Cisterns for Rainwater Re-Use

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SYSTEMS THINKING
Need to think differently about the problem...

- Whole System Design
  - "Site & Project" Relationships
- Integrated Design
  - "Design" Relationships
- Sustainable Design
  - Materials & Systems (relationships)

SYSTEMS THINKING
All Water is a Potential Source...

SYSTEMS THINKING
Water Management vs. Water Supply...

SYSTEMS THINKING
Potential Water Sources – Semantics are Important

Water Resources Defined
- Potable Water (Drinking)
- Stormwater (General rainwater run-off from sites)
- "Waste" water (An out-dated term; all types of water are considered resources)
  * Blackwater (Toilet water)
  * Greywater (Sinks, showers, laundry, etc.)
  * Combined Water (Blackwater & greywater)
- Rainwater (Roof run-off)
- Reclaimed Water (Treated water)

LEED
Water Efficiency

2. Innovative Wastewater Technologies (1)
3. Water Use Reduction (2)
**Introduction**

- Rainwater is a clean water source available at the site.
- Treatment provided by large-scale distillation process.
- Storage costs challenge the economics.
- Current water rates do not justify much in the way of water conservation.
- Utility incentives may be available.
- Systems can pay for themselves in some cases.

Not a new idea, been done for centuries.

In many areas rainwater harvesting is commonplace.

Many jurisdictions support or require Rainwater Harvesting.

- States of Texas, California, Hawaii allow rainwater catchment.
- City of Portland, Oregon allows rainwater catchment.
- San Juan County, Washington permits rainwater catchment systems for new construction.
- Bermuda and US Virgin Islands require the use of cisterns in all new construction.
- In rural Australia rainwater catchment is very common.

**Major System Types**

- In this brief talk we are covering two topics with competing needs...
  - Rainwater Re-use cisterns for water conservation *(tries to make tank full)*
  - Stormwater detention cisterns for flow-control during storms *(tries to make tank empty)*
  - Hybrid systems are possible, but they require seasonal changes in operation in this climate.

**Primary System Components**

- Catchment
- Pre-Treatment
- Storage
- Treatment
- Distribution/Use
- Re-Use
- O&M
- Education

**Standards, Guidelines, and Regulations**

- California Re-Use Standard (Title 20 of the CA public utilities code)
- New Guidelines from State Building Codes Council (CEDS 3316.3 PERMISSIVE RAINWATER HARVESTING SYSTEM GUIDELINES FOR NON-RESIDENTIAL OCCUPANCIES)
- WSDOH / WSDOE Re-Use Guidelines
- Texas Guide to rainwater harvesting
- San Juan County, WA
- City of Portland "Code Guide"

Stormwater charges are reduced a minimum of 10% if rainwater is used (RCW 36.89.080, RCW 86.15.160, etc.)

A note about Water Rights...
RAINWATER HARVESTING
System Design: Re-Use
- Supply, Demand, and Storage Sizing
  - Catchment Area
  - Storage Volume
  - Seasonal/Daily Supply and Demand
- Treatment
- O&M
- Education

RAINWATER HARVESTING
System Design: Stormwater
- Typically sized for a particular design event, say the 2-year storm
- Seasonal operational changes may be needed
- The design of these small volumes (300-3,000 gallon) can be very sensitive to orifice size
- Design depends location in the basin (i.e. do not detain in the lower reaches)

Component Design: Catchment and Storage
- Controlled Catchment Area
- Course Pre-Treatment
- Cistern Storage Tank
  - Underground Concrete (CIP, or Pre-Cast)
  - Underground Fiberglass
  - Partial Bury Plastic
  - Above Ground Plastic
  - Above Ground other (recycled stainless steel, etc.)
- Structural Considerations (geotechnical, seismic, etc.)

Component Design: Catchment and Storage
Many types of tanks are available:
- $0.50/gal - $4-6/gal

Component Design: Pumping and Water Quality
- Treatment Depends on Use
- WSDOE / WSDOH Re-Use Guidelines define Class A, B, C, D Reclaimed water (focused on municipal wastewater re-use)
- Filtration (Sand Filter, Cartridge Filter, etc.)
- Disinfection (UV, Ozone, Chlorine)
- Cross-Connection (6”Air-gap or Double Check Valve Reduced Pressure Backflow Prevention Device)
Per local stormwater management code
- Re-Use (conservation) system design assumes tank is full and therefore storm is un-detained
- Therefore another retention/detention Best Management Practice (BMP) may be required (same as what would be required of a downspout)
- Prefer Low-Impact Development (LID) BMP’s
- Stormwater cisterns are the BMP....

Local Public Buildings with Toilet Flush and Irrigation Systems
- King Street Center (re-use for toilet flushing)
- Seattle Central Library (re-use for irrigation)
- Seattle City Hall (retrofit for irrigation and fountain) (under construction)
- Cascade Eco-Renovation at the Cascade Neighborhood Center and P-Patch (re-use for toilet flushing and irrigation) (in design)
- Portland State University dorm (toilet flushing)
- Others...

Industrial Re-Use at local composting facilities
- Skagit Soils
  - Eliminated contaminated run-off
  - Eliminated the need for a costly water line extension
- NAS Whidbey Composting Facility
  - Re-used captured roof water in a recycled tank to balance moisture content in in-vessel compost units (conservation)

Large centralized CSO tanks are expensive (~$5-8/gallon)
Small decentralized CSO tanks are less expensive ($0.30 - $1/gallon)
Small decentralized allow seasonal re-use for irrigation or other uses
Maintenance and modeling issues

Bainbridge Island, WA, under construction
Rainwater as source of irrigation water for small market garden
- 1,100 sf roof, 18,000 gal. Storage, 5,000 sf market garden irrigation
- Rain garden Bioretention Area for overflow, meets COBI stormwater requirements
**RAINWATER HARVESTING**

**Commercial Hybrid Example Project**
- Bayview Corner Public Restroom Building – Rainwater Collection for toilet flushing
- Serves a Farmers Market and Plant Nursery
- Combines other strategies to be essentially “off the water grid”

**RAINWATER HARVESTING**

**Residential Potable Water Example Project**
- Swinomish Indian Reservation, Skagit County, WA, built 1999
- Rainwater as sole source of potable water
- 1,600 sf metal roof, 5,600 gal. Storage, 2 people, 20/5 micron cartridge filtration, 1/0.5 micron carbon at taps, UV disinfection
- Composting toilets & small greywater re-use system

**RAINWATER HARVESTING**

**Residential Potable Water Example Project**

**WATER EFFICIENCY**

**Ecological “Waste”water Treatment and Re-Use**
- Subsurface Drip Irrigation

**WATER EFFICIENCY**

**Water Conserving Fixtures**
- Waterless Urinals
- Dual Flush Toilets
- Washing Machines
- Fixtures
- Drought Tolerant Landscaping

**WATER EFFICIENCY**

**Commercial Pool Filter Water Re-Use Economics**
- Estimate of Filter Backwash:
  - Leisure Pool = 8,100 Gallons / 7 days = 1,157 GPD
  - Lap Pool = 4,050 Gallons / 7 days = 578 GPD
  - Whirlpool = 1,060 Gallons / 7 days = 151 GPD
  - 1,886 GPD (Average)
  - (~ 688,000 Gallons Per Year)

- Estimate of Daily Savings for Re-Use:
  - $2,473 per year (Governmental rate)
  - $3,572 per year (Commercial Rate)

- Capitalization:
  - $38,046 @ 6.5% (Gov.)
  - $54,953 @ 6.5% (Commercial Rate)

- 20-year Payback:
  - $49,460 (Gov.) or $71,440 (Commercial)

- City of Vancouver Combined Water and Sewer Rate
  - $0.0036 per gallon (Governmental Rate)
  - $0.0052 per gallon (Commercial Rate)

- **Water Conserving Fixtures**

- **Drought Tolerant Landscaping**

- **Composting Toilets**

- **Dual Flush Toilets**

- **Washing Machines**

- **Fixtures**