Garden Irrigation with Rainwater

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Backyard Garden Irrigation

Common Advice: Use Mulch, Avoid evaporation losses, Avoid Sprinklers.

Encourage deep rooting: Irrigate irregularly, and enough at once for at least 6 inches of moisture in soil

Slow watering preferred over fast (causes runoff)

In practice, perfect water requirements can be very complicated

General Recommendation: 1” of water / week

Know your soil type. Know your climate.

Tip: Build organic matter, and use biochar!

Celery is a heavy drinker! 30” water / plant!
At 15 weeks maturity time, this is 2” / week

1 inch of water…

1 square foot 12” x 12”

1 cubic foot = 12” x 12” x 12”

7.48 gallons of water per Cubic Foot (12” x 12” x 12”)

7.48 gallons / 12” = .62 gallons per 1” x 12” x 12”

1” of rain = .62 gallons per square foot

At 10 gal/min, roughly 1 hour at full flow for 1000’ garden

Tip: Keep it simple. My rain gauge is a 5 gallon bucket!

(fyi - mosquitoes mature in about 7 days)

A 5 gallon bucket:
1” of water for 8 square feet

275 gallons, or,
1” of water for 443 square feet

Benefits of Rainwater

Free! No or very low energy required!

Easier on shared potable water supplies during times of drought

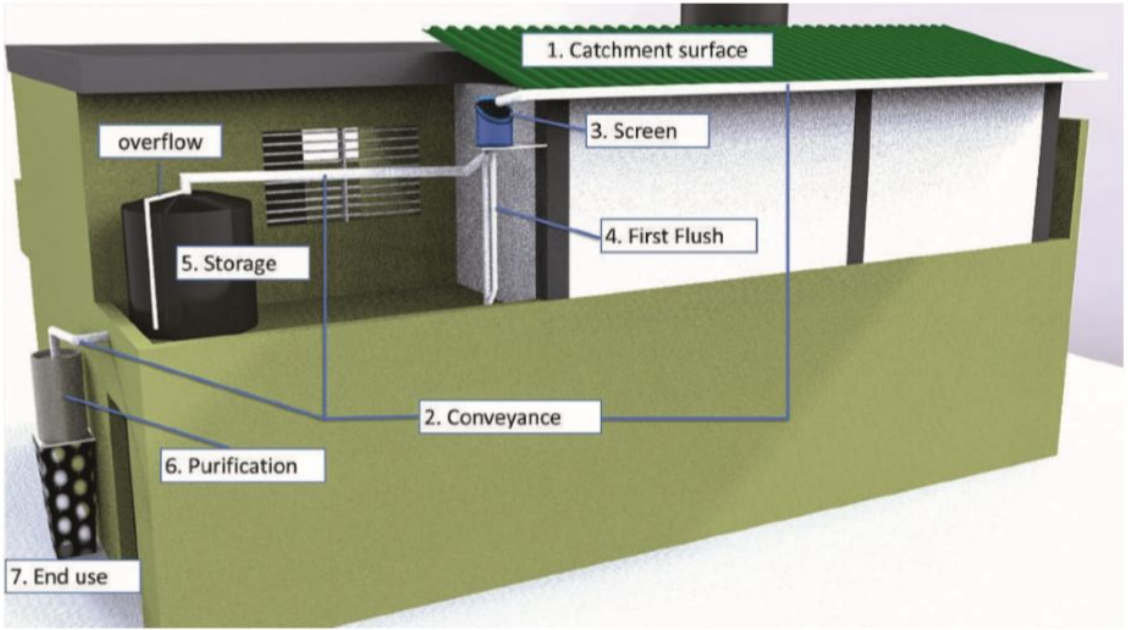
Municipal or well water may contain significant levels of unwanted minerals, salts, Chlorine or Chloramine.

Nitrogen Compounds in air can be absorbed by falling rainwater. N compounds stable in storage?

No cold shock from very cold ground water?

A powerful energy source for breaking apart N2 molecules!

Rainwater Harvesting System Components



From: To Catch the Rain *Lonny Grafman, Appropedia*

Calculating Collection Capacity

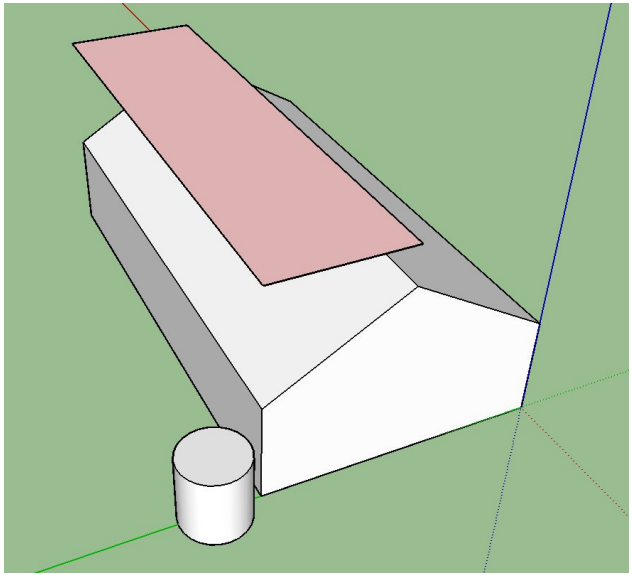
Determine **Horizontal Projection** of Roof

1 square foot = .62 gallons / inch of rain

Surface Efficiency Factor - .8 typ, .95 for metal

Subtract for potential losses in Conveyance

Subtract losses for **First Flush**



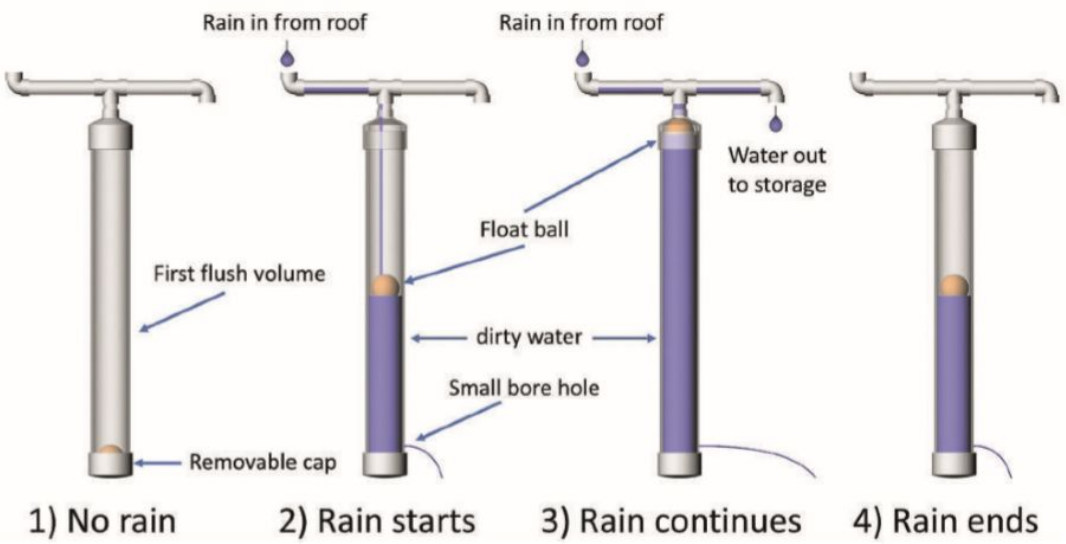
Rainwater Collection Hardware: “First Flush”

Collection point for roof wash sediment prior to tank storage.

Helpful for maintaining clean storage tank, preventing clogging issues down the line.

Necessary for irrigation water storage?

Maintenance!



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DIY Rainwater Collection Systems: Best Practices

Divert excess water back to existing gutter downspout (away from foundation!)

Cover ALL ports with minimum 1/16” mesh.

Opaque storage tank preferred. No Algae! Required for drip irrigation use.

Water is heavy! Have a well supported storage tank.

Consider “Nudges” - Design for maintenance reminders, convenience

For No Pump drip irrigation: storage tank MUST be above the garden!

Elevation of storage tank is source of pressure!

Water Pressure

Commonly measured in **Pounds per Square Inch**

Typ Household Water pressure: 40-80 psi

Typical drip irrigation pressure req's: 15-25 psi

Pressure in piping systems referred to as 'feet-of-head'

1 foot of head = .433 psi

2.31 feet of head = 1 psi

Static Head: Pressure of non-moving water

Dynamic Head: Factors in velocity, friction losses from piping

Ex: Rainwater collection for small garden near Asheville, NC

Effective Collection area = 330ft²

Roof Material (asphalt shingle) efficiency factor - .8

Diverter valve losses expected - .9 (total guess)

No First Flush losses

Remember, 1” rain = .62 g/ft²

330ft² x .62 = 204.6 g

204.6 g x .8 x . 9 = **147 gallons potential collection / inch of rain**

Example: 300 ft² Garden near Asheville NC

6 small beds, downhill from single drum storage.

2 drums - one uphill at house, gravity feed into one at garden. Only 4’-7’ drop to lowest bed.

Currently only 100 Gallons usable storage.

Estimated Weekly watering demand:

1” of water - .62 gallons / sq ft.

1” applied to 300 ft² = 186 gallons

Remember: This 1” is only needed if it doesn’t rain that much!

Climate Data - Asheville Area, last 3 years

Monthly Total Precipitation for ASHEVILLE AIRPORT, NC

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2016	3.29	5.69	1.56	2.50	1.84	2.53	4.39	6.65	0.58	0.52	1.54	2.31	33.40
2017	3.72	0.70	3.92	7.65	7.03	2.71	4.53	6.35	3.75	9.68	1.59	2.47	54.10
2018	4.04	5.57	3.11	4.64	14.68	2.57	6.58	10.41	4.00	5.85	7.16	10.87	79.48
2019	5.28	6.91	2.63	8.97	3.35	6.90	3.69	3.98	0.90	7.78	2.57	M	M
Mean	4.08	4.72	2.81	5.94	6.73	3.68	4.80	6.85	2.31	5.96	3.22	5.22	55.66
Max	5.28 2019	6.91 2019	3.92 2017	8.97 2019	14.68 2018	6.90 2019	6.58 2018	10.41 2018	4.00 2018	9.68 2017	7.16 2018	10.87 2018	79.48 2018
Min	3.29 2016	0.70 2017	1.56 2016	2.50 2016	1.84 2016	2.53 2016	3.69 2019	3.98 2019	0.58 2016	0.52 2016	1.54 2016	2.31 2016	33.40 2016

Source: https://nowdata.rcc-acis.org/gsp/

Monthly collection data on an average year

Sizing a Rainwater Tank based on Climatological and Usage Data

	User Input	Units	SI Units	
Footprint	339	ft²	31	m²
Roof Efficiency	0.72	*material dependent, e.g., 0.75 soil, 0.8 average, 0.95 metal*		
Size of Tank	110	gal	416	liters

ID #	Asheville AVG	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Total
Rainfall (in)		3.43	3.17	3.47	4.14	4.35	4.68	5.19	4.82	4.41	3.41	3.76	4.67	4.13	49.5
Collection Capacity (gal)		522	482	528	630	662	712	790	733	671	519	572	711	628	7,532
Usage (gal)		0	0	804	804	804	804	804	804	804	804	0	0	536	6432
Tank Vol, starting full in Jan (gal)		110	110	0	0	0	0	0	0	0	0	110	110	37	
2nd year tank volume (gal)		110	110	0	0	0	0	0	0	0	0	110	110	37	
Recommendation		At least one month with not enough water													

804 gallon usage estimated from 300 ft2 garden x .62 x 4.3(weeks in month) x 1 (inches water needed per week
Actual water needed for irrigation should account for rainfall… of course!

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size of garden	300	ft²		

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	Collection Capacity (gal)	522	482	528	630	662	712	790	733	671	519	572	711	628	7,532
	Weeks/month, inches of irrigation demand				4	4.42	4.28	4.42	4.42	4.28	4.28				
	Required inches Irrigation (demand-rainwater)				-0.14	0.07	-0.4	-0.77	-0.4	-0.13	0.87				
	garden demand factor - 1" required				-0.09	0.04	-0.25	-0.48	-0.25	-0.08	0.54				
	Usage - garden demand factor x total ft2	0	0	0	0	13	0	0	0	0	162	0	0	15	174.84
	Tank Vol, starting full in Jan (gal)	110	110	110	110	110	110	110	110	110	110	110	110	110	
	2nd year tank volume (gal)	110	110	110	110	110	110	110	110	110	110	110	110	110	
	Recommendation	**Sustainable Supply**													

Average Rainfall in our area is adequate for summer months. (at 1” per week recommendation)
It appears we never need to irrigate, but we irrigate more often than once a month!
If monthly rain was evenly divided by week we may never need to irrigate!

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	Rainfall (in)	3.29	5.69	1.56	2.5	1.84	2.53	4.39	6.65	0.58	0.52	1.54	2.31	2.78	33.4
	Collection Capacity (gal)	501	866	237	380	280	385	668	1012	88	79	234	351	423	5,082
	Weeks/month, inches of irrigation demand				4	4.42	4.28	4.42	4.42	4.28	4.28				
	Required inches Irrigation (demand-rainwater)				1.5	2.58	1.75	0.03	-2.23	3.7	3.76				
	garden demand factor - 1" required				0.93	1.60	1.09	0.02	-1.38	2.29	2.33				
	Usage - garden demand factor x total ft2	0	0	0	279	480	326	6	0	688	699	0	0	206	2477.52
	Tank Vol, starting full in Jan (gal)	110	110	110	110	0	59	110	110	0	0	110	110	78	
	2nd year tank volume (gal)	110	110	110	110	0	59	110	110	0	0	110	110	78	
	Recommendation	**At least one month with not enough water**													

Sizing a Rainwater Tank based on Climatological and Usage Data

	User Input	Units	SI Units
Footprint	339	ft²	*31 m²*
Roof Efficiency	0.72	*material dependent, e.g., 0.75 soil, 0.8 average, 0.95 metal*	
Size of Tank	1250	gal	*4731 liters*
size of garden	300	ft²	

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	garden demand factor - 1" required				0.93	1.60	1.09	0.02	-1.38	2.29	2.33				
	Usage - garden demand factor x total ft2	0	0	0	279	480	326	6	0	688	699	0	0	206	2477.52
	Tank Vol, starting full in Jan (gal)	1250	1250	1250	1250	1050	1110	1250	1250	650	30	264	616	935	
	2nd year tank volume (gal)	1116	1250	1250	1250	1050	1110	1250	1250	650	30	264	616	924	
	Recommendation	Sustainable Supply													

Spreadsheet modified from Appropedia - An open-source Appropriate Technology Wiki

A low-cost plan moving forward...

Expand storage to accomodate 2 weeks with no rain

2 inches storage for 300ft² = **372 gallons**

Keep 50 gallon storage in front area for ornamental plants, tool washing.

Collect and store water in 250 gal IBC tote in shaded area under back porch. Use small utility pump between house storage and garden storage as needed.

Add garden storage for one week's water for 3 to 4 beds. Build sturdy platform for leveling and some elevation gain.

Manifold for 3 or 4 beds on very low pressure drip.

Not going to automate. I'll watch my rain gauge myself.

Experiment with water distribution before planting.

Tip: Rotate beds with low demand summer cover crops like Buckwheat to build soil for better water storage (and much more) for cool season, low water demand vegetables.

Gravity Fed, Very Low Pressure Drip Irrigation

Possibly even more efficient irrigation given extremely slow application

Elevate rainwater storage tank as much as possible. **1 PSI / 2.31 feet** of head.

Even drip rates are dependent on steady pressure. Expect uneven flow rates

Design for heavy drinker plants at the beginning of the run

Instead of long runs, design with manifold and short runs.

Totally flat sites will need elevated tank to overcome friction losses of piping

Use ball valve type automated timers. Search “no pressure irrigation timer”

Use piping with inline emitters (holes in tough, but flexible pipe) with suitable filter (100-150 mesh typical)

Low cost entry level kits available from rainwater collection equipment suppliers.

Questions?

References and Additional Information:

Appropedia and To Catch the Rain from Lonny Grafman. Open source, free download. Thank you!

IrrigationTutorials.com. Very detailed, open source irrigation design help from landscape architect in CA

Regional Weather Data: https://nowdata.rcc-acis.org/gsp/

Estimated Water Requirements for Vegetable Crops from Texas A&M