lofts
Portland, Oregon

Rainwater System Components

Conveyance



Stephen Koch, landscape architect

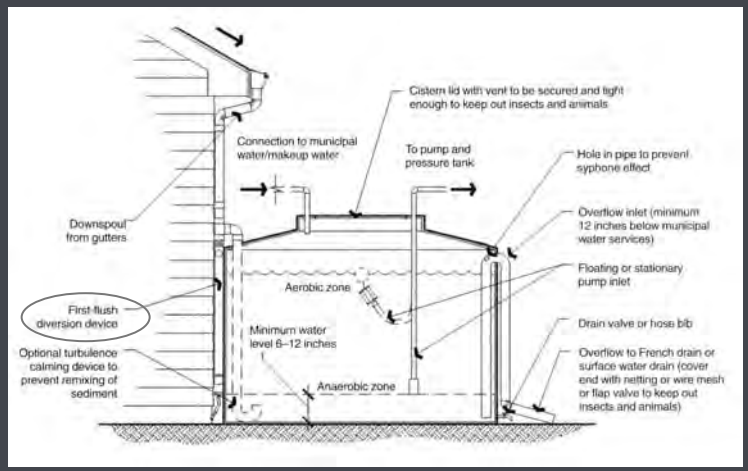
10th@Hoyt apartments
Portland, Oregon

Rainwater System Components

Filtration - Residential scale

- Roof washing
- Prefiltration
- Removes contaminants and debris

Tank + roof washer

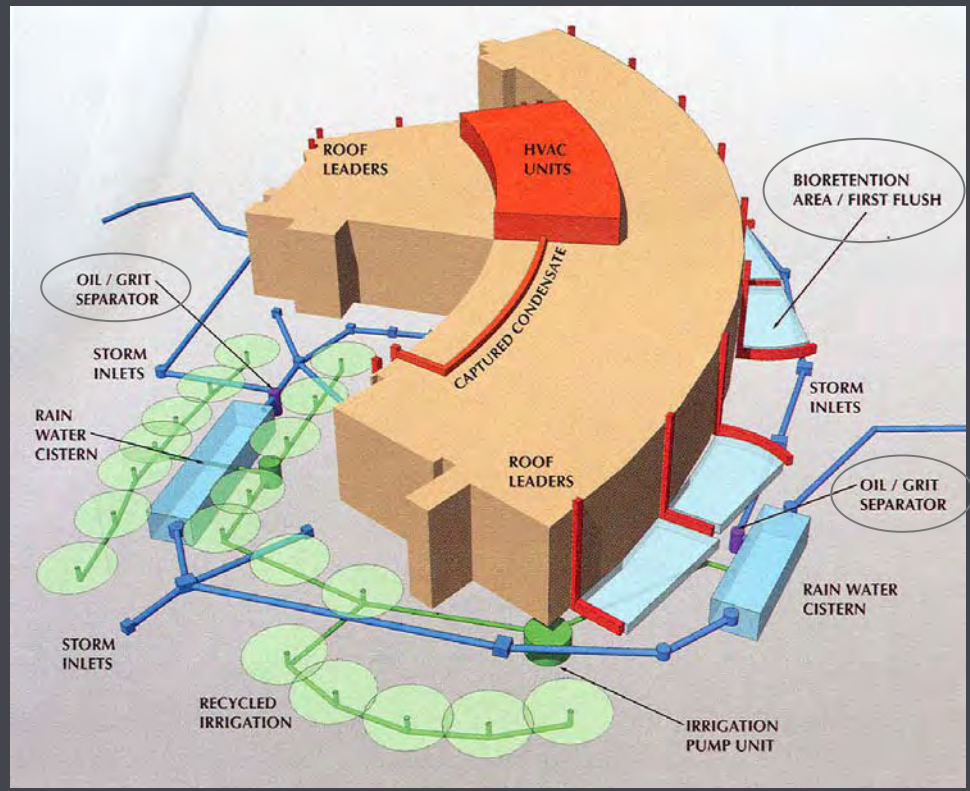


Landscape Architecture Magazine

First-flush downspout device

Rainwater System Components

Filtration - Institutional scale

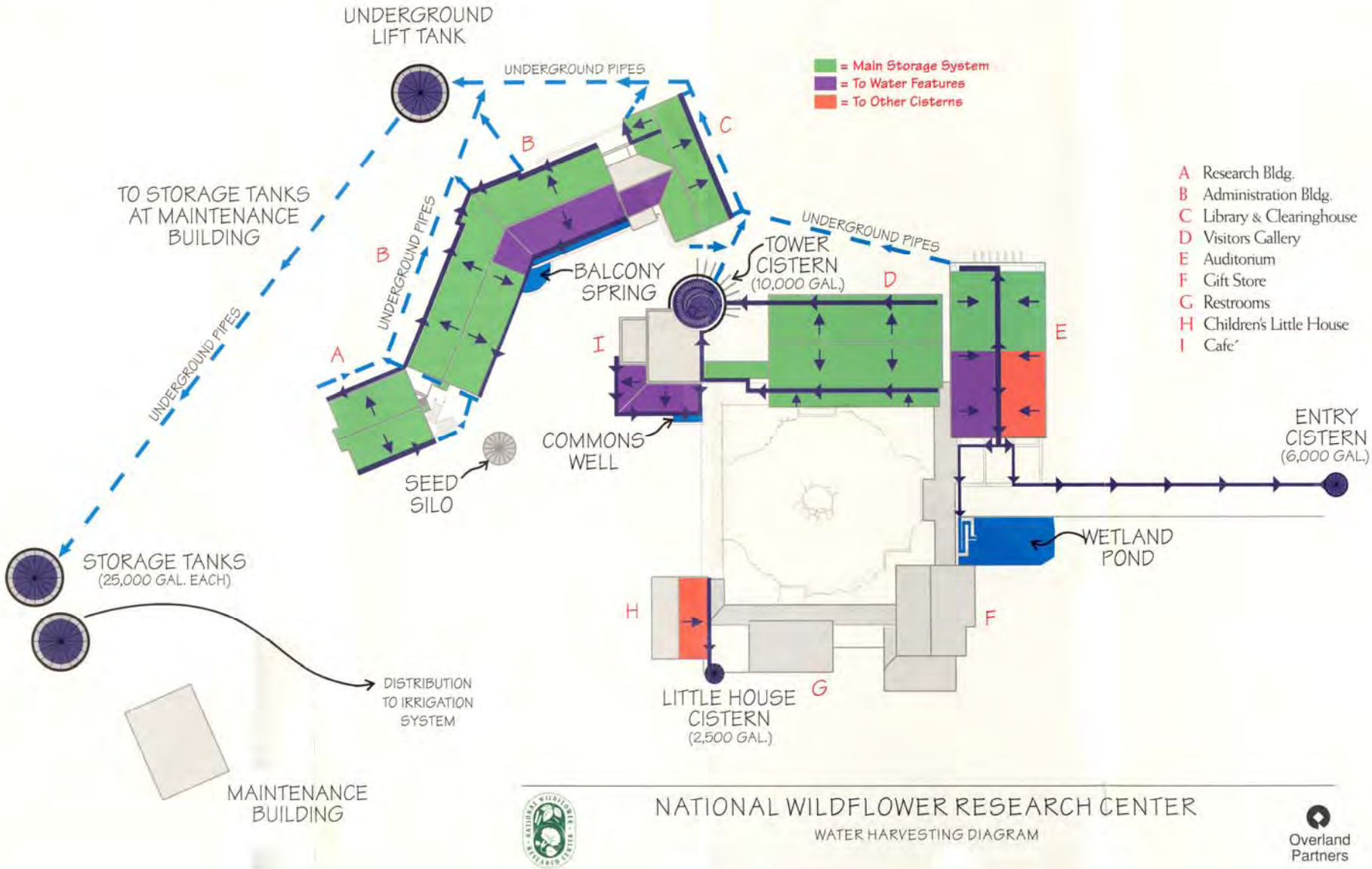


Georgia Institute of Technology
Christopher W. Klaus Advanced Computing Bldg.
and water reclamation center

Rainwater System Components

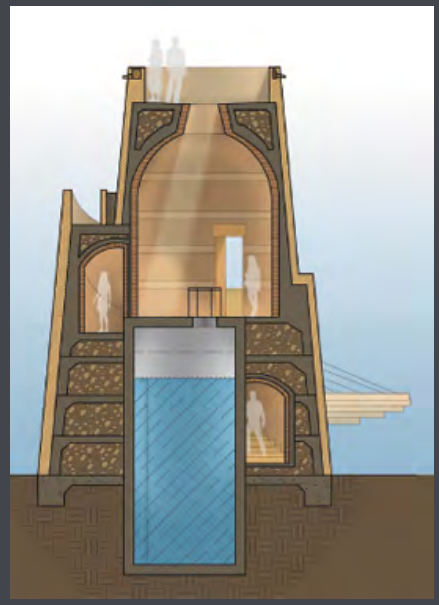
Storage

- Cisterns or tanks
- Locations:
  - Incorporated into building structure
  - Underground
  - Free-standing visible object


UNDERGROUND LIFT TANK
UNDERGROUND PIPES
= Main Storage System
= To Water Features
= To Other Cisterns
A Research Bldg.
B Administration Bldg.
C Library & Clearinghouse
D Visitors Gallery
E Auditorium
F Gift Store
G Restrooms
H Children's Little House
I Cafe´
TO STORAGE TANKS AT MAINTENANCE BUILDING
UNDERGROUND PIPES
UNDERGROUND PIPES
UNDERGROUND PIPES
BALCONY SPRING
TOWER CISTERN (10,000 GAL.)
COMMONS WELL
SEED SILO
ENTRY CISTERN (6,000 GAL.)
WETLAND POND
STORAGE TANKS (25,000 GAL. EACH)
DISTRIBUTION TO IRRIGATION SYSTEM
MAINTENANCE BUILDING
LITTLE HOUSE CISTERN (2,500 GAL.)
NATIONAL WILDFLOWER RESEARCH CENTER
WATER HARVESTING DIAGRAM
Overland Partners

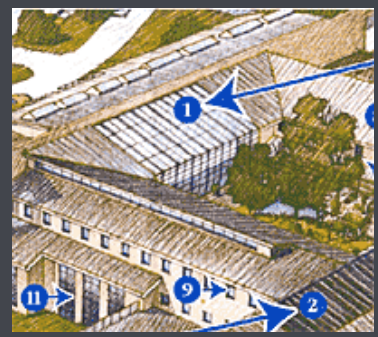
Cisterns

Ladybird Johnson Wildflower Center
Austin, Texas



Rainwater System Components

Storage - Incorporated into building structure



Mary Ann Colfrin Hall
University of Wisconsin

Rainwater System Components

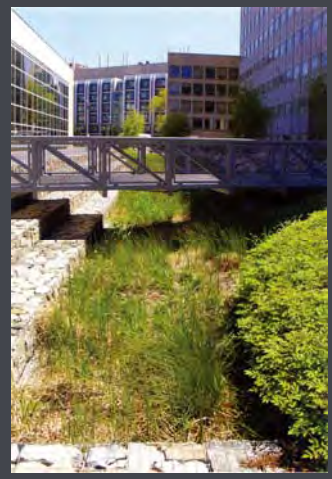
Storage - Underground

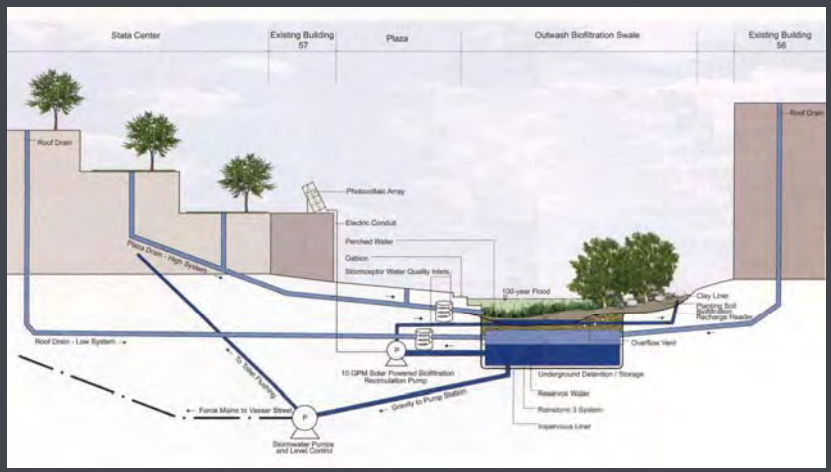
Georgia Institute of Technology
Christopher W. Klaus Advanced Computing Bldg.

Whitehead Biomedical Research Bldg.
Emory University, Atlanta

Rainwater System Components

Storage - Underground





Stata Center at MIT, Cambridge, Massachusetts

Rainwater System Components

Storage - Underground

Stephen Epler Residence Hall
Portland State University, Oregon

Rainwater System Components

Storage - Underground

Legislative Building
Raleigh, North Carolina

Seattle City Hall

National Assoc. of Realtors headquarters, Washington, D.C.

Rainwater System Components

Storage - Underground

Oregon Health Sciences University – Portland

Kelley Engineering Center
Oregon State University

Rainwater System Components

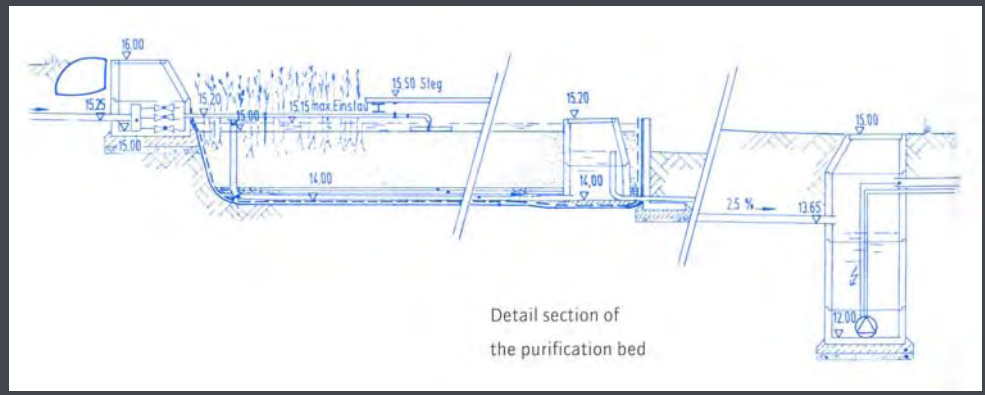
Storage - Underground

T. C. Williams High School
Alexandria, Virginia

USDA Research Facility – Maricopa County, Arizona

Rainwater System Components

Storage - Underground



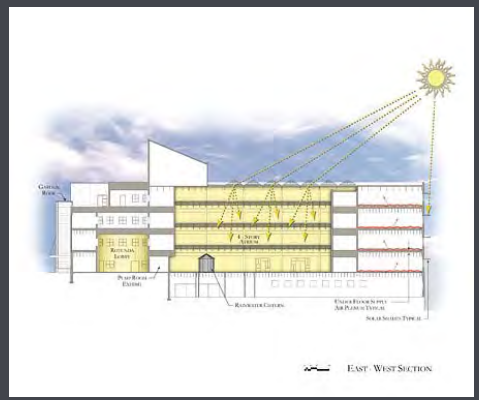
Detail section of the purification bed

Herbert Dreiseitl

Rainwater for bears
Zurich Zoo, Switzerland

Rainwater System Components

Storage - Visible



Dept. of Environmental Protection, SE region
Norristown, Pennsylvania

Philip Merrill Environmental Center
Chesapeake Bay Foundation
Annapolis, Maryland

Rainwater System Components

Storage - Visible

Residential development – Green Building pilot project
Eugene, Oregon

Rainwater System Components

Storage - Visible

Carkeek Park Environmental Learning Center
Seattle, Washington

(An opportunity missed?)

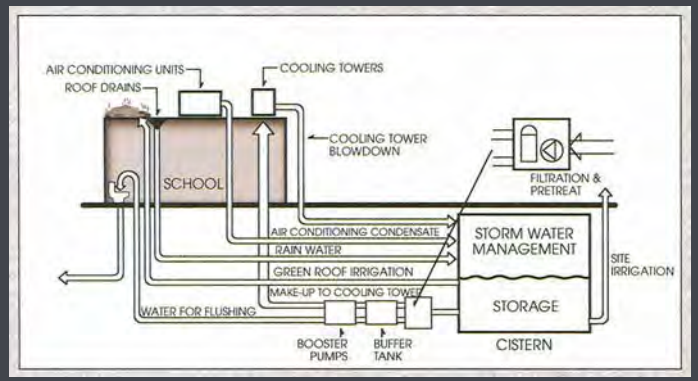
Vine Street - Seattle

Center for Maximum Potential Building Systems – Austin, Texas

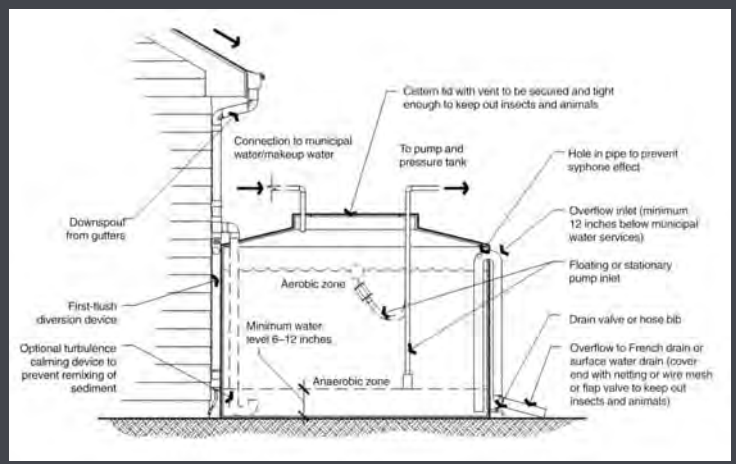
Rainwater System Components

Distribution

- Gravity or pumping
  - Water only flows downhill, unless you pump it.
- Floating extractor with filter
  - Cleanest water: 10-16” below surface

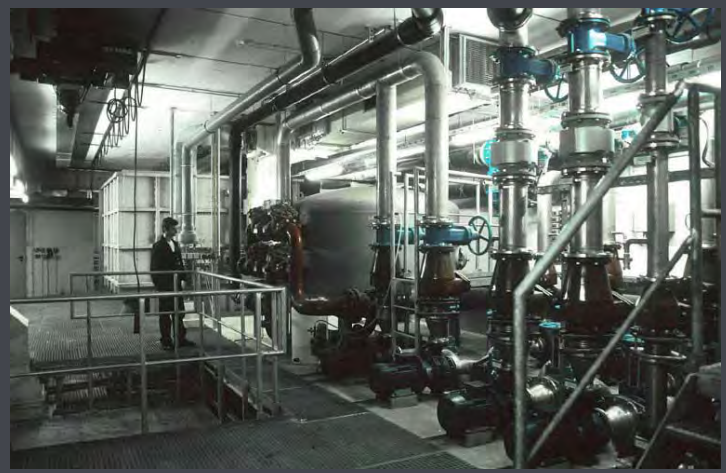


Stormwater Magazine



Landscape Architecture Magazine

Residential-scale tank



Potsdamer Platz pumping system

Rainwater System Components

Purification

- If for potable use
- Filters
  - Sediment filtration (5**µ**) +
  - 0.5**µ** carbon filtration or equivalent
- Disinfection
  - E.g., UV
  - Method requires National Sanitation Foundation (NSF) approval
- Buffering for pH control

Backflow Prevention

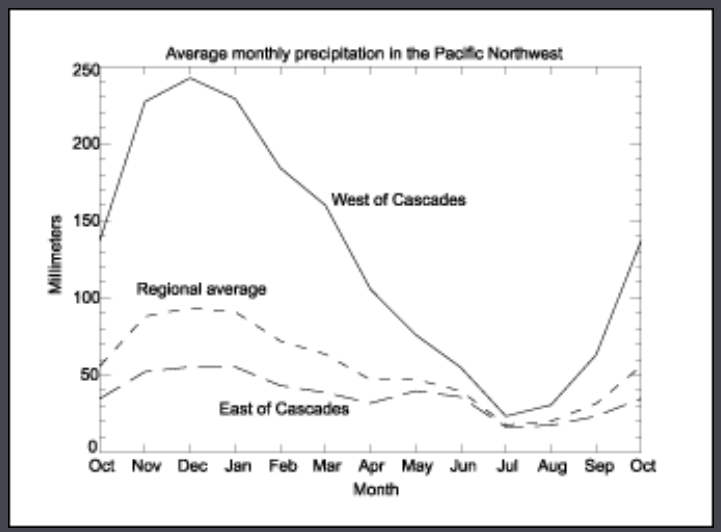
- If for potable use

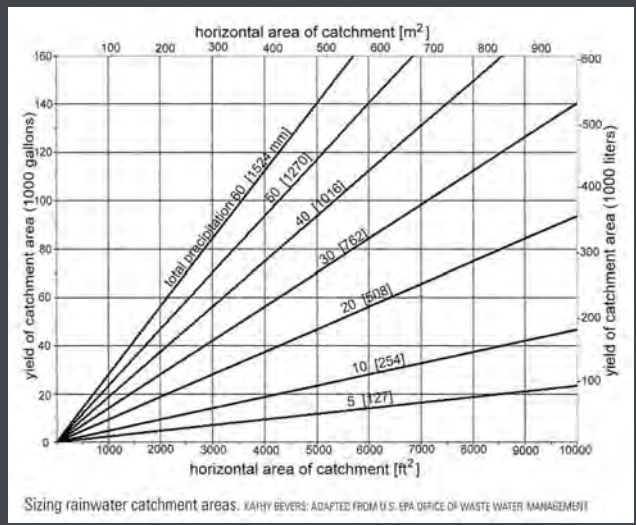
Sizing Rainwater Systems

- Calculate need
- Determine rainfall supply
- Month-by-month “Checkbook” method:
  - Cumulative water balance
  - Supplemental water needed

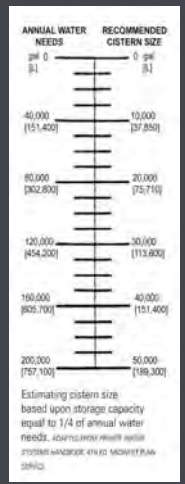
Sample Water Budget: Active System (Gallons)

Month	*R*	*I*	*W*	*S*	*X*
January	414	50	0	991	0
February	419	70	0	1,000	0
March	434	110	0	1,000	0
April	150	205	55	945	0
May	80	400	320	625	0
June	55	650	595	30	0
July	354	620	30	0	236
August	573	600	0	0	27
September	384	450	0	0	66
October	339	380	0	0	41
November	329	200	0	129	0
December	578	80	0	627	0
Annual	4,109	3,815	1,000		370



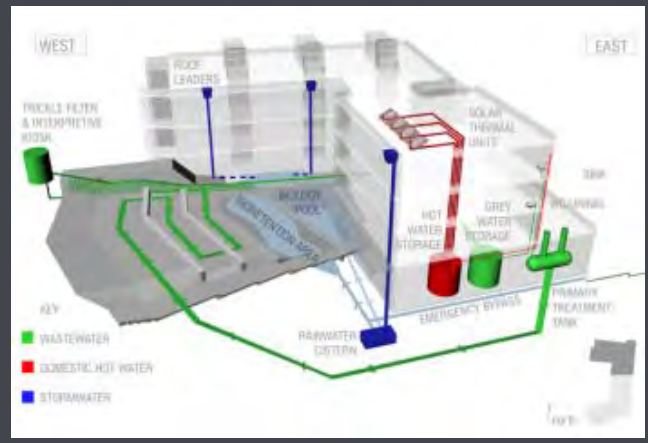


Sizing rainwater catchment areas. KATHY BEVERS; ADAPTED FROM U.S. EPA OFFICE OF WASTE WATER MANAGEMENT



Greywater Reuse

- Wastewater from laundry, showers, bathroom sinks
- Not kitchen water
- Not toilets



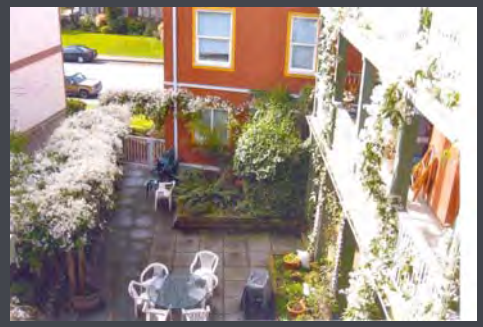
Andropogon, Landscape Architects

Sidwell Friends Middle School
Washington, D.C.

Greywater Reuse

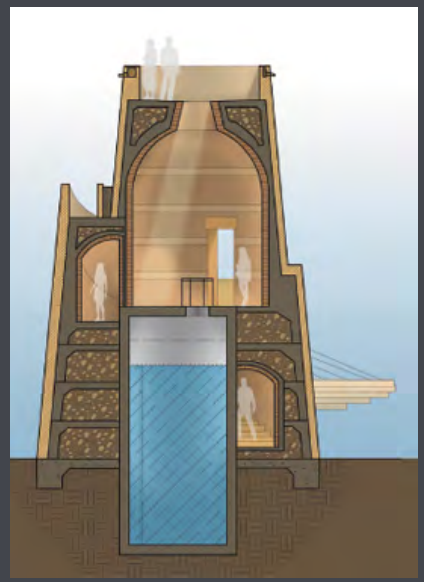
Natural Resources Defense Council
Santa Monica, California

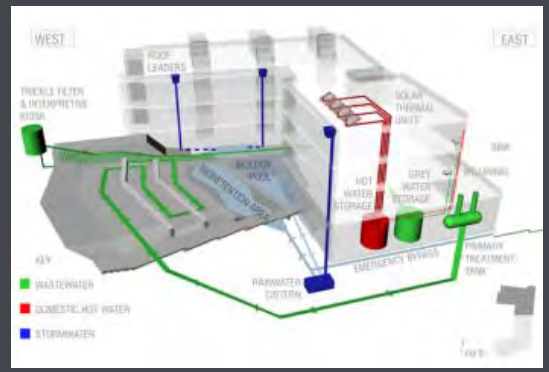
Greywater Reuse

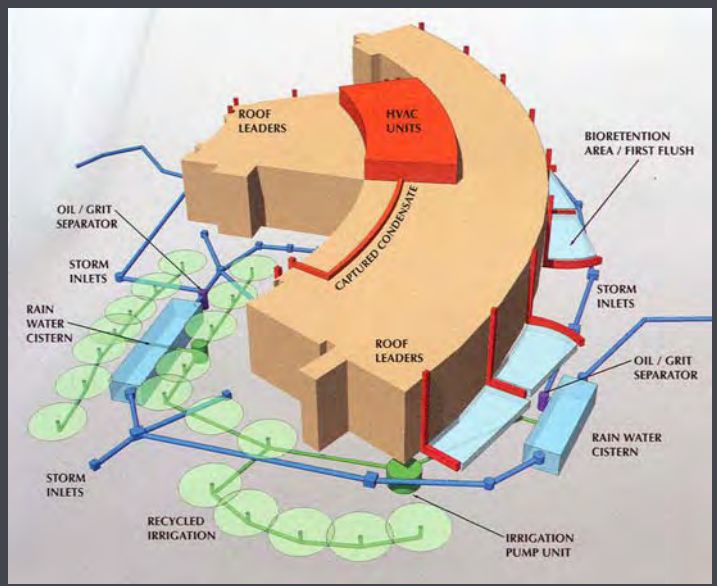


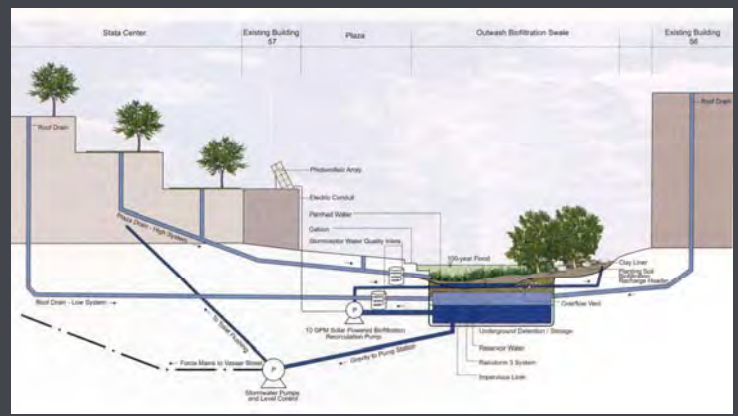
Quayside Village Cohousing Community
North Vancouver, British Columbia

Water = Resource









Questions?

Margaret Robertson robertsonm@lanecc.edu