

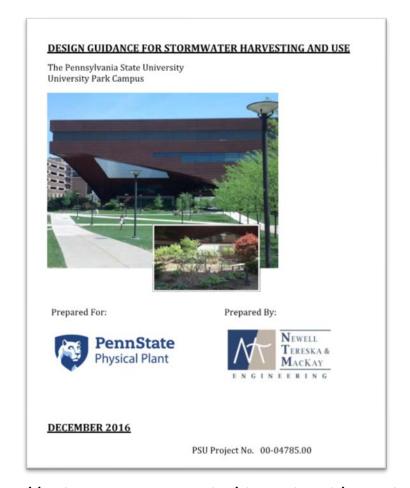


GUIDELINES FOR STORMWATER HARVESTING AND USE

A GUIDANCE DOCUMENT FOR CAMPUS BUILDING PROJECTS AT THE PENNSYLVANIA STATE UNIVERSITY

Scott Brown, PE, D.WRE Paul DeBarry, PE, PH, GISP, D.WRE

GOAL AND OBJECTIVES



https://wikispaces.psu.edu/download/attachme nts/357077532/SW%20Harvesting%20and%20Us e%20Final%20Report%202016-12-02.pdf?api=v2

 Goal: To bring consistency to the analysis, design, and component specifications for Penn State Stormwater Harvesting and Use Systems.

Objectives:

- Research State of Practice
- Develop a Design Guidance Document for Designers
- Create Stormwater Use Calculator
- Outline Process for Assessing Stormwater Harvesting and Use Opportunities
- Test Procedure on Three Sample Projects

GUIDANCE DOCUMENT OVERVIEW



Source: https://cmlandscapeweb.com/a/2018/02/cmlandscape-irrigation-installation-portland.jpg



Source: http://gardenhoseadviser.com/wp-content/uploads/2017/06/Best-Drip-Irrigation-System-mulch.jpg

- PSU Primary Stormwater Use Opportunities
 - Landscape irrigation
 - Graywater (toilet flushing)



Source: https://c8.alamy.com/comp/a5ye20/man-flushing-toilet-usa-a5ye20.jpg

EXISTING UNIVERSITY HARVESTING AND USE SYSTEMS





- Millennium Science Complex (University Park Campus)
 - 10,000-gallon cistern for planting bed irrigation;
 planting bed is under building overhang
 - System frequently runs dry; relies heavily on backup supplemental potable water
- Biobehavioral Health Building (University Park Campus)
 - 12,000-gallon cistern for green roof irrigation
 - System currently functioning as designed. Clover loves this roof

EXISTING UNIVERSITY HARVESTING AND USE SYSTEMS (2015)



http://www.alexanderbuilding.com/images/LEED gaige.jpg

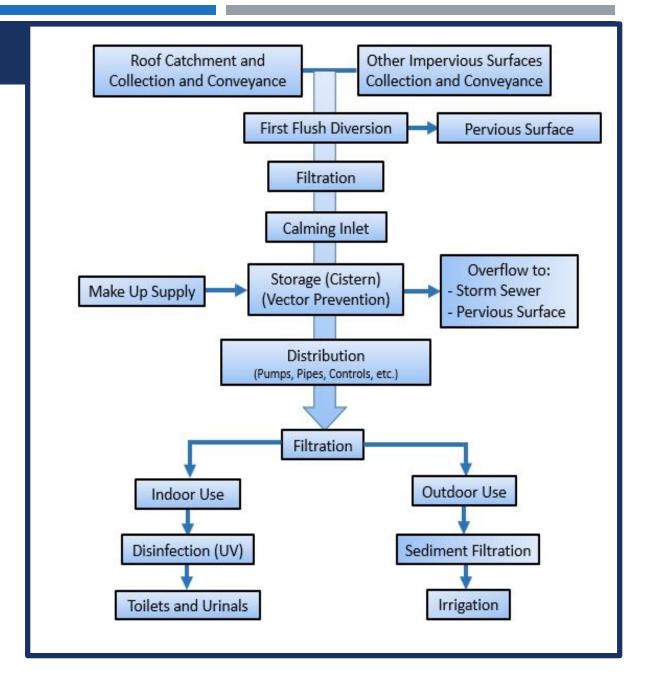


- Gaige Technology and Business Innovation Building (Berks Campus)
 - 34,000-gallon cistern supplying 25 toilets and 8 urinals
 - System functioning well with excess supply.
 System could have served additional facilities
- Child Care Center at Hort Woods
 - 6,000-gallon cistern used to supply graywater for toilet flushing
 - Maintenance costs have been reported to be high

SYSTEM COMPONENTS

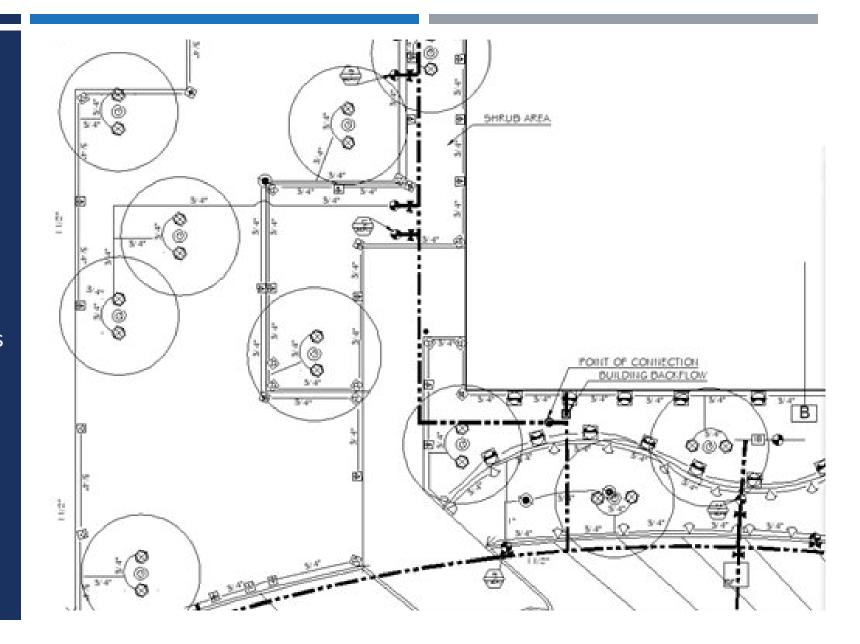


- Catchment and Collection (harvesting)
- Pre-treatment and Filtration
- Storage
- Treatment and Disinfection
- Pumps and Controls
- Distribution

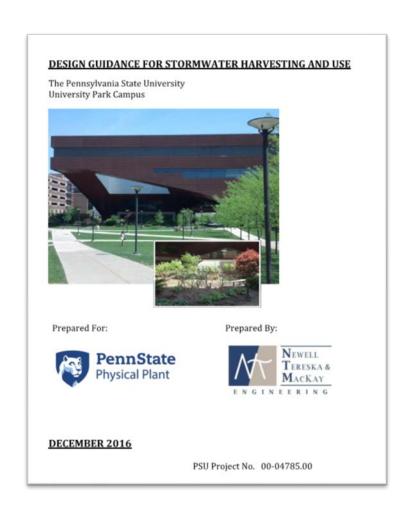


DESIGN GUIDANCE

- Guidelines specific to PSU campuses
- Identifies system components, their function and application, and advantages and disadvantages
- Outlines the design approach and provides design guidelines and plan requirements
- Encourages maximizing educational opportunities
- Identifies operation and maintenance considerations for system components
- Includes cost considerations



TO GET A COPY



Google "Penn State OPP Stormwater Harvesting"

OR

https://opp.psu.edu

Planning/Design/Construction

- Design and Construction Standards
 - Division 33 Utilities
 - > 3 40 00 Storm Drainage Utilities
 - Under related files click on Harvesting and Use Final Rpt.

OR

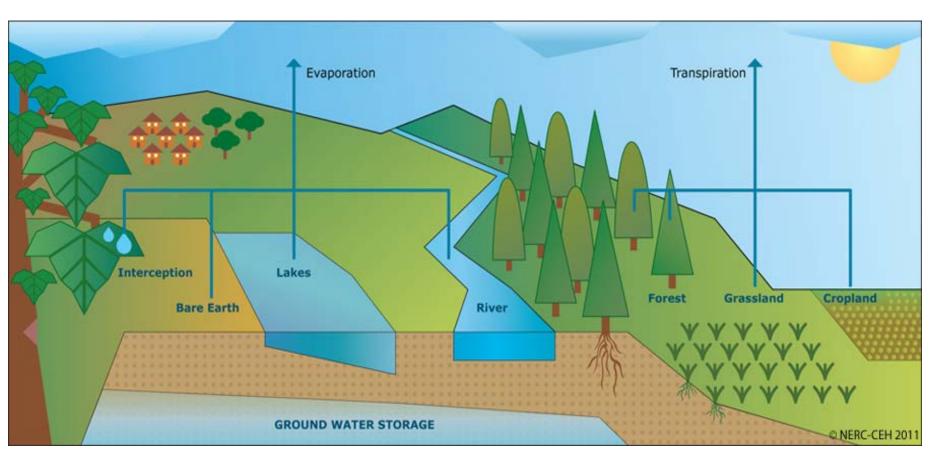
https://wikispaces.psu.edu/download/attachments/35707 7532/SW%20Harvesting%20and%20Use%20Final%20Repor t%202016-12-02.pdf?api=v2

Penn State Stormwater Harvesting Calculator - Average Conditions Project Name: OPP Project No: Prepared by: To use the calculator fill in all green highlighted in Blue cells (& red if negative) are calculated. White cells with red text are given information & non-Input Values for Catchment Area to Cistern Roof area (rainwater) (ft 2): Other impervious area (stormwater) unaff from other impervious surfaces (stormwater) Roof collection efficiency (%): Accounts for decressions torage, rainautter & downspout leakage, first flush diverters, etc Other impervious area collection Accounts for depression storage, cracks, misdirection, etc. Area to be irrigated area (ft 2): Voaotatod aroa boina irriaatod. Monthly summer irrigation (in): Barodan 0.5°tuook Monthly spring/fall irrigation (in): Barodan 0.25°/wook Irrigation efficiency Or plant officioncy (loakago, otc.) Saurco: Waniolista. "Obtain final valuo fram OPP Monthly indoor or other demand Tailetr.etc. Cistern volume size based on Total cirtorn capcacity arspocified by manufacturor Available cistern volume (gal): Arzumoz 90% af manufacturarzspocifiod valumo Typical annual tolume carryote Abro-Initial condition volume in cirtern (cell K23) - Set to 25% of tank volume for initial extimate. Iterate un Coll K35 oquals value in this coll. Set to coll K35 for the final iteration Cost in dollars/gallon of potable Supply / Demand Calculatio Surplurar Avg. Monthly Roof Total Total Imporviour Irrigation Romainin Ovorflas Procipitation Rainwator Supply Domand (Gallonr) Stormwatr Domand qin Water Reg'd (Gallenz) (Gallow) (Gallow) (Supply Initial Conditions 5,199 February 2,878 4,545 7,423 2,132 5,291 24,972 4.051 | 6.396 | 10.447 | 2,132 8,315 33,287 April 4,004 6,321 10,325 2,132 8,193 41,480 Irrigation month May 7,070 11,547 10,390 12,522 Irrigation month June 12,188 | 20,781 | 22,913 29,781 Irrigation month July 11,455 20,781 22,913 18,324 August Irrigation month 22,913 Irrigation month September 3,714 10,330 12,522 3,478 October 12,522 Irrigation month 9,164 November 2,132 Annual Total: Total rain/stormwater utilized: 113,074 gallons Cost Data: Life expectancy of system: To be determine by designer based on manufacturers recommendations Typical cost of cistern / gallon: rior by typo-roo "Starago Tank Cartr" in "Typical Cartr" tab-GA Toch SW Martor Plan rocammondr \$3/qo Typical cost of cistern + installation: ypical cirtorn cwrt * manufacturor capacity (Roforonco Typical Cwrtr Tab + manufacturor cwrtr). Other costs: rom "Typical Cortr" tab - GA Toch SW Martor Plan approximator \$100,000 for typical installation. Annual maintenance / operation Will be applied to life expectancy of the system Approximate total costs: \$235,000 irtorn, other cortr plur annual cortr. Cost to implement SW controls with \$100,000 otormined by designer. Harvesting costs excluding \$135,000 atal SW harvorting cortr minur cort to imploment required starmuster controls. Life expectancy cost savings from quivalent rainwater/stormwater utlilzed. (Assumes an alternates tormwater facility of same cost would be oauriod if rouro nat implomented) SW harvesting: Annual cost savings from harvesting: nnual cartravings from not wing potable water. System payback period: Doziqn lifo dividod by tho annual cartzavings. Annual return on investment (%): Annual cartravings divided by annual cast (compounding not considered). Annual cost of supplemental potable Barodon 1 cont por gallon (Rof: OPP).

WATER HARVESTING CALCULATOR

WATER HARVESTING CALCULATOR

$P = RO + ET + Use + \Delta S$



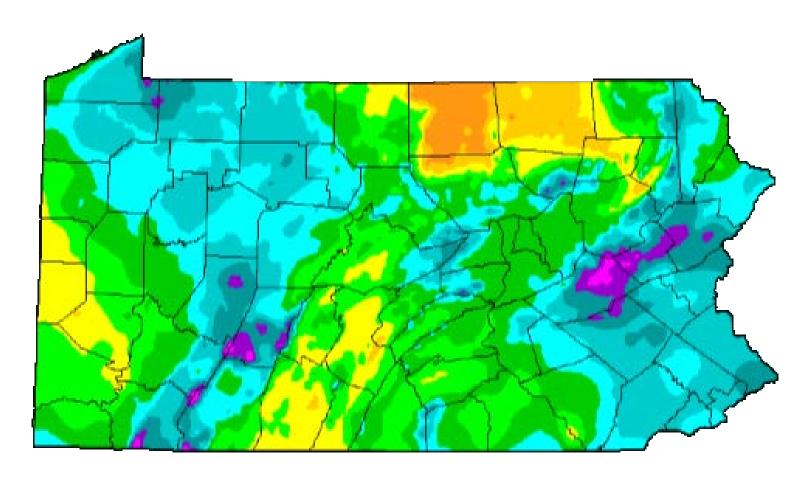
Other input:

- Roof Area
- Other Impervious
- Collection Efficiency
- Area to be Irrigated
- Irrigation Efficiency
- Water Use/Demand
- Cistern size
- Cost

Source: https://www.mckeanweather.com/mwevap.php

P = Precipitation

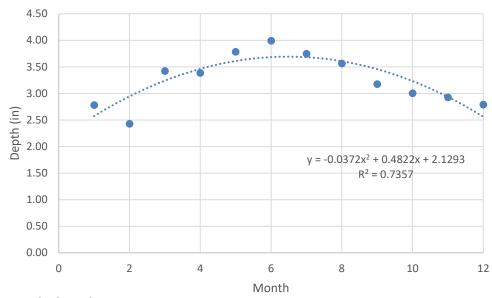
- <u>Daily</u> rainfall records for State College dating back to January 1, 1896 obtained
- Therefore, average daily, weekly, or monthly rainfall averages could be determined



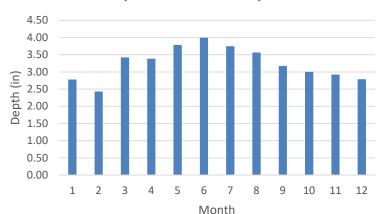
Monthly Data

- University Weather Station rain gage show that the average annual rainfall in State College is ~39 inches per year
- Lowest average monthly total P occurs in February (2.43 in)
- Highest average monthly total P occurs in June (3.99 in)
- $R^2 = .7357$

Average Monthly Precipitation (1896 to 2015)



Average Monthly Precipitation (1896 to 2015)

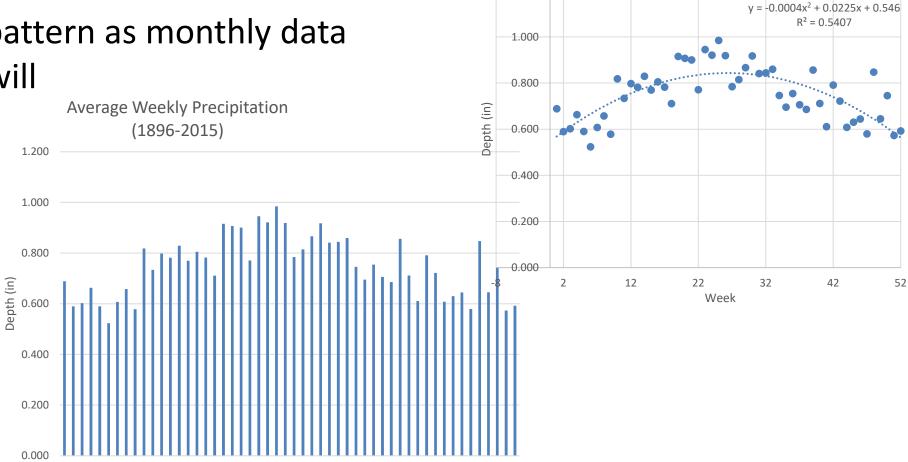


		Average
Month	Mo	Precipitation
January	1	2.78
February	2	2.43
March	3	3.42
April	4	3.38
May	5	3.78
June	6	3.99
July	7	3.75
August	8	3.56
September	9	3.18
October	10	3.00
November	11	2.92
December	12	2.79

Total 38.99

Weekly Data

- Generally same pattern as monthly data
- Extreme events will have more of an influence on the results on a weekly basis
- $R^2 = .5407$

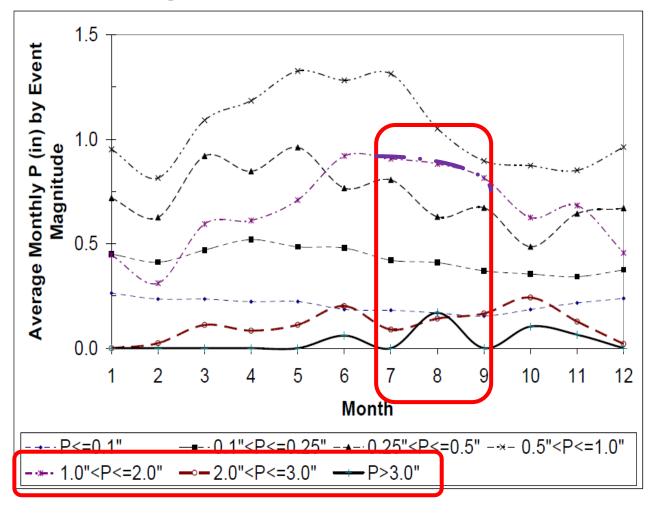


1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 Week

Average Weekly Precipitation (1896-2015)

1.200

Challenges



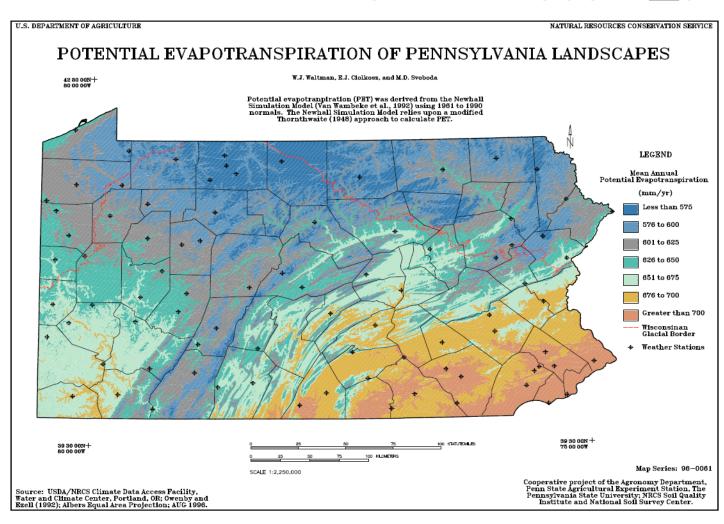
Challenges:

- Highest rainfall in June when irrigation not required
- The majority of the rainfall events
 (particularly the high intensity events)
 greater than one inch occur when soil
 moisture is the most depleted or ET is
 highest during summer and early fall
 (July August) (Fennessey, 2005)
- Ten to twenty percent (10-20%) of the average annual rainfall is comprised of events less than or equal to 0.25 inches which produce very little runoff depending on the season

WATER HARVESTING CALCULATOR - EVAPOTRANSPIRATION

- PET is the ET that occurs when all surface-atmospheric interfaces are wet
- PET usually has a higher value than Actual ET since AET includes ET during dry spells
- Since irrigation is used at PSU, the PET values will be utilized in the guidance document
- PET ranges from 24.6 to 26.2 in/yr depending on source

$P = RO + ET + Use + \Delta S$

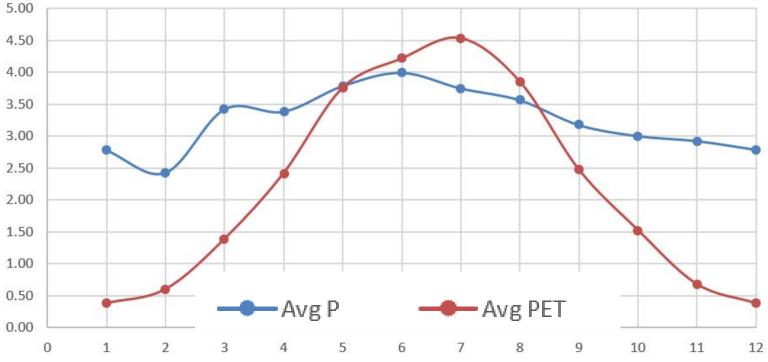


WATER HARVESTING CALCULATOR - EVAPOTRANSPIRATION

$P = RO + ET + Use + \Delta S$

ET:

• State College shows a rainfall/ET deficit during the months of June, July, and August.



				Surplus
		Avg	Avg	(+) or
		Precip.	PET	Deficit
	Month	(in)	(in)	(-)
	January	2.78	0.38	+2.4
	February	2.43	0.60	+1.38
	March	3.42	1.39	+2.03
	April	3.38	2.42	+0.96
	May	3.78	3.76	+0.02
	June	3.99	4.22	-0.23
	July	3.75	4.54	-0.79
	August	3.56	3.86	-0.3
	September	3.18	2.48	+0.7
	October	3.00	1.53	+1.47
	November	2.92	0.68	+2.24
_	December	2.79	0.38	+2.41
	Average			
	Total	38.99	26.24	+12.74
				I

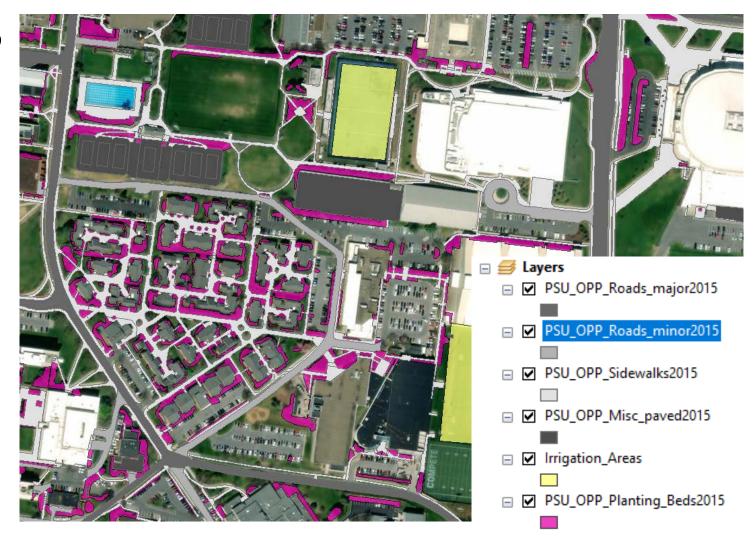
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WATER HARVESTING CALCULATOR - RUNOFF

 $P = RO + ET + Use + \Delta S$

RO = Roof Area * Efficiency

- + Other Impervious
- * Efficiency



WATER HARVESTING CALCULATOR - USE

$P = RO + ET + Use + \Delta S$

Use = Area to be Irrigated * Summer Versus Fall Irrigation * Irrigation Efficiency + Indoor or Other Demand

Building Use Sources:

- Branch campus metering
- National databases
- Seasonal occupancy records

Irrigation Use

U Park records



Table 3. Default Fixture Use adapted from USGBC (2012)

Non-Residential Fixture Use								
Fixture Type	Full Time Occupant (FTO) Use/Day	Transient Occupant (TO) Use/Day						
Toilet Female (high flush)	1	0.1						
Toilet Female (low flush)	2	0.4						
Toilet Male	1	0.1						
Urinal Male	2	0.4						
Resid	ential Fixture Use							
Fixture Type	Full Time Occupant Use/Day	NA						
Toilet Female	5	NA						
Toilet Male	5	NA						

Table 2. Default occupancy numbers by building type (USGBC, 2009).

	Gross Square	Feet Per Occupant
Type of Building Space	Full Time Occupants (FTO)	Transient Occupants (TO)
General Office	250	0
Restaurant	435	95
R&D Laboratory	400	0
Hotel (Dormitory)	1,500	700
Post-Secondary	2,100	150
Education		

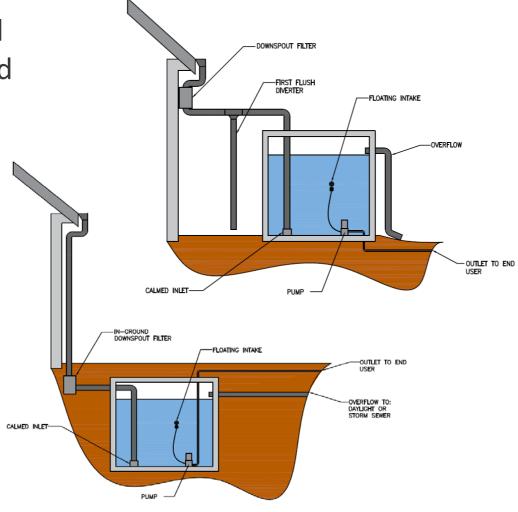
Building	Urinal Uses	Mens Toilet Uses	Womens Toilet Use	Number of Men	Number of Women	Urinal Use/Male-day	Toilet Use/Male-day	Toilet Use/Female-day
Olmstead	7080	1490	2330	1685	1989	0.35	0.07	0.10
S&T	2950	353	887	1685	1989	0.15	0.02	0.04
Swatara	676	198	972	624	968	0.06	0.02	0.06
Susquehanna		75	240	624	968		0.01	0.02

WATER HARVESTING CALCULATOR - STORAGE

$P = RO + ET + Use + \Delta S$

- The Calculator developed to determine required cistern storage volume based on local supply and demand, and to establish a consistent design methodology
- Performance for four (4) existing PSU Storage systems analyzed
- Winter months where P ~ 0 due to frozen conditions considered
- Above ground and below ground systems considered
- Overflow

Storage = Cistern Volume * % Available - % Carryover



CISTERN DESIGN FLOW DIAGRAM

Determine Cistern(s) Location

Determine Uses of Harvested Water

Determine Drainage Area

Determine Roof Area

Determine Other Impervious Area Determine Pervious Area

Calculate Irrigation Area and Demand

Calculate Indoor Demand

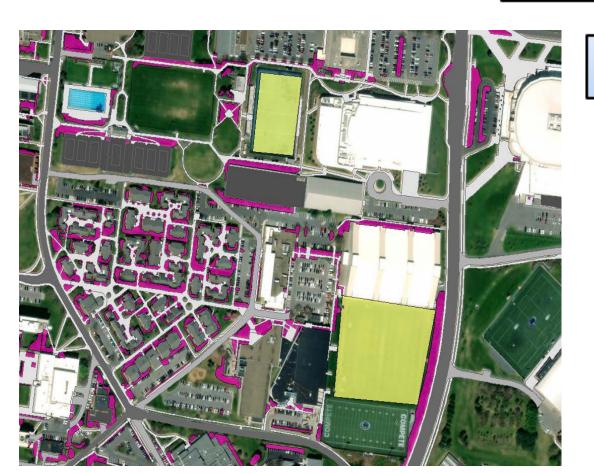
Estimate Reg'd Cistern Volume Using Calculator

Adjust Cistern Volume or Irrigated Area until Overflow and Supplemental Water Columns = or near 0

Determine Costs and Cost Savings

Discuss Results with OPP

Determine if Economically Feasible



WATER HARVESTING CALCULATOR

- The Calculator can be used for:
 - Determining storage tank size (cistern volume)
 - Determining drainage area required for particular constraints including roof area
 - Determining required irrigation area based on tank size, contributing drainage area, etc.
 - Determining water supply available for toilet flushing or other non-potable uses
 - Determining dry year shortfall or capabilities
- The Calculator is flexible with what parameters are changeable such as:
 - Those parameters above
 - Collection efficiency
 - Irrigation amounts and efficiency
 - Rainfall, ET, costs, etc.

This calculator estimates cistern or irrigation area sizing. Values may be modified until the proper balance is obtained. The maximum or desired cistern size results when the overflow in column M just reaches zero in each row, in other words, there is no overflow.



HARVESTER CALCULATOR - OVERVIEW

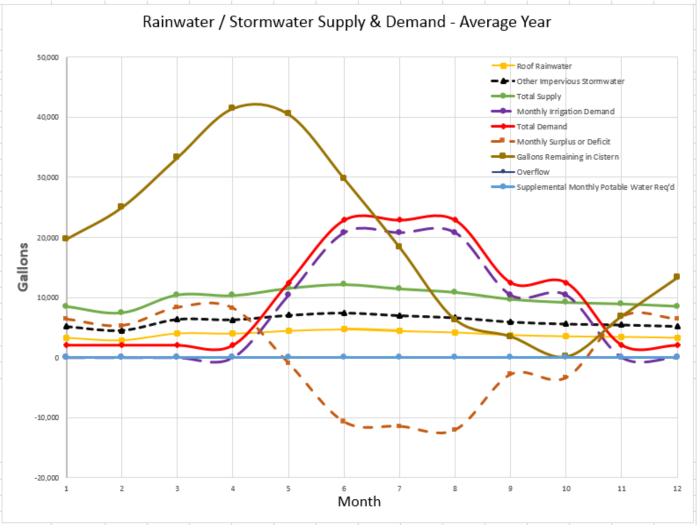
Site data

Monthly supply / demand ______ calculations

Summary and cost data

Penn State Stormwater	Harvesti	ng Cal	culator	- Ave	rage (ondif	ions			
Project Name:					roject				Δ	
Date:				Prepar					-	
7	47-487-44				_				All	
To use the calculator fill in all green Blue cells (& red if negative) are cal-		a input	This calcular Values may							
White cells with red text are given in		& non e	obtained. T	he maximus	n or desire	d cistern size	results			2
Input Values for Catchment Area to			row, in other	verflow in co ir words, the			ero in each		7	
Roof area (rainwater) (ft ²):	2,000	Runaff from	n roofsurfac	ır (rainwat	or)					
Other impervious area (stormwater)	4,000	1	n ather imper							
Roof collection efficiency (%):	95 75		ar depression					rzt fluzh die	ortors, etc	
Other impervious area collection Area to be irrigated area (ft²):	15,000		ar doprossi a n aroa boing irr		ackr, mird	irocti a n, ot	e.			
Monthly summer irrigation (in):	2	Baredon 0.		igatea.						
Monthly springfall irrigation (in):	- 1	Barodon 0.	25°/wook							
Irrigation efficiency	0.90	Orplantoff	icioncy (loak	ago,otc.)S	aurce: Wa	nielirta.*O	btain final :	alue from	OPP	
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(gal):	13,321		ualr value in t						ir imiciai ba c	imaco. Icoraco anci
Cost in dollars/gallon of potable	0.0100	Saurce: OP	P							
	S	upply / D	emand C	alculati	ons					
							Monthly	Gallens		l
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Initial Conditions:					_	 		13,321	_	
January:	2.78	3,293	5,199	8,492	0	2,132	6,360	19,681	0	0
February:	2.43	2,878	4,545	7,423	0	2,132	5,291	24,972	ō	0
March:	3.42	4,051	6,396	10,447	0	2,132	8,315	33,287	0	0
April:	3.38	4,004	6,321	10,325	0	2,132	8,193	41,480	0	0
Irrigation month May:	3.78	4,477	7,070	11,547	10,390	12,522	-975	40,505	0	0
Irrigation month June: Irrigation month July:	3.75	4,726 4,442	7,462	12,188	20,781	22,913	-10,724 -11,457	29,781	0	0
Irrigation month August:	3.56	4,217	7,013 6,658	11,455 10,875	20,781	22,313	-12,038	18,324 6,286	0	Ö
Irrigation month September:	3.18	3,767	5,947	9,714	10,330	12,522	-2,808	3,478	ŏ	ő
Irrigation month October:	3.00	3,553	5,611	9,164	10,390	12,522	-3,358	120	0	0
November:	2.92	3,459	5,461	8,920	0	2,132	6,788	6,908	0	0
December:	2.79	3,305	5,218	8,523	0	2,132	6,391	13,298	0	0
Annual Total:	38.98	46,171	72,902		93,513	119,097	-23		0	0
Total rain/stormwater utilized:	119,074	azilons	Summary							
Total falls storage active act	110,014		Cost Date							
Life expectancy of system:	30	Tabo dotori	mino by dorig	norbarodo	ın manufa	turors roce	ammondati	onr.		
Typical cost of cistern / gallon:	\$1.50									
Typical cost of cistern + installation:	\$75,000									commondr\$3/qal.
Other costs:	\$100,000		orn court "ma cal Courts" tab							
Annual maintenance / operation	\$2,000						X11114CE4 #10	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	, predriid ce	indian.
Approximate total costs:	\$235,000									
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SW harrestina: Annual cost savings from harresting:	\$1,191		savingsfrom							
System payback period:	113		travingrerum divided by the							
Annual return on investment (%):	26		ravingr divid			mpounding	not conside	orod).		
Annual cost of supplemental potable	\$0		ontporgalla							

Penn State Stormwater	Harvesti	ng Cal	culator	- Ave	rage (ondif	ions				
Project Name:				OPP Project No:							
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To use the calculator fill in all green	hiahliahte	d input	This calculat		e eleteen oe	loslanalas as	one ships		All		
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Input Values for Catchment Area to	Cistern		when the or row, in othe				iro in each		7	53	
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Other impervious area (stormwater)	4,000	Runoff from	n athor impor	vioursurfa	cos (starm	wator)					
Roof collection efficiency (%):	95	Accountri	ır doprossian.	storago, ra	inquttor&	dawwpaut	loakago, fi	at flurh div	ortors, etc.		
Other impervious area collection	75	Accountri	ar doprossian.	starago, cr	ackr, mirdi	roction, ot	e.				
Area to be irrigated area (ft²):	15,000		aroa boing irri	iqatod.							
Monthly summer irrigation (in):	2	Barodon 0.									
Monthly springfall irrigation (in):	0.30	Baradan 0.									
Irrigation efficiency Monthly indoor or other demand	2,132		icioncy (loak	aqo,otc.)S	aurco: Wa	niolista.*O	btain final (alue from 1	OPP		
Cistern volume size based on	50,000	Tailett, etc.									
Available cistern volume (gal):	45,000		n capcacity a % of manufac								
Typical annual rolume carryoter	13,321						25% of tan	k valume fa	rinitial orti	 imato. Itorato unt	
(gal):	·	Coll K35 og	ualr valuo in t	hir cell. Se	t to coll K3	5 far the fir	alitoration				
Cost in dollars/gallon of potable	0.0100	Saurce: 0P									
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	Avg. Monthly	Roof	Other Imperviour	Total	Monthly Irrigation	Tatal	Surplur or Deficit	Gallons Romainin	Overflau	Supple-menta Manthly Patable	
	Procipitation (P)(in)	Rainwater (Gallone)	Starmuatr	Supply (Gallenr)	Domand	Domand (Gallanr)	(Gallenr)	qin	(Gallenr)	Water Reg'd	
	. , ,,	`	or (Gallanz)	((Gallenr)	((Supply - Domand)	Cirtorn		(Gallenz)	
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Initial Conditions: January:	2.78	3,293	5,199	8,492	0	2,132	6,360	13,321	0	0	
January: February:	2.43	2,878	5,199 4,545	7,423	0	2,132	5,291	19,681 24,972	0	0	
rebruary: March:	3,42	4,051	6,396	10,447	0	2,132	8,315	33,287	0	0	
April:	3.38	4,004	6,336	10,325	0	2,132	8,193	41,480	0	0	
Irrigation month May:	3.78	4,477	7,070	11,547	10,390	12,522	-975	40,505	0	ő	
Irrigation month June:	3,99	4,726	7,462	12,188	20,781	22,913	-10,724	29,781	0	ő	
Irrigation month July:	3.75	4,442	7,013	11,455	20,781	22,913	-11,457	18,324	0	0	
Irrigation month August:	3.56	4,217	6,658	10,875	20,781	22,913	-12,038	6,286	0	0	
Irrigation month September:	3.18	3,767	5,947	9,714	10,330	12,522	-2,808	3,478	0	0	
Irrigation month October:	3.00	3,553	5,611	9,164	10,390	12,522	-3,358	120	0	0	
Hovember:	2.92	3,459	5,461	8,920	0	2,132	6,788	6,908	0	0	
December:	2.79	3,305	5,218	8,523	0	2,132	6,391	13,298	0	0	
Annual Total:	38.98	46,171	72,902		93,513	119,097	-23		0	0	
Total rain/stormwater utilized:	119,074	gallons	Summary								
i otal lanestormwater utilized:	110,014		Cost Data								
Life expectancy of system:	30		mino by dorig		n manuf	turorr ro	mmondeti	20.5			
	\$1.50										
Typical cost of cistern / gallon:		Varior by ty	po-soo*Star	ago Tank C	ourto*in *T∋	rpical Cart	r*tab-GA1	och SW Ma	rtor Plan ra	commondr\$3/qa	
Typical cost of cistern • installation:	\$75,000	-,,									
Other costs:	\$100,000		:al Courtr*tab				ximatos \$10	10,000 far t	ypicalinrta	llation.	
Annual maintenance / operation	\$2,000										
Approximate total costs:			orcartrolar		r.						
Cost to implement SV controls with Harvesting costs excluding		1	d by darigner.								
Life expectancy cost savings from			ırvasting cast rainuator/ste							mo cart uauld bo	
SW harresting:	\$35,722		rainwaterrsti 'ewe nat impl			. Januaran a	rmave1tt		acincy under	car cand be	
Annual cost savings from harvesting:	\$1,191		ravings from		otable wat	er.					
System payback period:	113										
System payback period.											
Annual return on investment (%):	26	Annual cart	ravingrdivid:	lod by annu	al cort (cor	mpaunding	nat canrida	red).			

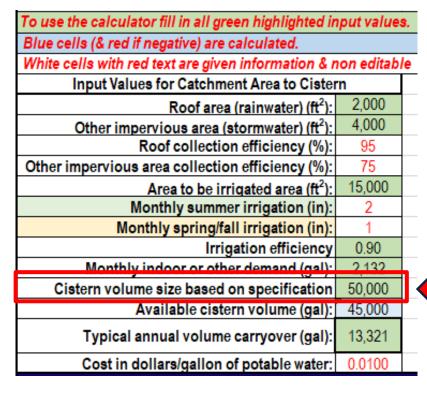


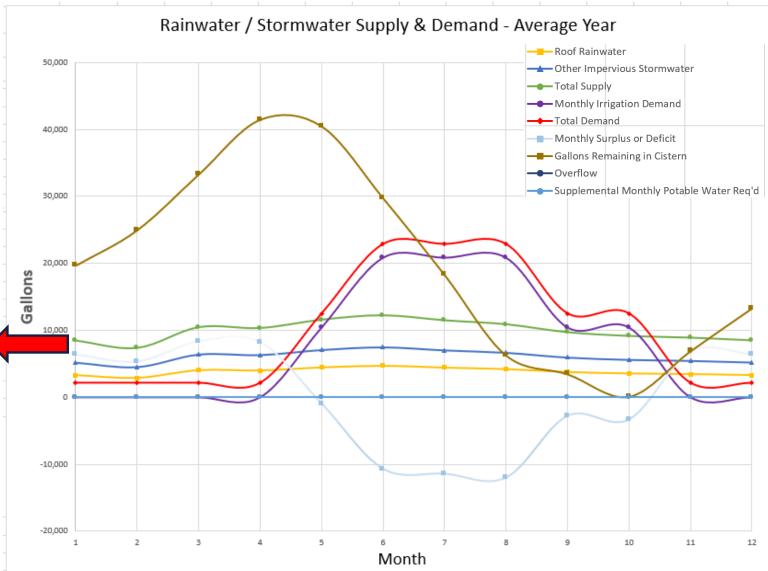
HARVESTER CALCULATOR – INPUT SITE DATA

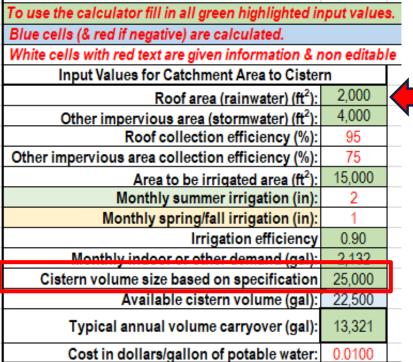
Penn State Stormwate	r Harvest	ing Calculate	or - Av	erage Co	ndition	IS			
Project Name:				OPP Project No:					
Date:				Prepared by:					
To use the calculator fill in all green highlighted in	This calcu	lator estimates c	istern or irrig	ation area siz	zing.				
Blue cells (& red if negative) are calculated.				y be modified ur			. 4	2	
White cells with red text are given information & n		The maximum of overflow in colu				20			
Input Values for Catchment Area to Cister	n			her words, there	-		Cucii		
Roof area (rainwater) (ft ²):	2,000	Runoff fro	m roof sur	faces (rainwat	er)				
Other impervious area (stormwater) (ft ²):	4,000	Runoff fro	m other in	npervious surfa	ces (storm)	water)			
Roof collection efficiency (%):	95	Accounts	or depres	sion storage, ra	aingutter &	downspout	leakage, 1	first flush diverters, etc	
Other impervious area collection efficiency (%):	75	Accounts	or depres	sion storage, c	acks, misdi	rection, etc			
Area to be irrigated area (ft ²):	15,000	Vegetated	l area beir	ng irrigated.					
Monthly summer irrigation (in):	2	Based on	0.5"/week						
Monthly spring/fall irrigation (in):	1	Based on	0.25"/wee	k					
Irrigation efficiency	0.90	Or plant e	fficiency (eakage, etc.) S	ource: Wan	ielista. "Ob	tain final	value from OPP"	
Monthly indoor or other demand (gal):	2,132	Toilets, et	c.						
Cistern volume size based on specification	50,000	Total ciste	ern capcac	ity as specified	by manufa	cturor.			
Available cistern volume (gal):	45,000	Assumes 90% of manufacturors specified volume							
Typical annual volume carryover (gal):	13,321		Also = Initial condition volume in cistern (cell K23) - Set to 25% of tank volume for initial estimate. Iterate until Cell K35 equals value in this cell. Set to cell K35 for the final						
Cost in dollars/gallon of potable water:	0.0100	Source: Of	P						

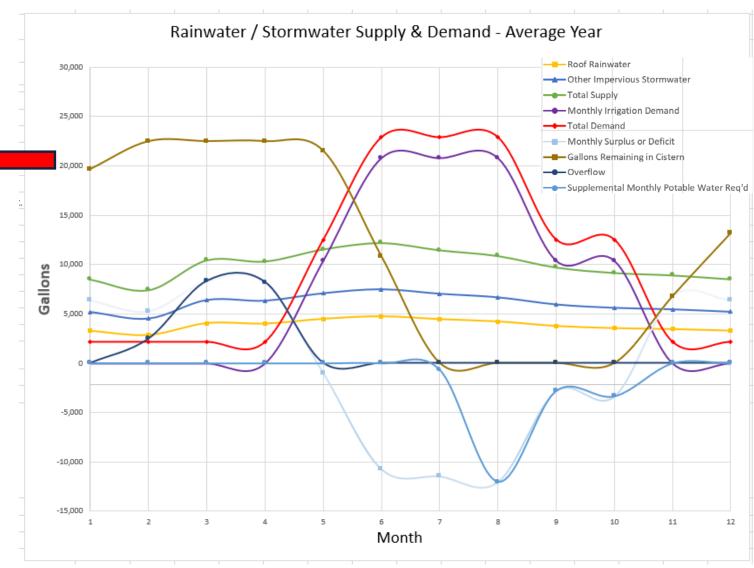
HARVESTER CALCULATOR – SUPPLY / DEMAND CALCULATIONS

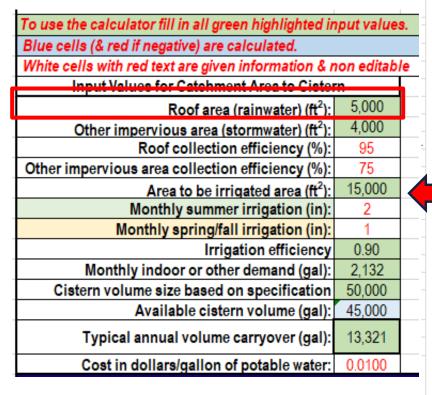
Supply / Demand Calculations													
	Month	Avg. Monthly Precipitation (P) (in)	Avg. PET (in)	Difference	Roof Rainwater (Gallons)	Other Impervious Stormwatrer (Gallons)	Total Supply (Gallons)	Monthly Irrigation Demand (Gallons)	Total Demand (Gallons)	Monthly Surplus or Deficit (Gallons) (Supply - Demand)	Gallons Remaining in Cistern	Overflow (Gallons)	Supplemental Monthly Potable Water Req'd (Gallons)
Init	tial Conditions:										13,321		
	January:	2.78	0.4	2.4	3,293	5,199	8,492	0	2,132	6,360	19,681	0	0
	February:	2.43	0.6	1.83	2,878	4,545	7,423	0	2,132	5,291	24,972	0	0
	March:	3.42	1.4	2.03	4,051	6,396	10,447	0	2,132	8,315	33,287	0	0
	April:	3.38	2.4	0.96	4,004	6,321	10,325	0	2,132	8,193	41,480	0	0
Irrigation month	May:	3.78	3.8	0.02	4,477	7,070	11,547	10,390	12,522	-975	40,505	0	0
Irrigation month	June:	3.99	4.2	-0.23	4,726	7,462	12,188	20,781	22,913	-10,724	29,781	0	0
Irrigation month	July:	3.75	4.5	-0.79	4,442	7,013	11,455	20,781	22,913	-11,457	18,324	0	0
Irrigation month	August:	3.56	3.9	-0.3	4,217	6,658	10,875	20,781	22,913	-12,038	6,286	0	0
Irrigation month	September:	3.18	2.5	0.7	3,767	5,947	9,714	10,390	12,522	-2,808	3,478	0	0
Irrigation month	October:	3.00	1.5	1.47	3,553	5,611	9,164	10,390	12,522	-3,358	120	0	0
	November:	2.92	0.7	2.24	3,459	5,461	8,920	0	2,132	6,788	6,908	0	0
	December:	2.79	0.4	2.41	3,305	5,218	8,523	0	2,132	6,391	13,298	0	0
	Annual Total:	38.98	26	12.74	46,171	72,902	119,074	93,513	119,097	-23		0	0



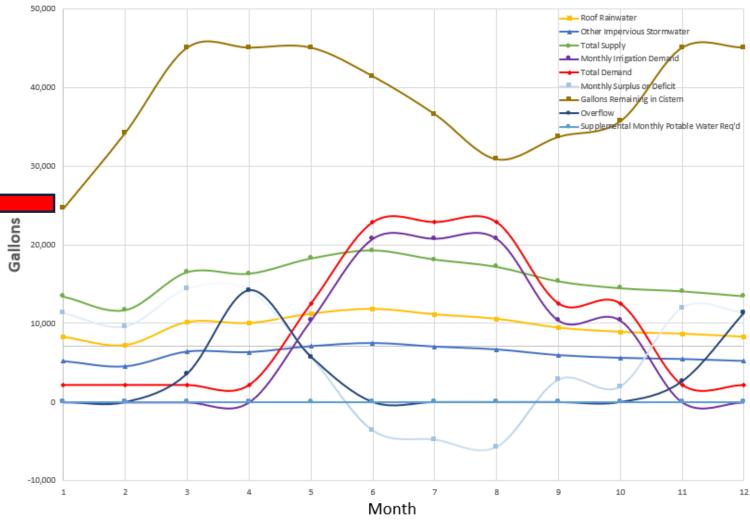


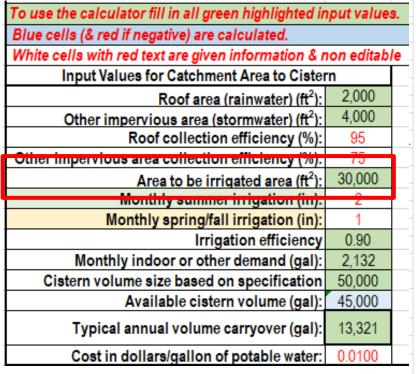


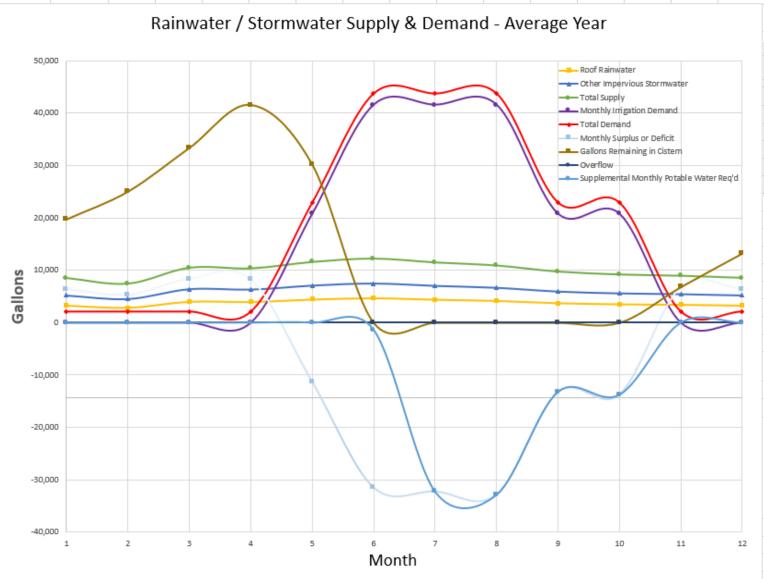












HARVESTER CALCULATOR – SUMMARY & COST DATA

		Cost Data:							
Life expectancy of system (Yrs):	30	To be determine by designer based on manufacturers recommendations.							
Typical cost of cistern / gallon:	\$1.50	Varies by type - see "Storage Tank Costs" in "Typical Costs" tab - GA Tech SW Master Plan recommends \$3/gal.							
Typical cost of cistern + installation:	\$75,000	Typical cistern cost * manufactures capacity (Reference Typical Costs Tab + manufacturer costs).							
Other costs:	\$100,000	From "Typical Costs" tab - GA Tech SW Master Plan approximates \$100,000 for typical installation.							
Annual maintenance / operation costs:	\$2,000	Will be applied to life expectancy of the system.							
Approximate total costs:	\$235,000	Cistern, other costs plus annual costs.							
Cost to implement SW controls with no	\$100,000	Determined by designer.							
Harvesting costs excluding mandatory SW	\$135,000	Total SW harvesting costs minus cost to implement required stormwater controls.							
Life expectancy cost savings from SW harvesting:	\$35,722	Equivalent rainwater/stormwater utilized. (Assumes an alternate stormwater facility of same cost would be requried if reuse not implemented).							
Annual cost savings from harvesting:	\$1,191	Annual cost savings from not using potable water.							
System payback period (Yrs):	113	Design life divided by the annual cost savings.							
Annual return on investment (%):	26	Annual cost savings divided by annual cost (compounding not considered).							
Annual cost of supplemental potable water:	\$0	Based on 1 cent per gallon (Ref: OPP).							

SUMMARY



There is a lot to consider when designing Stormwater Harvesting and Use Systems

Questions?