



# Rainwater Harvesting

2016 KSA Annual Conference  
June 30, 2016

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# Contech Engineered Site Solutions



Bridges, Drainage, Stormwater Management, Erosion Control, Structures, Retaining Walls, Roadway & Earth Stabilization



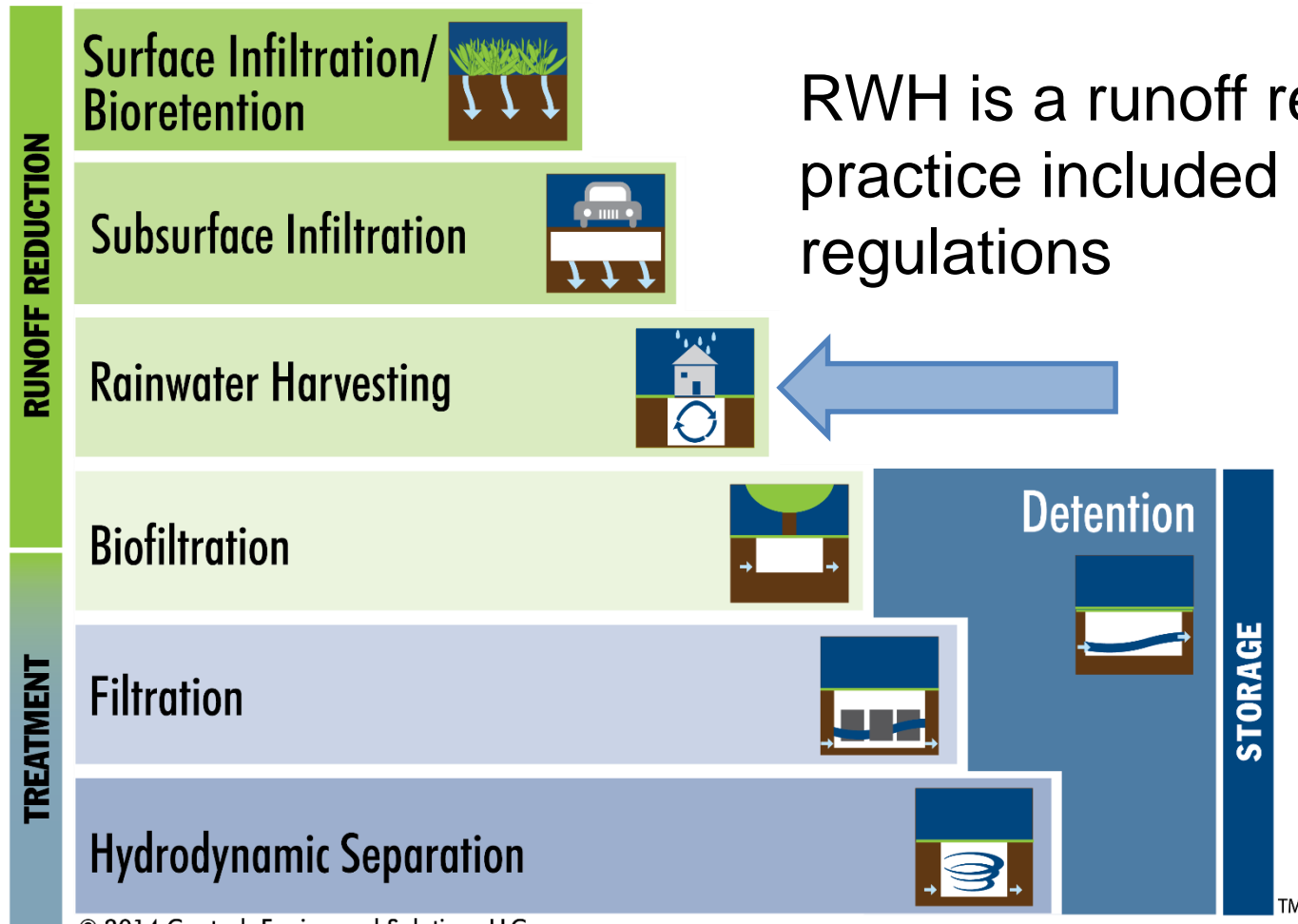
# Agenda

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- RWH as a Runoff Reduction Tool
- System Components
- Design Considerations
- Calculating Benefits



# Stormwater Staircase



RWH is a runoff reduction practice included in many LID regulations

# Divided Water Management

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**DRINKING**

**STORM**

**WASTE**

## Harvesting as LID

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*Traditional Water Harvesting is the collection and reuse of stormwater, grey water, and other sources to **reduce or eliminate the consumption of municipal potable water.***



***Water Harvesting for LID is the collection and reuse of stormwater for beneficial purposes to **reduce or eliminate post-construction runoff.*****

# RWH – Two Perspectives

	Conservation Focus	Stormwater Focus
<b>Primary Goal</b>	Reduced municipal demand	Eliminate runoff (pollution prevention)
<b>Secondary Benefits</b>	Reduce SW Runoff, Energy, CO <sub>2</sub>	Conservation, Energy, CO <sub>2</sub>
<b>Catchment Area</b>	Maximize, to Increase Supply	Minimize, to Reduce Supply
<b>Water Usage</b>	Minimize and Conserve	Find Reuse Applications
<b>Seasonal Challenge</b>	Dry Season – not enough rain	Wet Season – too much rain
<b>Cistern Goal</b>	Keep it full	Empty it quickly
<b>Economic ROI</b>	Negative – “external costs” not included in market price of water	Positive – best LID solution in many cases

# Rainwater Harvesting & LEED

Sustainability Sites		
6.1 Stormwater Quantity	Pre-development peak & quantity	1 pt
6.2 Stormwater Quality	Reduce annual TSS by 80%	1 pt

Water Efficiency		
1.0 Water Efficient Landscaping	Reduce by 50%	2 pt
	No Potable Use	4 pt
2.0 Innovative Wastewater	Reduce potable water used for sewage	2 pt
	50% onsite treatment	2 pt
3.0 Water Use Reduction	30% reduction from Baseline	2 pt
	35% reduction from baseline	3 pt
	40% reduction from baseline	4 pt



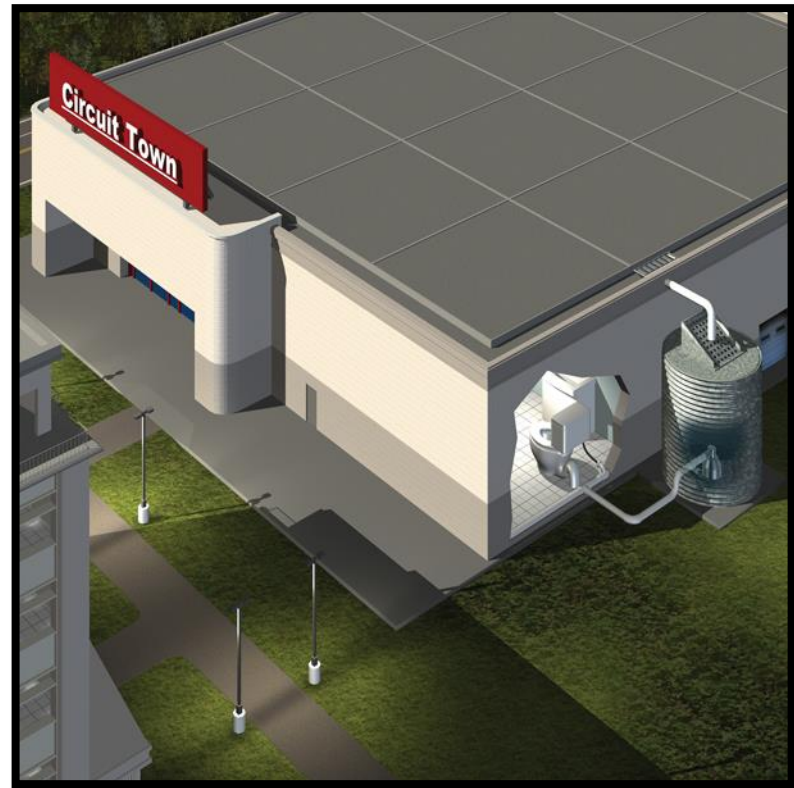
## Rainwater Harvesting & LEED

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LEED Credits	
SS 6.1 (Quality)	1
SS 6.2 (Quantity)	1
WE 1 (Irrigation)	4
WE2 (Wastewater)	2
WE 3 (Indoor water)	4
Maximum Total	12

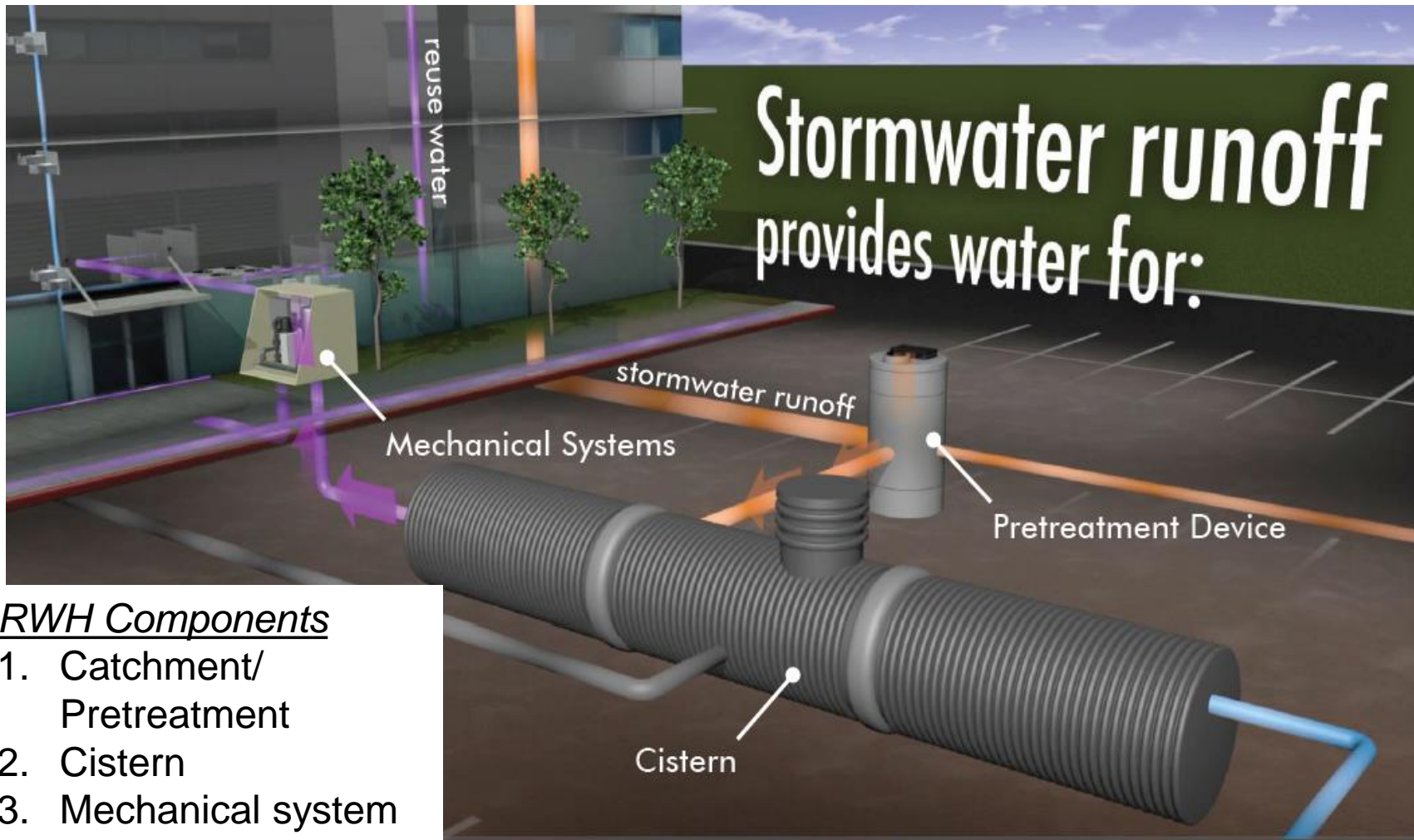
# Runoff Reduction: Beyond Irrigation

- **For Runoff Reduction**
  - Find reuse applications during wet season
  - Irrigation may not be enough to offset runoff
- **Applications**
  - Irrigation
  - Toilet flushing
  - Clothes washing
  - Vehicle washing
  - Cooling Makeup
  - Process Water
  - *May total 90+% of total water usage*



# Typical System Components

# RWH: Complete System Components



## RWH Components

1. Catchment/  
Pretreatment
2. Cistern
3. Mechanical system

# System Components: Catchment & Pretreatment

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Catchment

Pretreatment

Storage

Makeup H<sub>2</sub>O

Pumps

Treatment

Disinfection

Controls

## Catchment

- Rooftop – cleaner, needs treatment
- Surface – more pollutants

## Pretreatment

- Reduce maintenance
- Protect downstream equipment
- Reduce organic matter
- Reduce potential for odor
- Screening: 500 um to 2000 um
- Filtration/Separation: 20um to 200um



# Programmable First Flush & Pretreatment

## Passive First Flush Diversion

- Volume proportional to catchment area
- Bypasses each time it starts to rain
- Can be 5%-40% of annual runoff



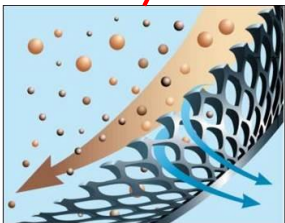
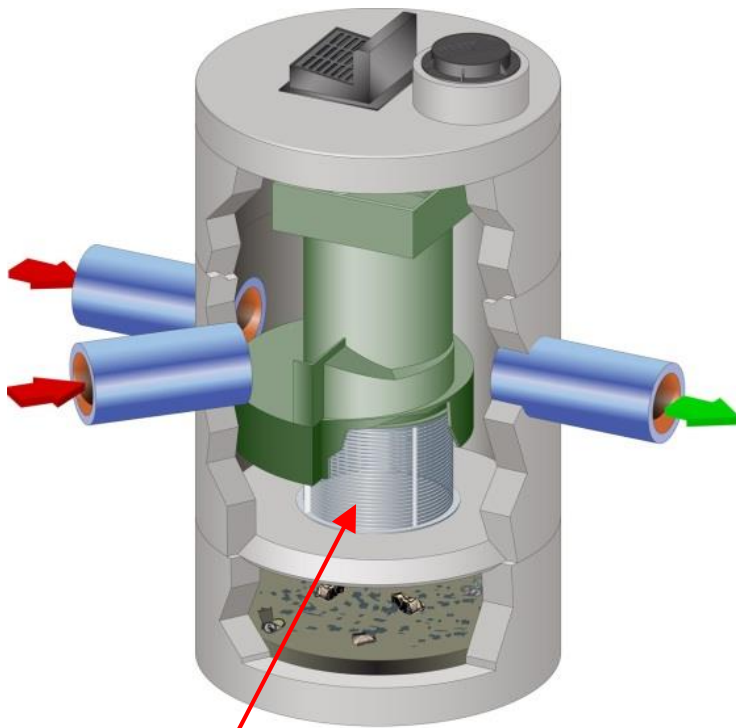
## Active First Flush Diversion

- Set rainfall depth and time duration
- Bypasses only when necessary
- <5% of the annual runoff volume



# Pretreatment

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Continuous Deflection self cleaning 2.4mm screen

- Swirl Concentration and continuous deflection separation
- 100% capture of floatable debris
- Sediment removal to 100 micron
- Up to 1 cfs treatment capacity
- Up to 5.6 cubic yard storage capacity
- H-20 Traffic rated
- 100% capture of harvested water with no first flush diversion

# System Components: Storage

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Catchment

Pretreatment

**Storage**

Makeup H<sub>2</sub>O

Pumps

Treatment

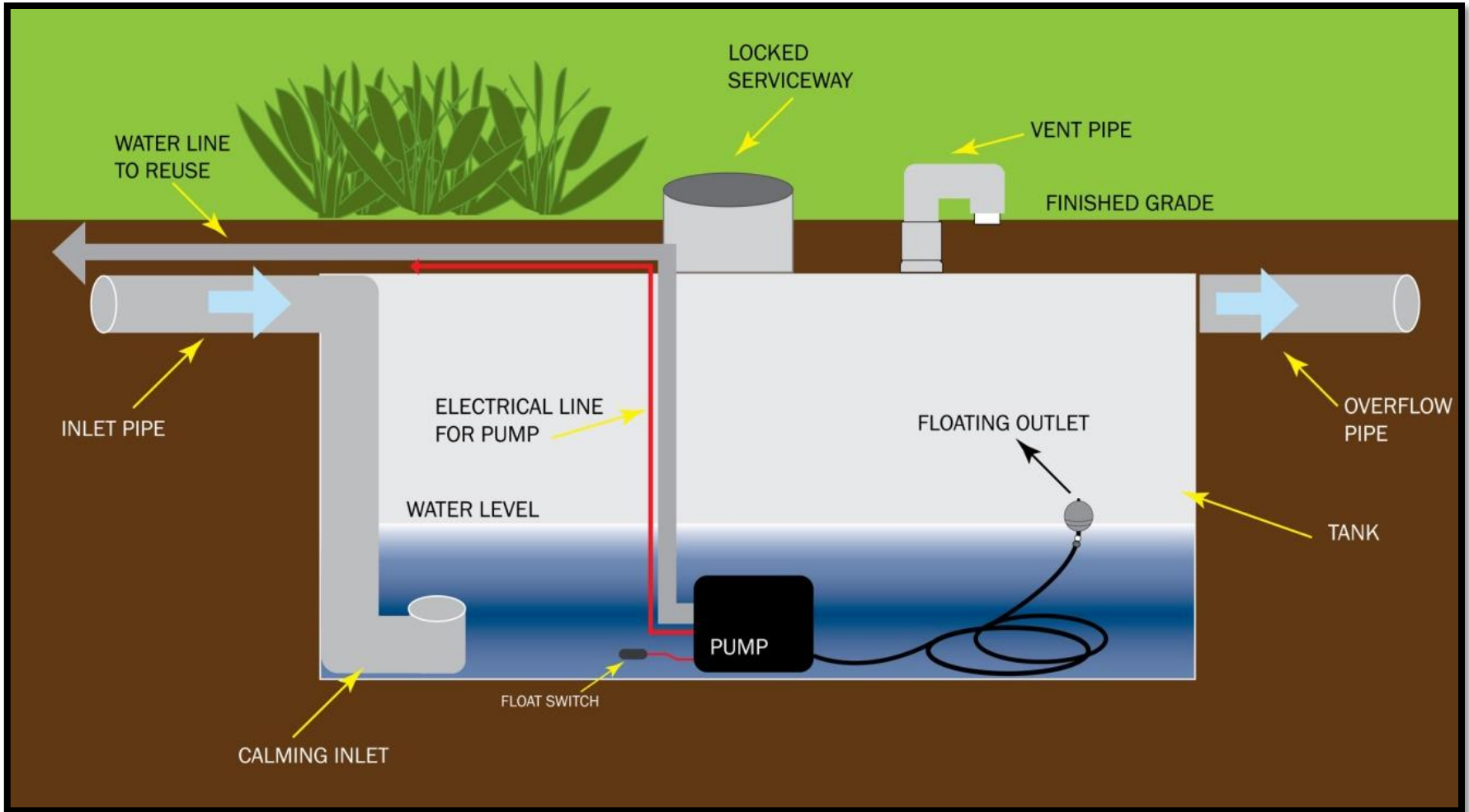
Disinfection

Controls

## Considerations

- Above-ground vs Below-ground
- Metal, plastic, concrete, fiberglass
- Watertight integrity
- Ability to overflow when cistern is full
- Anti-buoyant
- Access provided for inspection and maintenance
- Corrosion resistant material
- Capable of maintaining structural integrity under earth and traffic loads

# System Components: Storage



# Steel Reinforced Polyethylene (SRPE)

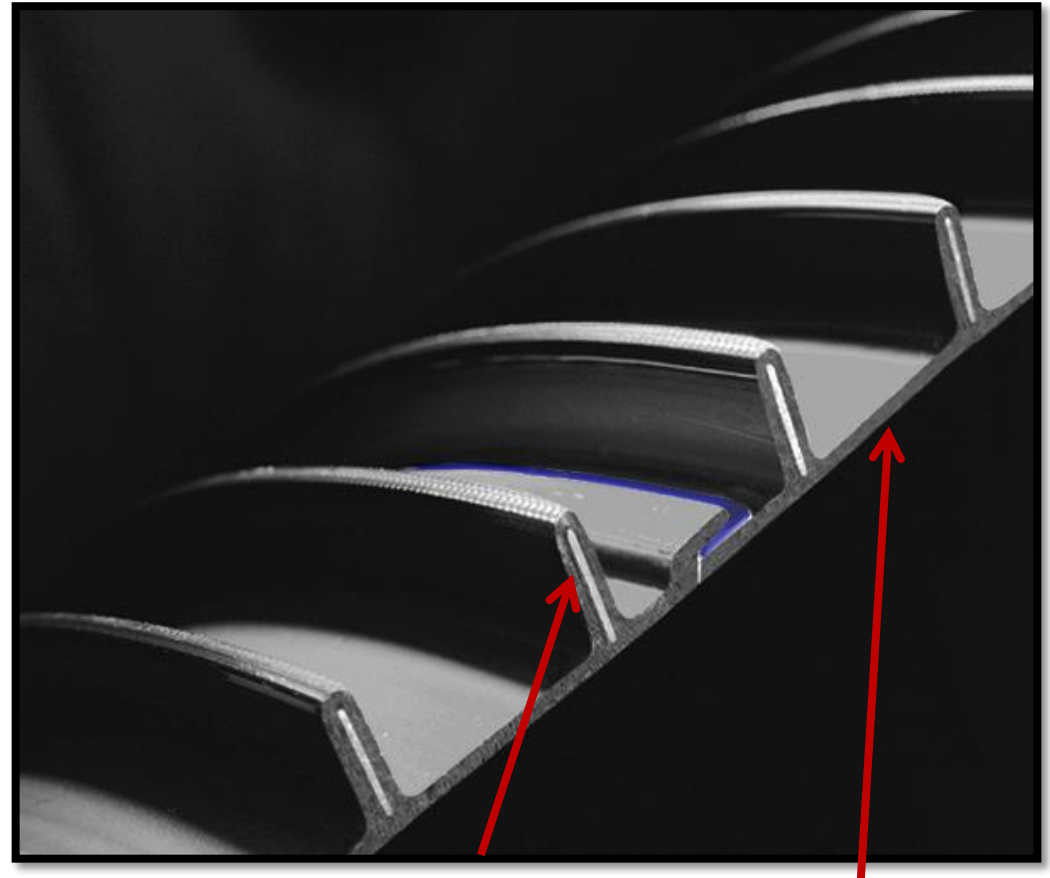
## Best of Both Materials

### Steel

- 85ksi steel reinforcing
- High load bearing capacity
- Long term structural stability

### Polyethylene

- High performance HDPE resin
- Superior corrosion resistance
- 100 yr design service life



Encapsulated Steel  
Reinforcement

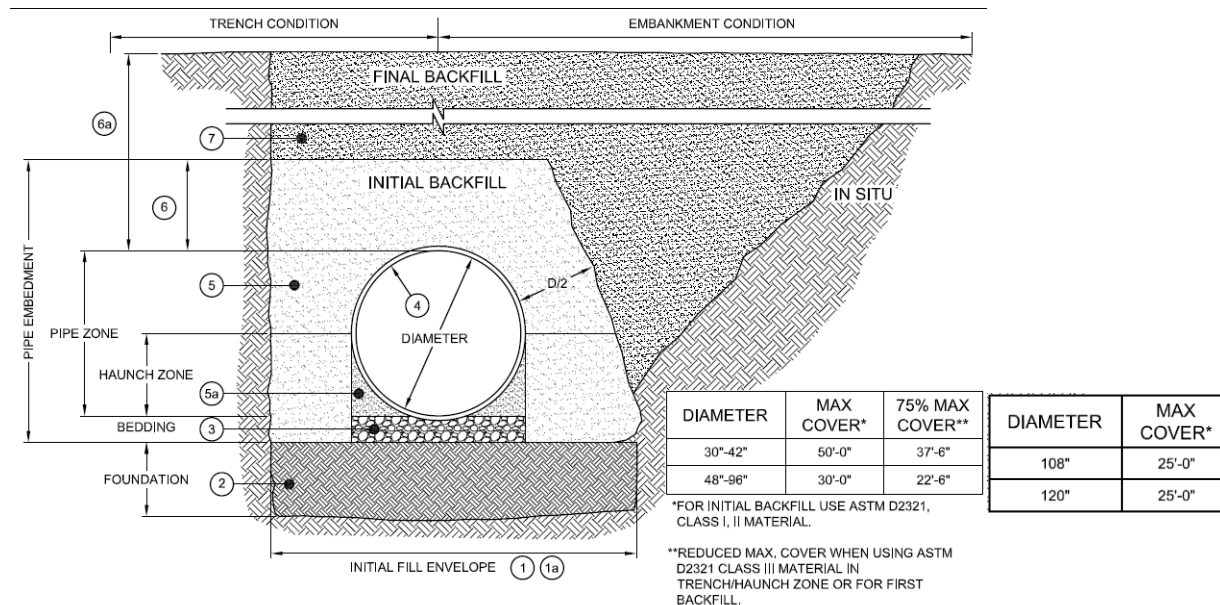
PE Pipe Wall



# Structural Strength of SRPE

## SRPE

- Min cover = 1ft to 3 ft
- Max cover = 25+ ft
- Steel reinforcement carries the load



# SRPE Standard Detail

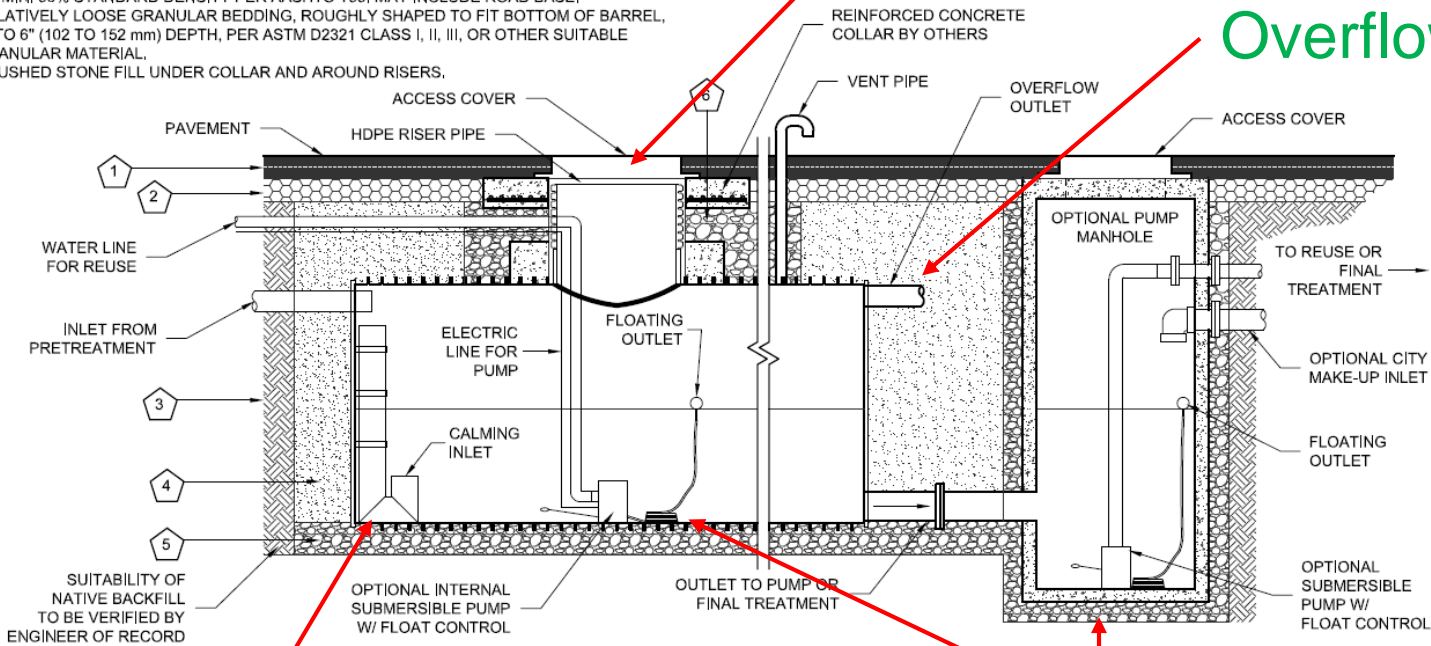
**KEY**

1. RIGID OR FLEXIBLE PAVEMENT.
2. GRANULAR COMPACTED ROAD BASE.
3. ANY SUITABLE NATIVE OR GENERAL BACKFILL, SEE ENGINEER PLANS.
4. WELL GRADED GRANULAR FILL. ASTM D2321 CLASS I, II, III, OR EQUIVALENT. COMPACT TO MIN. 90% STANDARD DENSITY PER AASHTO T99, MAY INCLUDE ROAD BASE.
5. RELATIVELY LOOSE GRANULAR BEDDING, ROUGHLY SHAPED TO FIT BOTTOM OF BARREL, 4" TO 6" (102 TO 152 mm) DEPTH, PER ASTM D2321 CLASS I, II, III, OR OTHER SUITABLE GRANULAR MATERIAL.
6. CRUSHED STONE FILL UNDER COLLAR AND AROUND RISERS.

**PLAN VIEW**

Manhole Access

Overflow



**ELEVATION VIEW**

**GENERAL NOTES**

1. CONTECH
2. FOR SITE
3. YOUR CO
4. ALL ELEV
5. RECORD.
6. PRIOR TO
7. ATTEN
8. ENGINEE
9. THE CISTI
10. SYSTEM I
11. ACCESS C
12. MINIMUM
13. BOTTOM (
14. mm) PIPE
15. FOR INFO
16. DETAILS C

**INSTALLATION**

- A. INSTALLA
- B. CONTRAC
- C. CONTRAC
- D. PRIOR TO
- E. EVENT TH
- F. UTILIZED
- G. APPROVE
- H. MATERIAL
- I. STONE EN
- J. (152 mm)
- K. THE BARF
- L. BE ADVAN
- M. DISPLAC
- N. REFER TC
- O. IT IS ALW
- P. GENERAL



Calming inlet for non turbulent flow

Pump in cistern or in manhole sump

Diam (in)	Max Length (ft)	Max Capacity (gal)
60	48	6,500
72	48	9,500
84	48	13,000
96	48	17,000
108	40	19,000
120	40	22,500

- Available in 60” to 120” diameter
- Storage volumes from 2,000 gal to 22,500 gal in a single tank
- All tanks provided with a calming inlet and inlet / outlet pipe
- All tank provided with 36” access riser

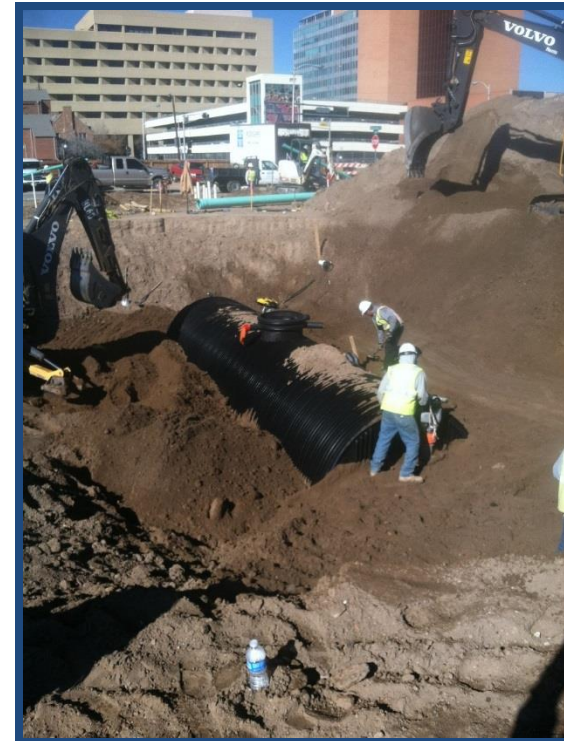
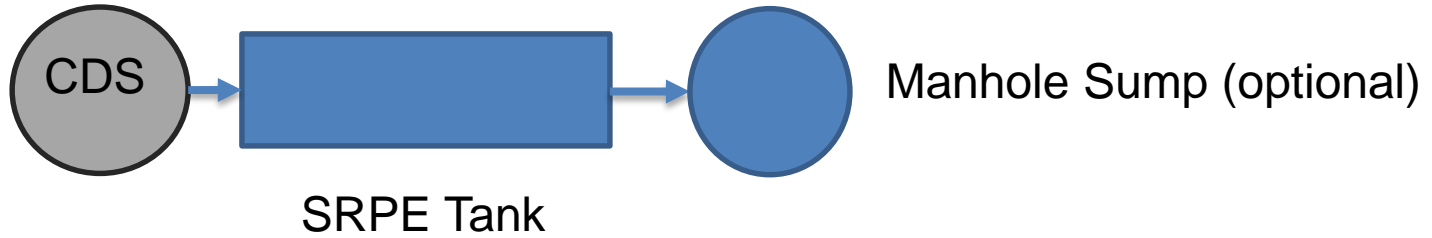




- Fully assembled at factory
- Leak tested at factory
- Several tanks can be manifolded together for large storage capacity



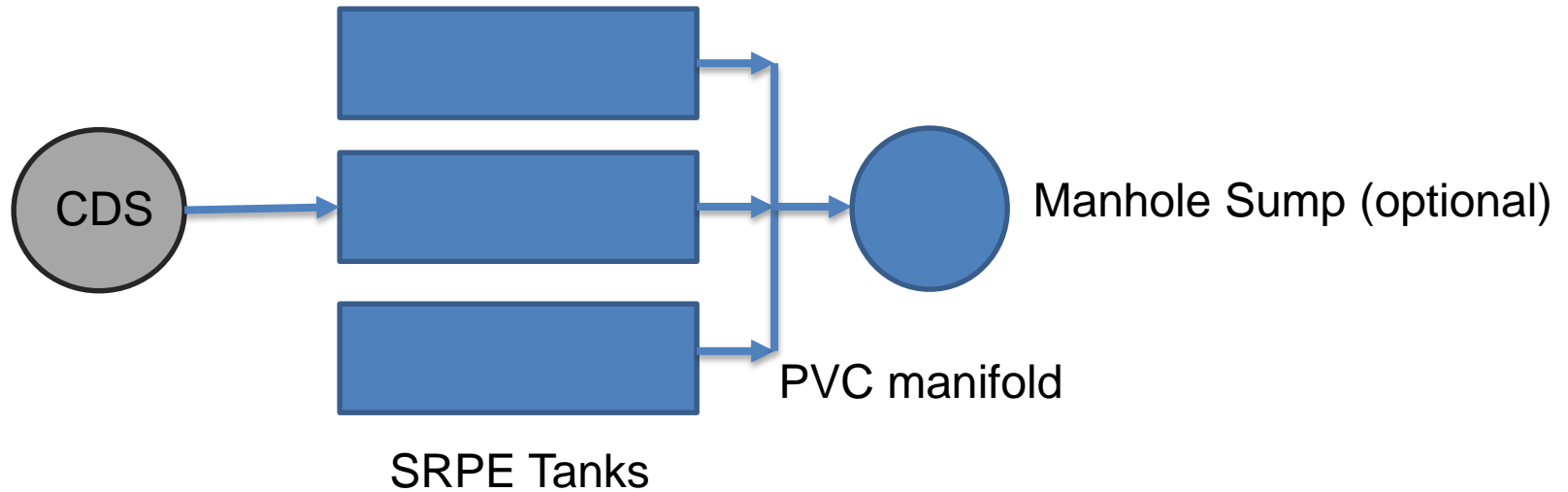
# Single Tank Design





# Multiple Tank Design

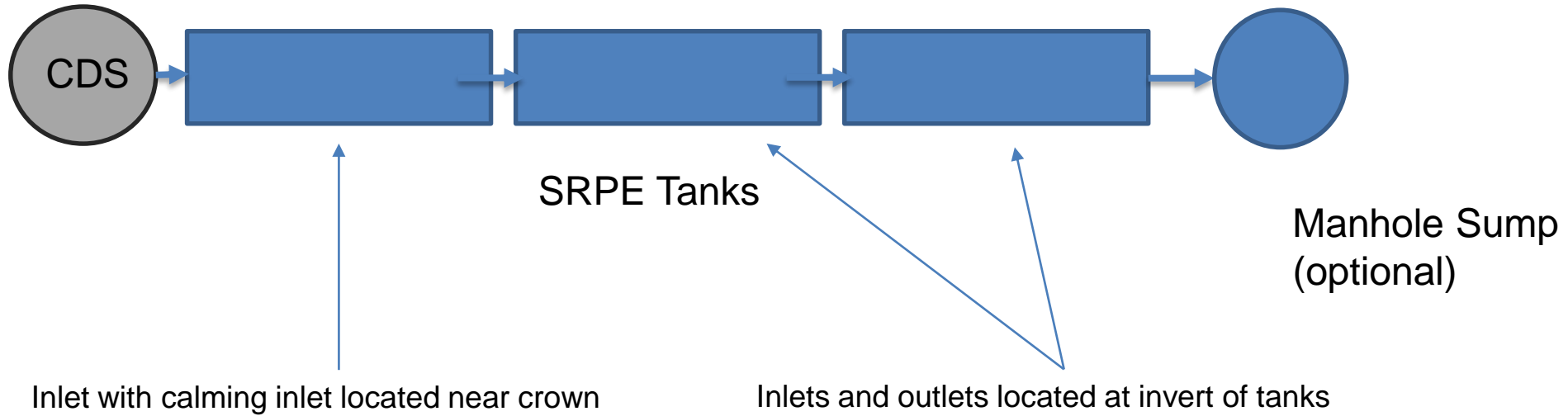
## Parallel Configuration



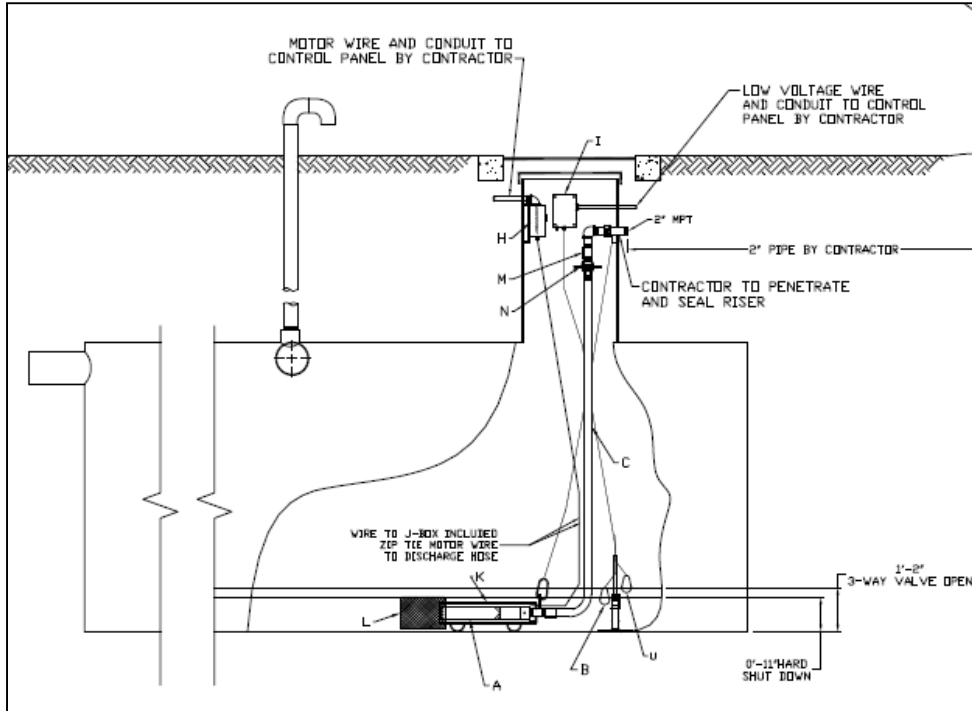
# Multiple Tank Design

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## Series Configuration

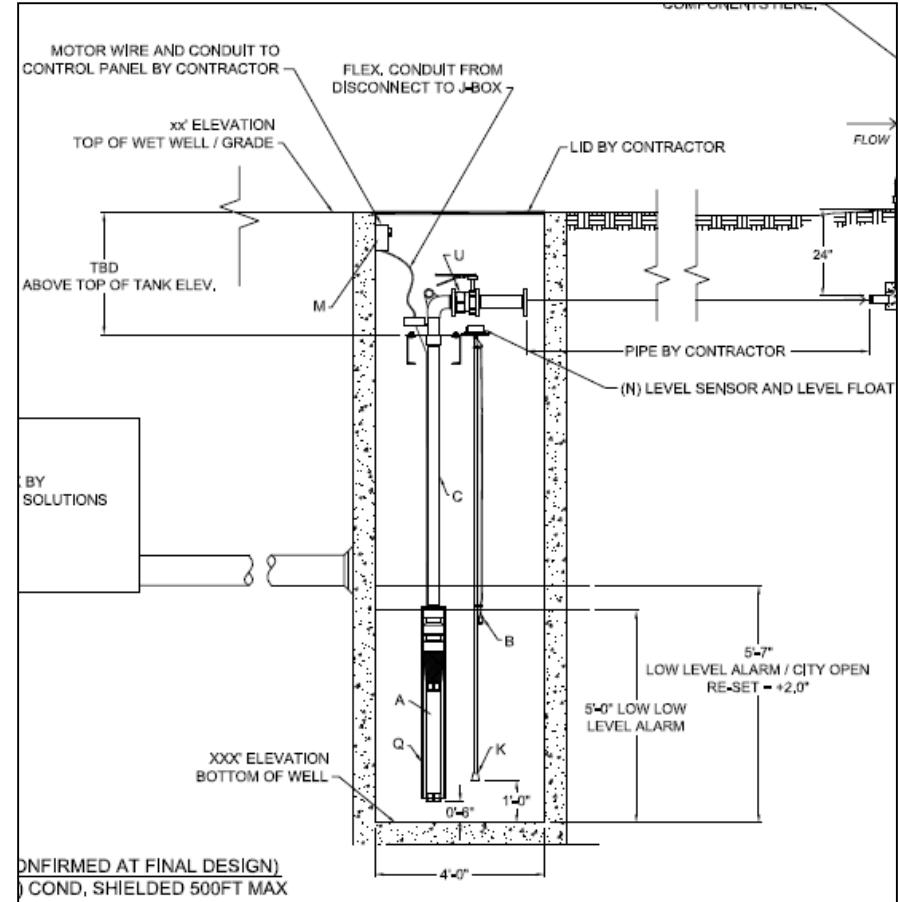


## Pump in cistern



- Requires “dead storage” in the bottom of tank to keep pump submerged
- Additional storage volume may be required

## Pump in manhole



- Added cost of concrete manhole
- Provides easy access to pump
- Provides less “dead storage”

# System Components: Mechanical System

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Catchment

Pretreatment

Storage

**Makeup H2O**

**Pumps**

**Treatment**

**Disinfection**

**Controls**

## Typical Components Options

- Treatment
  - Screens; filters; ultra filtration
  - manual or auto back flush
- Make-up Water (code-dependent)
  - Day-tank with air-gap; back-flow preventer
- Disinfection (code-dependent)
  - UV; chlorination
- Pressurization
- Controls
  - Operation; monitoring ; tie to building mgmt
- Power Supply
- Enclosure
  - Indoor; Outdoor; Underground

## System Components: Mechanical System

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Design based on re-use application

- Drip irrigation
- Spray irrigation
- Toilet flushing
- Cooling tower makeup
- Wash-water





# Mechanical System: Install Locations

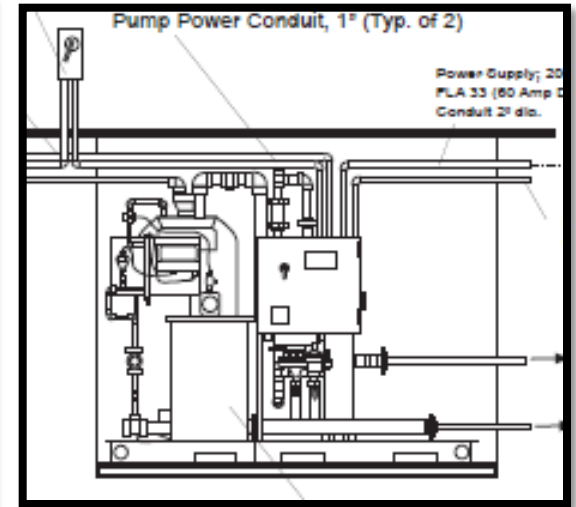
## Indoor Skid Mounted



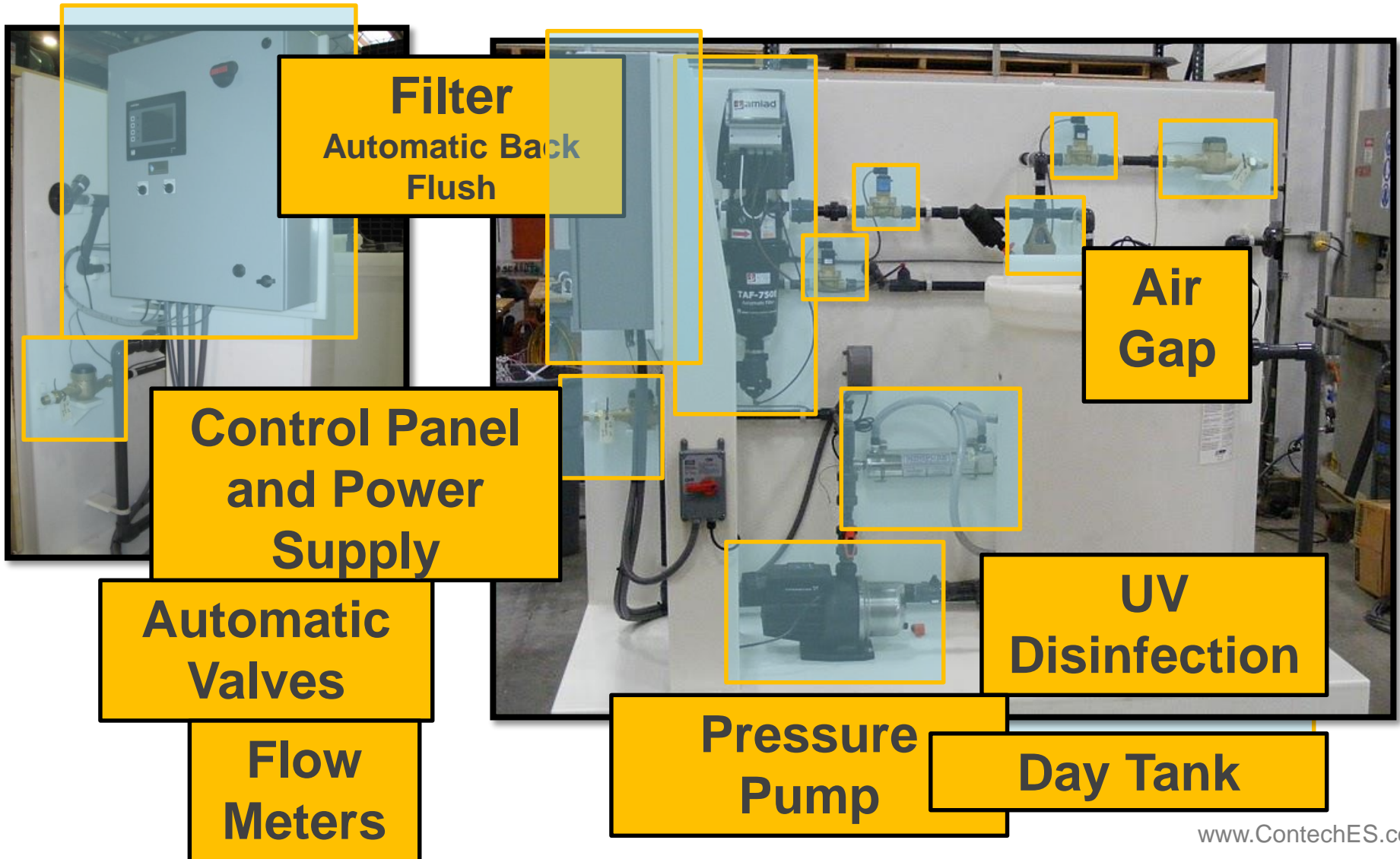
## Outdoor Enclosure



## Underground Vault



# Example: Mechanical System



# UrbanGreen Standard Irrigation Systems

Level 1 Drip Irrigation



Level 2 Drip Irrigation



Level 3 Spray Irrigation



## Mechanical System Packages<sup>1,2</sup>

Model	Irrigation Level 1	Irrigation Level 2	Irrigation Level 3
<b>Typical Application</b>	Drip Irrigation (up to 25 gpm)	Drip Irrigation (up to 60 gpm)	Spray Irrigation (up to 40 gpm)
<b>Pump</b>	2HP submersible	2 to 7.5HP submersible	5 to 7.5HP submersible
<b>Filtration</b>	Manual Flush 100 micron	Manual Flush 100 micron	Automatic Flush down to 5 micron
<b>Ultraviolet (UV) Disinfection</b>	No	No	Yes
<b>Water Level Monitor</b>	Low Level Float Switch	Low Level Float Switch	Level Sensor
<b>Outdoor Enclosure</b>	Fiberglass	Painted Steel	Painted Steel
<b>Enclosure Dimensions (inches)</b>	36W x 24D x 36H	50W x 34D x 36H	50W x 34D x 36H
<b>Automatic Backup Water Supply</b>	Cistern fills with city water on cistern low level alarm	City water supplied by valve open on cistern low level alarm	City water supplied by valve open on cistern low level alarm
<b>User Interface</b>	On/Off/Reset Button	LCD interface	PLC with color touchscreen

<sup>1</sup> All systems include one year warranty, and startup and training are included in the cost of each system.

<sup>2</sup> Additional system configurations for filtration and disinfection are available.



# Level 1 Drip Irrigation



On/Off/Reset  
Pressure Controller



Manual Flush  
Filter





# Level 2 Drip Irrigation



RUN	Term	+60.00Hz	5.4A
1.1-SIMPLY START			
2/3 wire control	:	2 wire	
Macro-configuration	:	Pumps, Fans	
Standard mot. freq.	:	60Hz NEMA	
Rated motor power	:	10HP	
Rated motor volt.	:	460V	
Code	<<	>>	406V

VFD Motor control  
and LED interface

3 way valve to city water makeup

Manual Flush filter

# Level 3 Spray Irrigation



3 way valve to city water makeup



Automatic flush filter

UV disinfection light

Variable Frequency Drive (VFD)



Color touch screen



# Design Your Own RWH Sizing Online

## UrbanGreen™ Rainwater Harvesting Runoff Reduction Calculator

Calculate the  
benefits of  
Rainwater  
Harvesting



Launch the Runoff  
Reduction Calculator™



With dozens of adjustable variables, CONTECH's Runoff Reduction Calculator™ allows you to quickly and easily determine the benefits of a CONTECH Rainwater Harvesting System.

Later, when the project matures, you can refine your assumptions and create a detailed report documenting the runoff reduction, water conservation, and the financial savings your design will provide.

**Rainwater Harvesting Runoff Reduction Calculator**

Configuration
Stormwater

Project Summary
Supply
Demand
Analysis
Graph
Detail Result

Model # / Option # : 21 / 1
Project Name: Demo Example - [Edit Mode](#)

**Rainfall Data**

Rain Station by Map: Middletown (12.06)

OR

Station by List

Years Modeled: 1981 - 2001

Missing Data: Nov-1988, Dec-1988

Avg Annual Rainfall: 39

**Supply Source**

Include?	Annual Volume(gal)
<input checked="" type="checkbox"/> Rooftop	1,004,610
<input type="checkbox"/> Hardscape	
<input type="checkbox"/> AC Condensate	
<input type="checkbox"/> Gray Water	
<b>Total</b>	
1,004,610	

**Demand Source**

Include?	Annual Volume(gal)
<input checked="" type="checkbox"/> Irrigation	827,017
<input checked="" type="checkbox"/> Toilet Flush	728,970
<input type="checkbox"/> Cooling Makeup	
<input type="checkbox"/> Wash Water	
<input type="checkbox"/> Laundry	
<b>Total</b>	
1,555,987	

**Design Storm**

First Flush Bypass (in): 0.00

Design Storm (in): 01.50

**Utility Rates**

Water Rate: \$0.0030 /gallon

Sewer Rate: \$0.0060 /gallon

**Cistern Size**

Cistern Size (gallons): 35,000

Calculate Result
Cancel

[www.conteches.com/Design-Toolbox/DYO-Project.aspx](http://www.conteches.com/Design-Toolbox/DYO-Project.aspx)

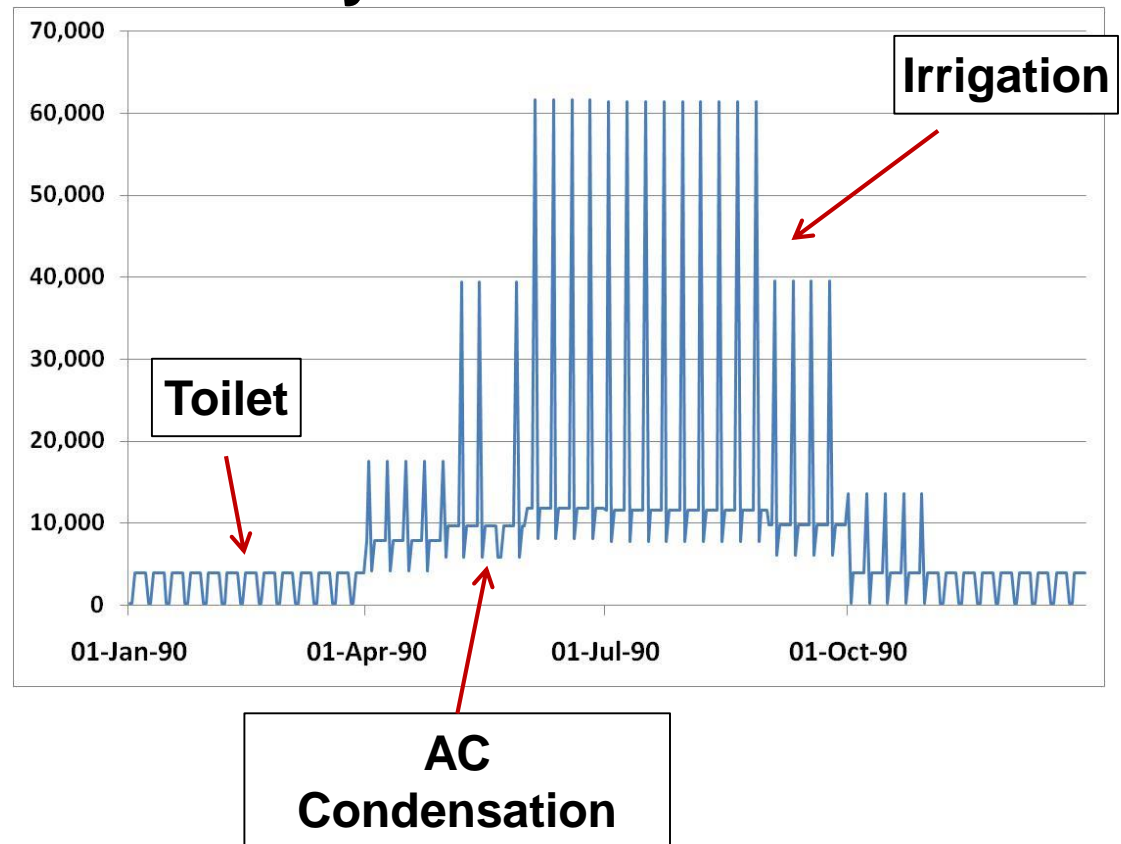
www.ContechES.com

# Runoff Reduction Model

## Modeling

- Continuous daily model
- Local rainfall history
- Seasonal and daily demand
- Seasonal and daily supply
- Outputs:
  - Runoff reduction
  - Water savings
  - Financial savings

## Daily/Seasonal Demand



# Runoff Reduction Model

Location		Supply			Demand			
WA DC Dulles		Source	Include?	Area/Volume	Application	Include?	Annual Volume	
Years Modeled	7	Stormwater	Rooftop ( effective ft <sup>2</sup> )	yes	40,850	Toilet	no	0
First Flush Bypass (in)	0.00		Surface (effective ft <sup>2</sup> )	no	0	Laundry	no	0
Design Storm (in)	2.00		Total (ft <sup>2</sup> )		40,850	Wash water	no	0
Cistern Size (gallons)	50,000	Secondary	AC Condensate (gallons)	no	0	Irrigation	yes	1,065,433
			Gray Water (gallons)	no	0	Cooling Makeup	no	0
			Total (gal)		0	Total		1,065,433

## User Variables

- Rain Data
- Supply Sources
- Cistern Size
- First Flush Bypass
- Design Storm
- Water Rates



# Runoff Reduction Model: Supply Inputs

		Rooftop		Landscape	Hardscape	Total
		Traditional	Green Roof			
<b>Basin 1</b>	Area	43,000	0	43,000	43,000	129,000
	Runoff C	0.95	0.50	0.05	0.90	
<b>Basin 2</b>	Area	0	0	0	0	0
	Runoff C	0.95	0.50	0.05	0.90	
<b>Basin 3</b>	Area	0	0	0	0	0
	Runoff C	0.95	0.50	0.05	0.90	2
<b>Effective Runoff Area</b>		40,850	0	2,150	38,700	81,700

Secondary Sources of Re-Use Water						
			AC Condensation		Gray Water Capture (gal/month)	
			% of Peak	gal/month		
Building Sq Footage (ft <sup>2</sup> )		172,000	Jan	0%	0	0
Condensation Rate	gal/hr/ft <sup>2</sup>	0.0007	Feb	0%	0	0
	gal/hr	246	March	0%	0	0
	gal/day	5,897	April	25%	44,229	0
	<b>Peak</b> gal/month	176,914	May	50%	88,457	0
<b>Assumptions:</b>			June	75%	132,686	0
			July	100%	176,914	0
			Aug	100%	176,914	0
			Sep	66%	116,763	0
			Oct	25%	44,229	0
			Nov	0%	0	0
			Dec	0%	0	0
			<b>Total</b>		780,192	0

# Runoff Reduction Model: Demand Inputs

Toilet	Residential	Units	People/Unit	Occupancy	GPD/Person	Demand (gal)	
		0	0	100%	8	0	
	Office/Com	Flushes per day		Volume (gal per flush)		Daily Demand	
		Weekday	Weekend			Weekday	Weekend
		3,058	153	1.28		3,914	196
	Retail	Flushes per day		Volume (gal per flush)		Daily Demand	
Weekday		Weekend	Weekday			Weekend	
	0	0	1.28		0	0	
Other	Visitor		Flushes (per Visitor)	Volume ( gal per	Daily Demand		
	Weekday	Weekend			Weekday	Weekend	
	0	0	1.28	1	0	0	
Total	Daily Average				3,914	196	
	Annual Total				2,844	1,038,177	

	Irrigation		Cooling Makeup
	Area (ft <sup>2</sup> )		Gallons of blow down makeup required per day
	43,000		
	Input Units		
Inches per week			
Jan	0.0	0	0
Feb	0.0	0	0
Mar	0.0	0	0
Apr	0.3	6,701	3,939
May	1.0	26,803	5,718
Jun	2.0	53,607	7,878
July	2.0	53,607	7,623
Aug	2.0	53,607	7,623
Sep	1.0	26,803	5,908
Oct	0.3	6,701	0
Nov	0.0	0	0
Dec	0.0	0	0
Annual Demand	951,518	1,181,640	

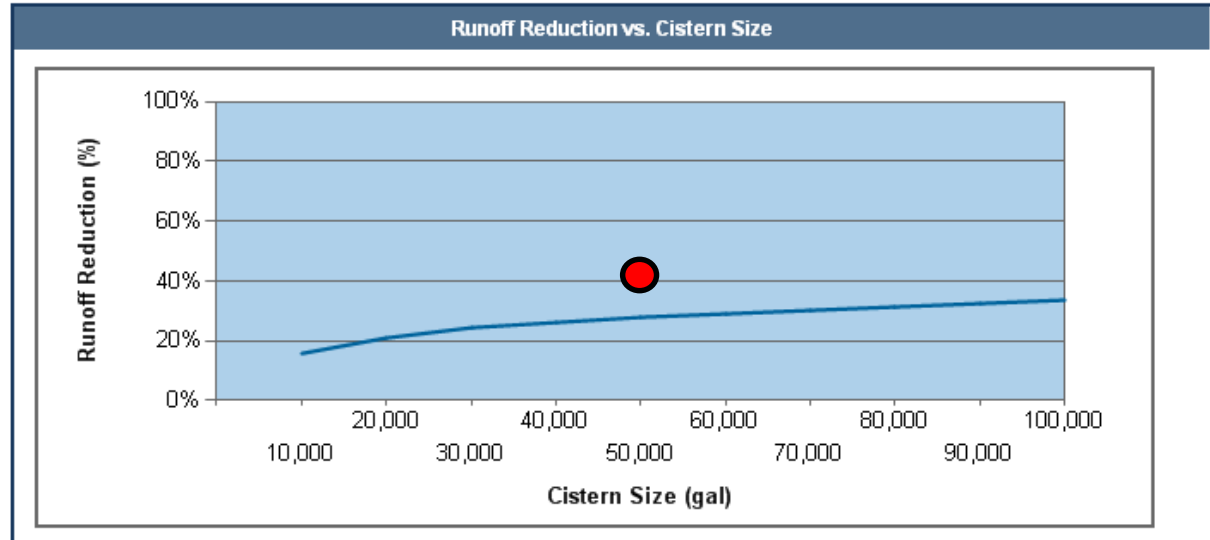
Laundry		Loads/Day	Gallons/Load	Cold Fraction	Daily Total
	Residential	0	40	70%	0
	Non-Res	0	0	50%	0
	Daily Total				0
	Annual Total				0

	Area (ft <sup>2</sup> )	Occupancy
Total Building Space	172,000	
Office/Com	0	764
Retail	0	0
School	0	

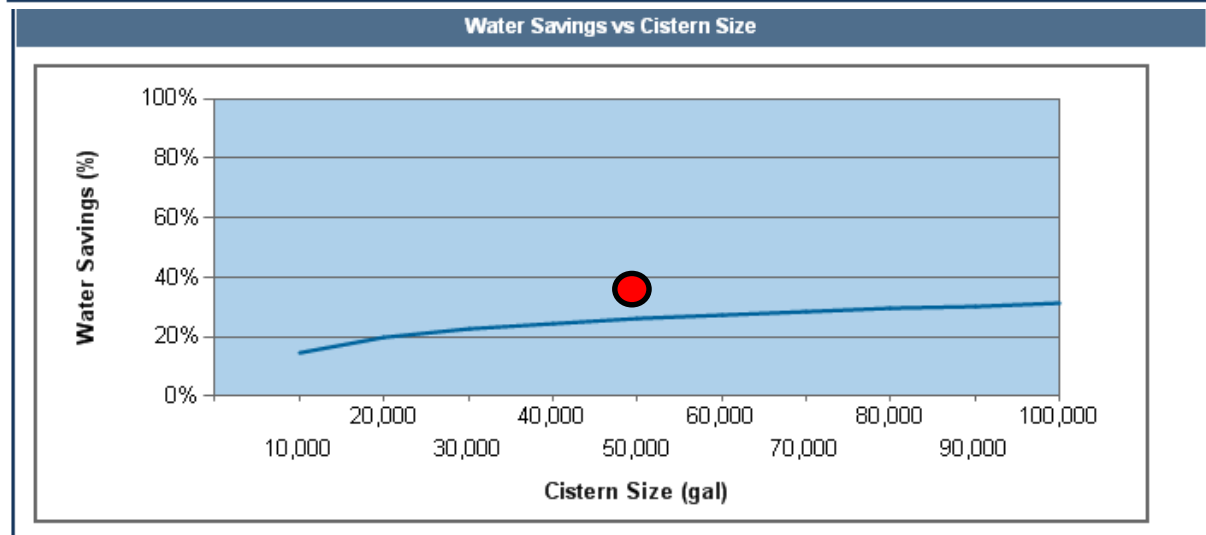
Wash Water	Daily Average	
	Residential	0
	Non-Res	0
	Daily Total	0
	Annual Total	0

# RWH Model Outputs: Cistern Size Optimization

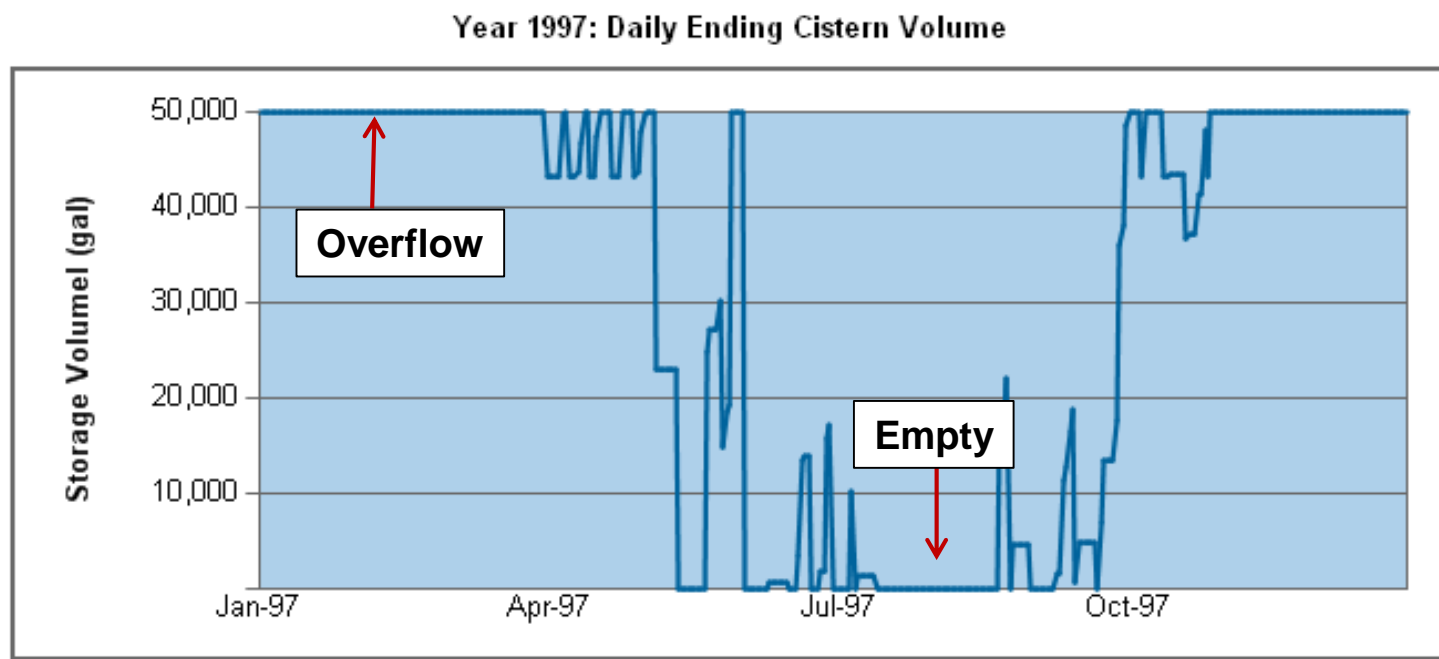
**Runoff Reduction  
VS.  
Cistern Size**



**Water Savings  
VS.  
Cistern Size**



## Daily Ending Cistern Volume



**20 years of geographic specific rainfall data will model water levels in cistern**

# RWH Model: Reported Results

	Rainfall		Stormwater		Supply		Demand	Captured
	Total	Targeted	Targeted	Peak	TargetedSW	Total		
Average	37	36	1,830,907	25,719	2,191,309	2,197,432	5,272,352	1,456,926
Max Year	63	62	3,130,455	44,204	3,130,455	3,535,061	5,272,352	1,710,996
<b>Total</b>	<b>767</b>	<b>765</b>	<b>38,449,037</b>	<b>128,594</b>	<b>46,017,482</b>	<b>46,146,076</b>	<b>110,719,392</b>	<b>30,595,437</b>

	Runoff Retained (Targeted Rainfall)		Water Savings		Total Retained (Targeted, Peak, Secondary)		Savings
Average	1,096,523	62%	1,452,740	28%	1,456,926	68%	\$13,112
Max	1,350,594	43%	1,709,101	32%	1,710,996	48%	\$15,399
<b>Total</b>	<b>23,026,991</b>	<b>60%</b>	<b>30,507,538</b>	<b>28%</b>	<b>30,595,437</b>	<b>66%</b>	<b>\$275,360</b>



## Runoff Reduction

- 60%
- 1.1M gal/year



## Water Savings

- 28%
- 1.4M gal/year



## Financial Savings

- \$13,000/yr



# Product Design online



[Register](#) | [Login](#)

PRODUCTS    MARKETS    **START A PROJECT**    KNOWLEDGE CENTER    COMPANY

Start A Project > Product Design Worksheets > **Rainwater Harvesting Product Design Worksheet**

## Product Design Worksheet - Rainwater Harvesting

After submitting your worksheet a Stormwater Design Engineer will review and contact you shortly regarding your request.

### Project Information (Fill out as much as possible)

[Upload Site Plans](#)

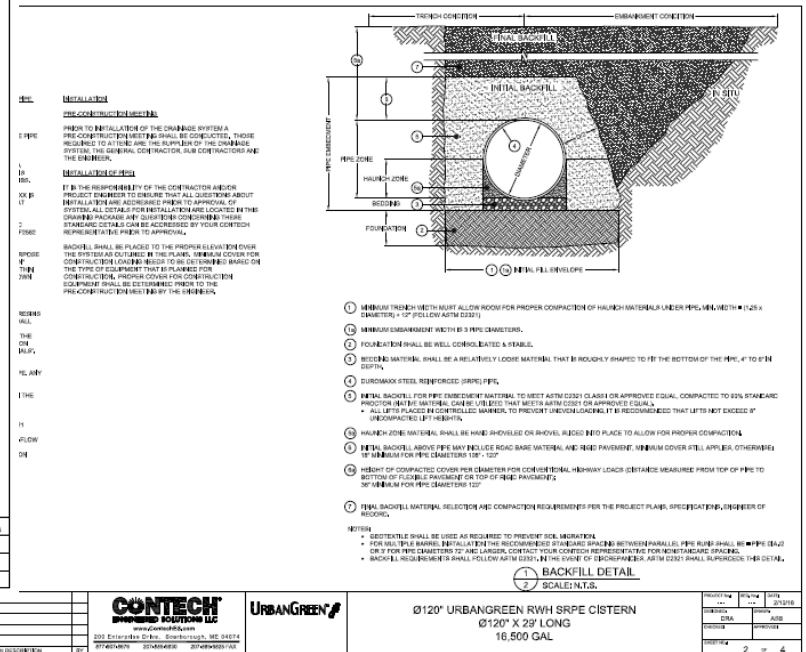
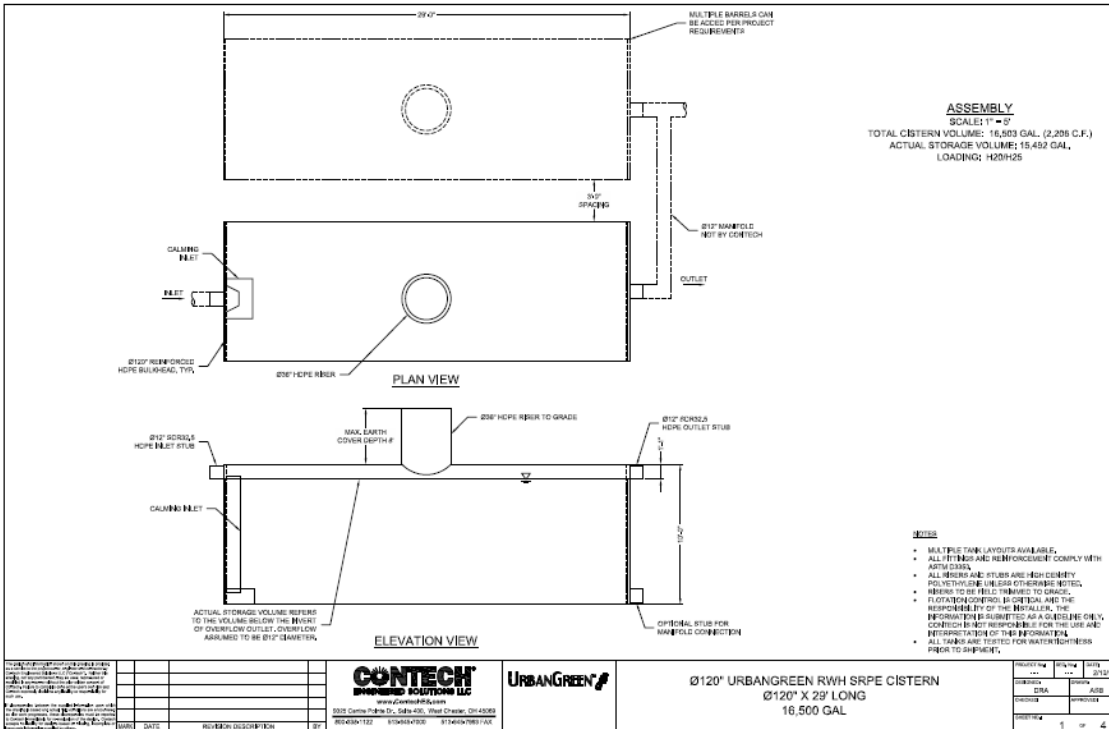
Project Name:\*     Site Plan Available:

Project Location:\*     Regulatory Agency:

Deliverable Request:\*     Design Assistance     Sizing     Drawing     Quote     Rush Request     LEED Cert.

- Online Product Design Worksheet (PDW)
- [www.ContechES.com](http://www.ContechES.com)

# Standard Drawings- Online

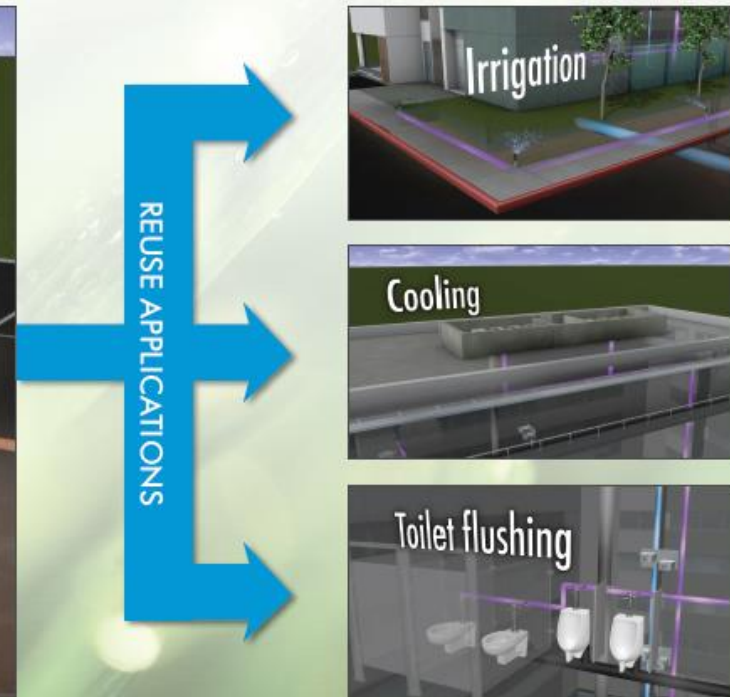
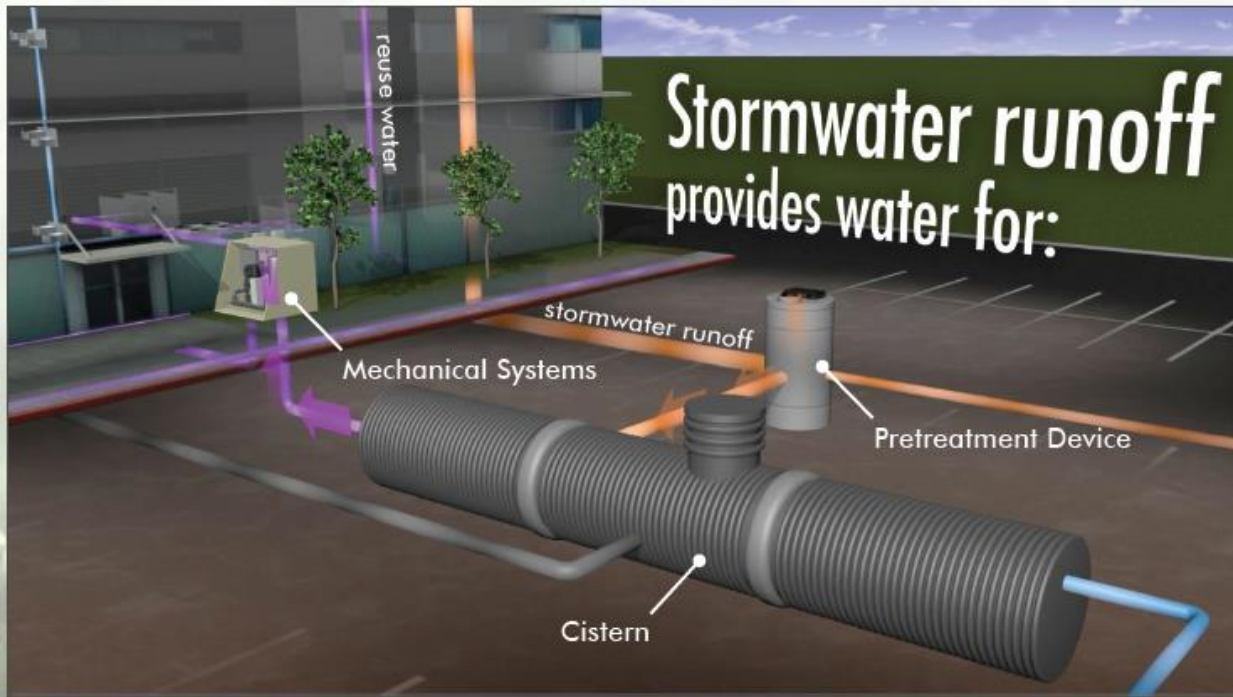


# Water Management Convergence

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# Contech Rainwater Harvesting



- Complete packaged RWH systems
- Integrated design approach for a complete stormwater solution
- Design assistance at every phase

# Your Stormwater Support team

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# QUESTIONS?

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