Zero Net Water

A sustainable water development concept for the Texas Hill Country – and beyond

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ARCSA 2014

Imagine a water management strategy that would accommodate growth and development without unsustainably pumping down aquifers or incurring the huge expense and societal disruption to build reservoirs or transport water from remote supplies to developing areas.

Welcome to the concept of

Zero Net Water.

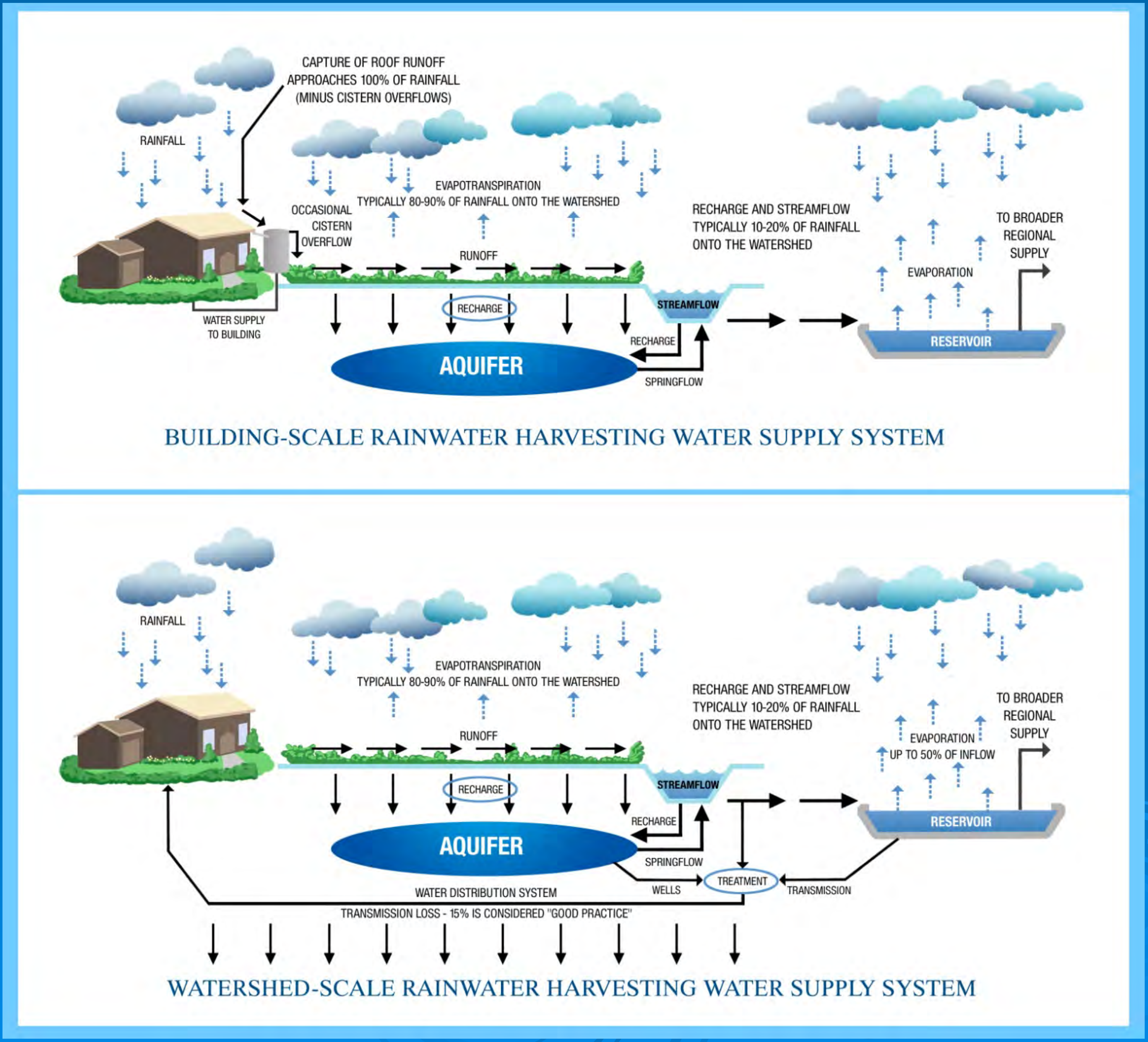
The ***Zero Net Water*** Concept:

- Water supply is centered on building-scale rainwater harvesting.
- “Waste” water management is centered on decentralized reclamation and reuse to supply irrigation demands.
- Stormwater management is centered on LID/green infrastructure/volume-based hydrology to hold water on the site, maintaining hydrologic integrity of the watershed.

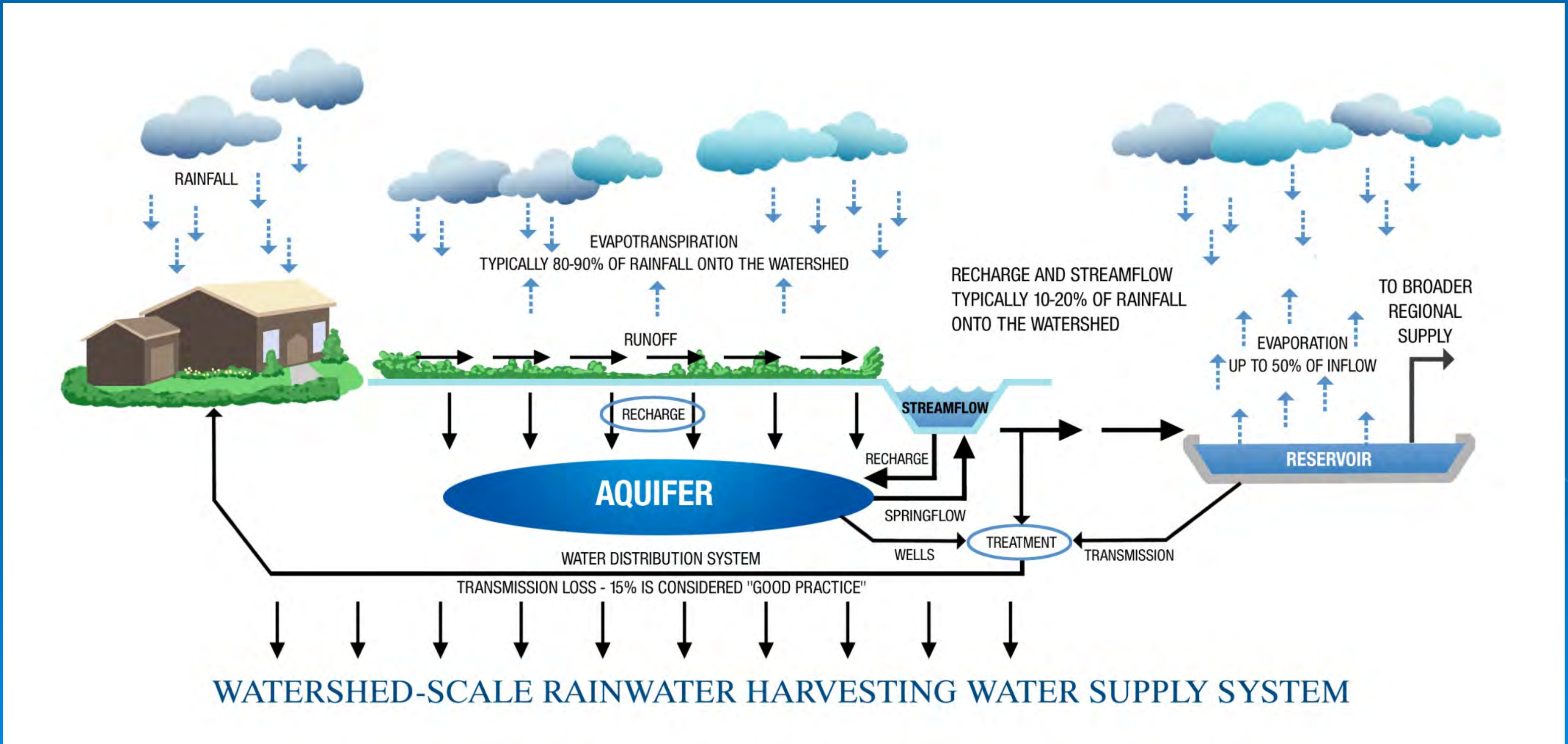
The Result:

Minimal disruption of flows through the watershed, even as water is harvested at the site scale to be used – and reused there – to support development, creating a *sustainable water* development model

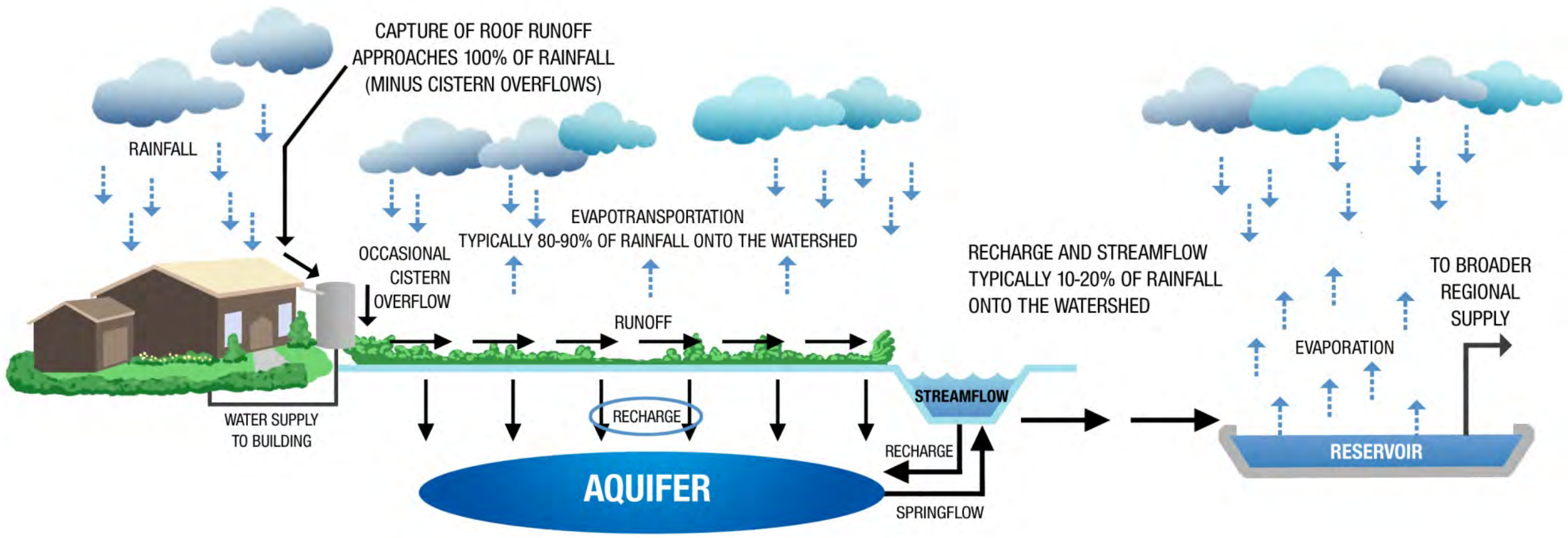
Take advantage of difference in the inherent water capture efficiency of building-scale vs. watershed-scale rainwater harvesting



Inefficiencies are inherent in the Watershed-Scale Rainwater Harvesting water supply model



Building-Scale Rainwater Harvesting significantly blunts those inefficiencies



BUILDING-SCALE RAINWATER HARVESTING WATER SUPPLY SYSTEM

Which model is more sane?

Capture rainfall at extremely high efficiency, very lightly impaired, over the little parts of the watershed right where the water is needed – the buildings – and use it there?

or

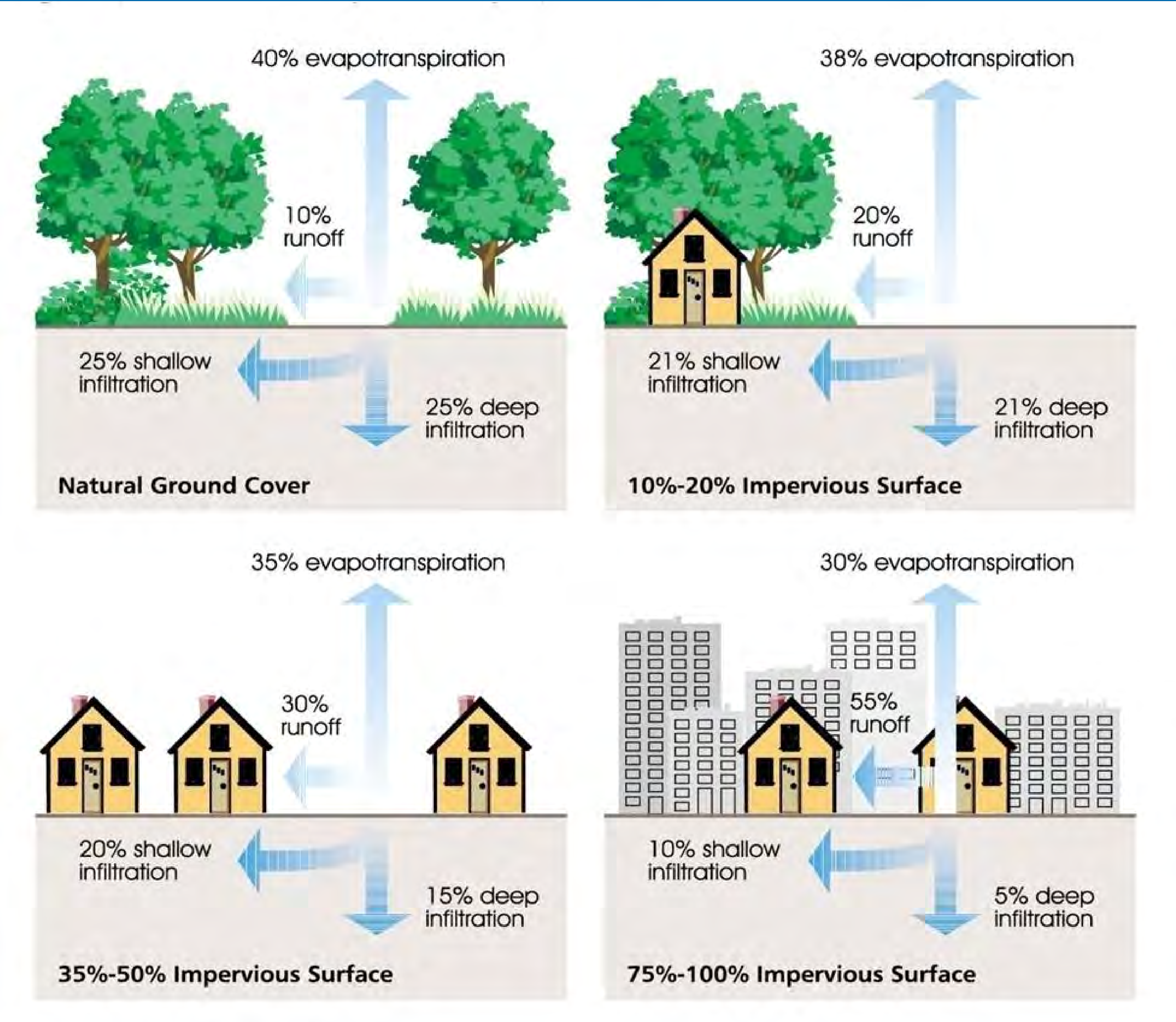
Capture rainfall at very low efficiency, with degraded quality, over the whole watershed, then lose a great deal of it in storage and in moving the same amount of water that fell on a building back to that building? And use a lot of energy doing that?

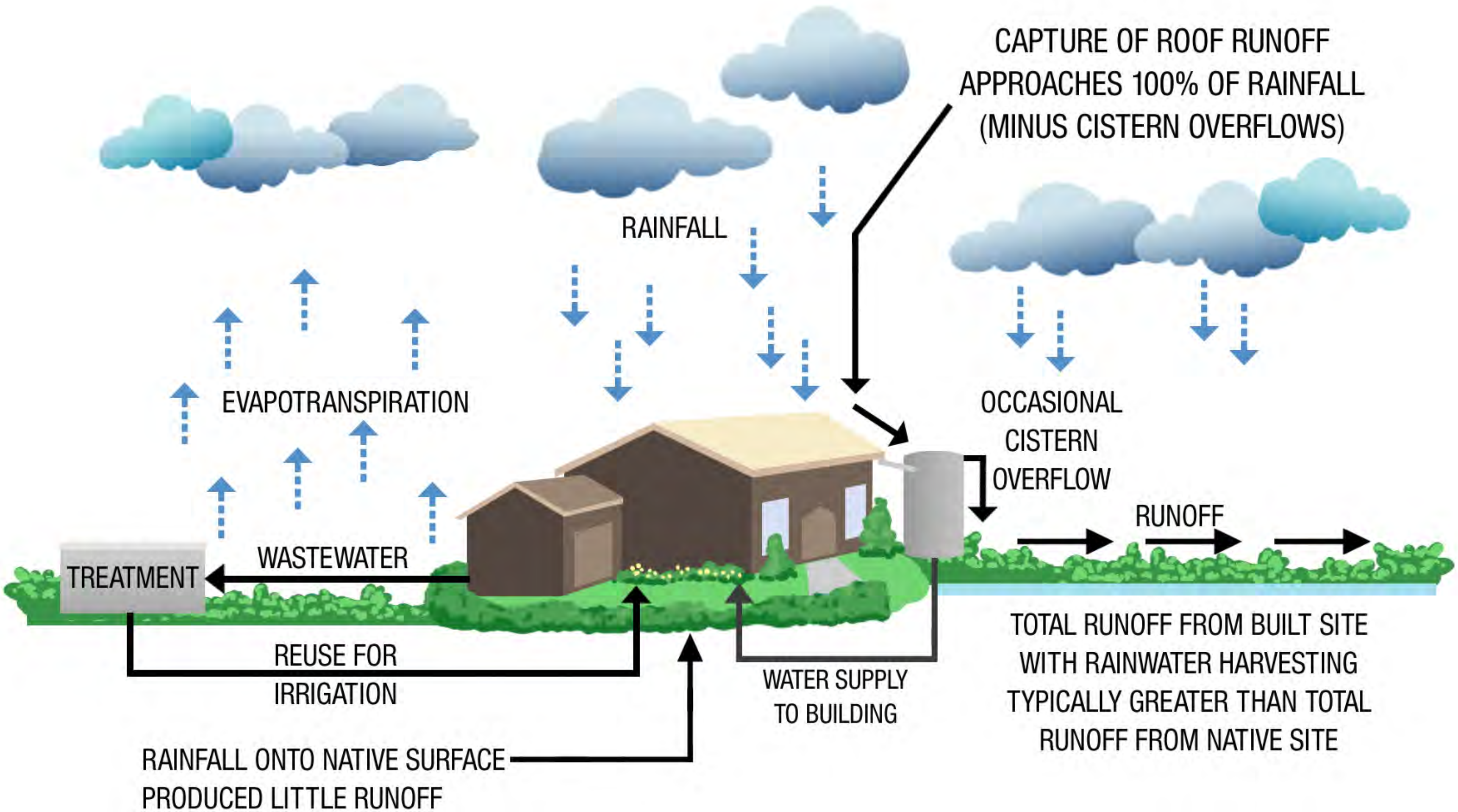
Building-scale RWH "grows" water supply in direct proportion to increasing demand

Besides more efficiently transforming water falling on the watershed into a water supply usable by humans, creating a *sustainable* water supply system,

ALSO creates a more *economically efficient* water supply system – supply is built, and paid for, only in response to imminent demand, one building at a time.

Building-scale rainwater harvesting does NOT rob streamflow


40% evapotranspiration
10% runoff
25% shallow infiltration
25% deep infiltration
Natural Ground Cover
38% evapotranspiration
20% runoff
21% shallow infiltration
21% deep infiltration
10%-20% Impervious Surface
35% evapotranspiration
30% runoff
20% shallow infiltration
15% deep infiltration
35%-50% Impervious Surface
30% evapotranspiration
55% runoff
10% shallow infiltration
5% deep infiltration
75%-100% Impervious Surface



BUILDING-SCALE WATER CYCLE

Bottom line …

- We capture and utilize on site some of the *additional* runoff created by development.
- Do this instead of allowing that additional runoff to become quickflow.
- If not mitigated in some other way, that quickflow creates water quality, channel erosion and downstream flooding problems.
- We *can* capture a water supply directly usable by humans off new impervious surfaces *without* any significant impact on streamflow out of the watershed.

The caveat to “Zero” …

The building-scale cistern is a "distributed reservoir"

- Stores water for future use
- Has a "firm yield" that will cover a given water demand profile
- Considerations of cost efficiency lead to concept of "right-sizing" the RWH system – roofprint and cistern capacity – so that "firm yield" would cover demands in all but most severe drought periods
- Forego spending a lot to cover the last little bit of demand, instead bringing in a backup supply to cover it

Backup supply would be drawn from the watershed-scale RWH system

- "Right-sizing" would minimize this draw
- Need for backup supply from watershed-scale system occurs just when that system is also most stressed by drought
- "Off-loading" demands on the watershed-scale system most of the time allows it to retain more supply to buffer drought stress
- Watershed-scale system recovers more quickly when rains do come

Dripping Springs, 1987-2014
Interior Usage Only

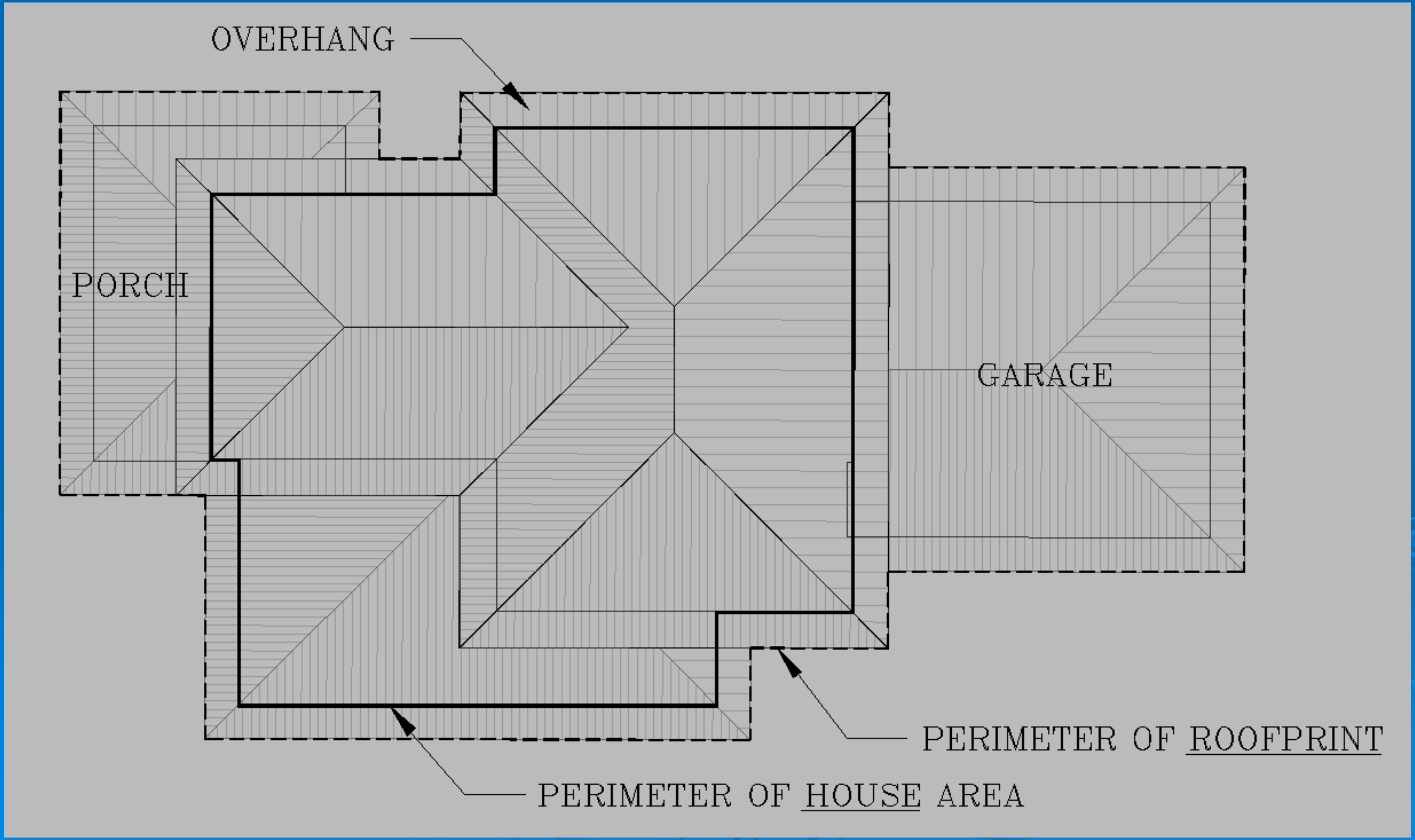
Roofprint	4,500 sq. ft.
Cistern capacity	35,000 gallons
Occupancy	4 persons
Water usage rate	45 gpcd

Backup supply requirements

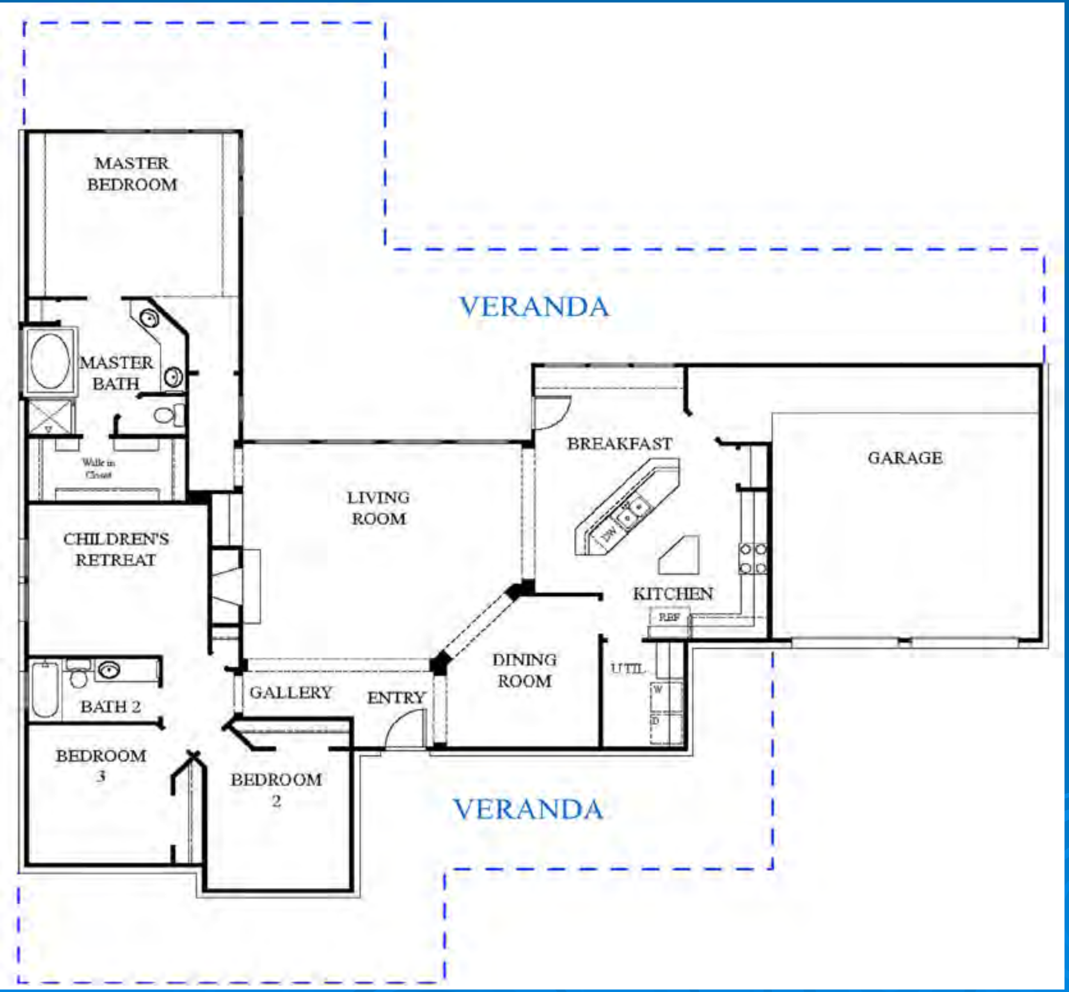
2009	4,000 gallons
2011	10,000 gallons
Total =	14,000 gallons

Portion of demand supplied by rainwater in drought period 2008-2014 = 97.0%

Roofprint is the plan area of the ROOF, all the roof, NOT the house living area

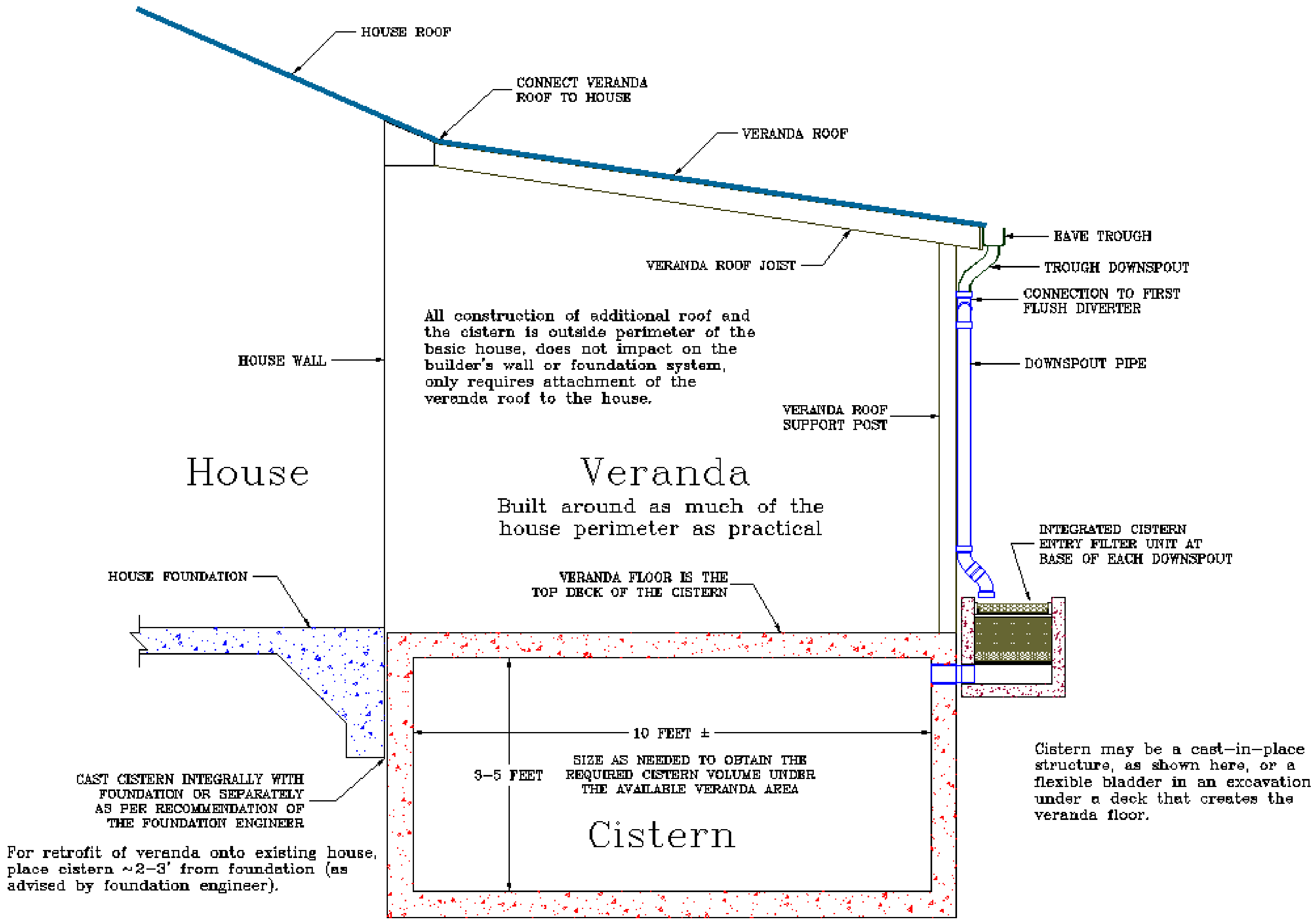


The "Veranda Strategy"
Relatively cost-efficient additional roofprint



The "Veranda Strategy"

to create the Hill Country Rainwater Harvesting Vernacular House Design



Dripping Springs, 1987-2014
Interior Usage Only

Roofprint	4,500 sq. ft.
Cistern capacity	35,000 gallons
Occupancy	4 persons
Water usage rate	40 gpcd

<u>Backup supply requirements</u>

2011	2,000 gallons
Total =	2,000 gallons

Portion of demand supplied by rainwater in drought period 2008-2014 = 99.5%

Dripping Springs, 1987-2014
Interior Usage Only

Roofprint	4,000 sq. ft.
Cistern capacity	30,000 gallons
Occupancy	4 persons
Water usage rate	40 gpcd

<u>Backup supply requirements</u>

2009	6,000 gallons
2011	10,000 gallons
Total =	16,000 gallons

Portion of demand supplied by rainwater in drought period 2008-2014 = 96.1%

Dripping Springs, 1987-2014
Interior Usage Only

Roofprint	4,000 sq. ft.
Cistern capacity	30,000 gallons
Occupancy	4 persons
Water usage rate	35 gpcd

Backup supply requirements

2011	2,000 gallons
Total =	2,000 gallons

Portion of demand supplied by rainwater in drought period 2008-2014 = 99.4%

Dripping Springs, 1987-2014
Interior Usage Only

Roofprint	3,500 sq. ft.
Cistern capacity	25,000 gallons
Occupancy	4 persons
Water usage rate	35 gpcd

Backup supply requirements

2009	6,000 gallons
2011	10,000 gallons
Total =	16,000 gallons

Portion of demand supplied by rainwater in drought period 2008-2014 = 95.5%

Dripping Springs, 1987-2014
Seniors Oriented Development

Roofprint	2,500 sq. ft.
Cistern capacity	15,000 gallons
Occupancy	2 persons
Water usage rate	45 gpcd

Backup supply requirements

2009	2,000 gallons
2011	8,000 gallons
Total =	10,000 gallons

Portion of demand supplied by rainwater in drought period 2008-2014 = 95.7%

San Antonio

Standard subdivision – 4 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal) 2008	2009	2010	2011	2012	2013	2014*	Portion of Demand from Rainwater
45	4,500	35,000	8,000	18,000	0	8,000	0	0	0	92.6%
40	4,250	32,500	4,000	14,000	0	4,000	0	0	0	94.6%
35	4,000	30,000	0	10,000	0	2,000	0	0	0	96.6%

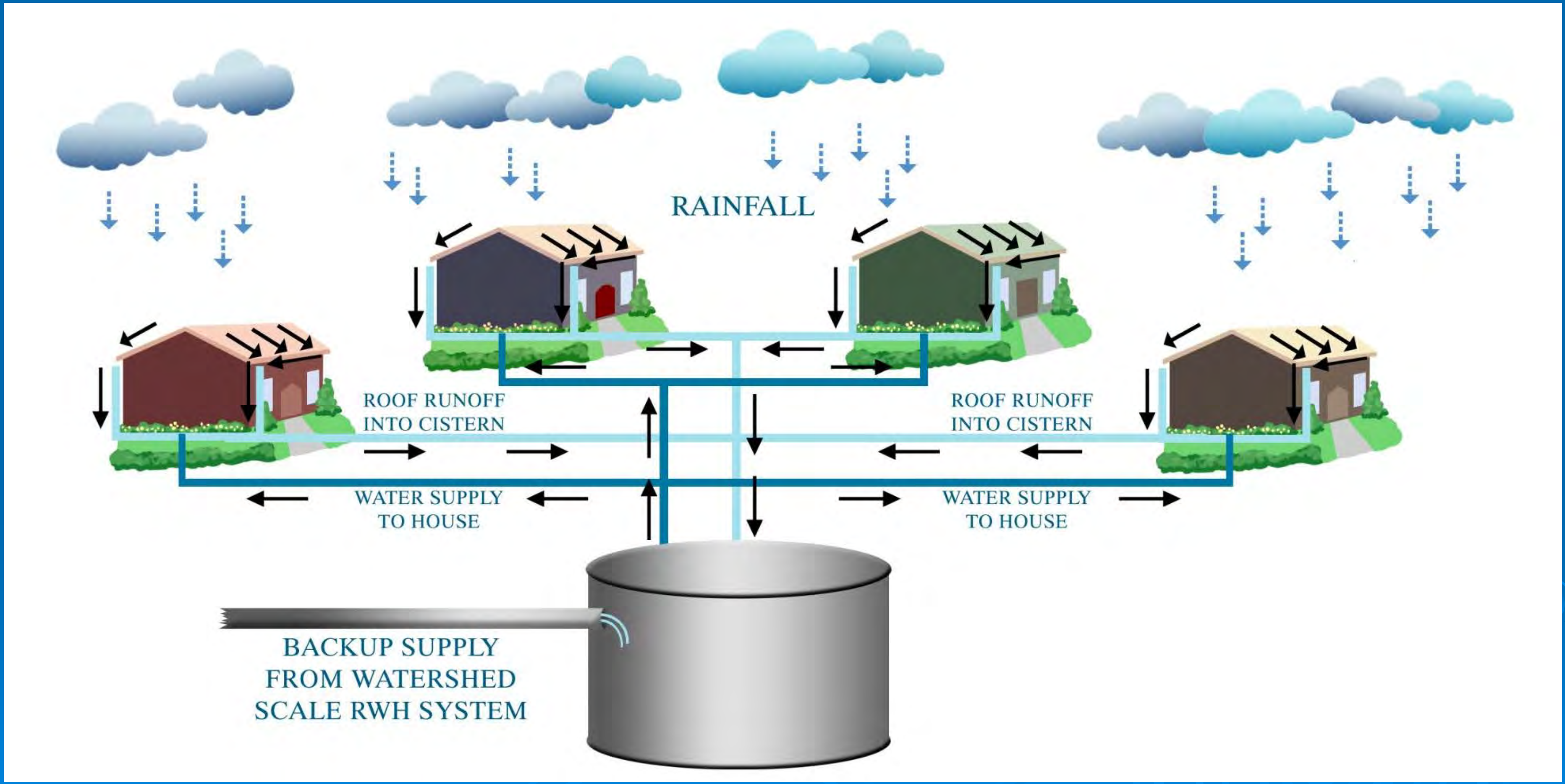
*thru September

Seniors oriented subdivision – 2 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal) 2008	2009	2010	2011	2012	2013	2014*	Portion of Demand from Rainwater
45	2,500	20,000	2,000	6,000	0	2,000	0	0	0	95.7%
40	2,250	17,500	2,000	6,000	0	2,000	0	0	0	95.1%
35	2,000	15,000	2,000	6,000	0	2,000	0	0	0	94.4%

*thru September

Collective Conjunctive-Use System



Brownwood

Standard subdivision – 4 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal)							Portion of Demand from Rainwater
			2008	2009	2010	2011	2012	2013	2014*	
45	4,250	27,500	0	2,000	0	4,000	0	0	2,000	98.2%
40	3,750	25,000	0	2,000	0	4,000	0	0	2,000	97.9%
35	3,250	22,500	0	2,000	0	4,000	0	0	2,000	97.7%

*thru September

Seniors oriented subdivision – 2 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal)							Portion of Demand from Rainwater
			2008	2009	2010	2011	2012	2013	2014*	
45	2,250	15,000	0	0	0	2,000	0	0	0	99.1%
40	2,000	12,500	0	0	0	2,000	0	0	0	99.0%
35	1,750	10,000	0	2,000	0	4,000	0	0	0	96.5%

*thru September

DFW Metroplex Area

Ferris

Standard subdivision – 4 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal) 2008	2009	2010	2011	2012	2013	2014*	Portion of Demand from Rainwater
45	3,250	25,000	0	0	0	2,000	0	0	2,000	99.1%
40	3,000	20,000	0	0	0	4,000	0	0	0	98.9%
35	2,750	17,500	0	0	0	2,000	0	0	0	99.3%

*thru September

Seniors oriented subdivision – 2 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal) 2008	2009	2010	2011	2012	2013	2014*	Portion of Demand from Rainwater
45	2,000	12,500	0	0	0	0	0	0	0	100%
40	1,750	10,000	0	0	0	0	0	0	0	100%
35	1,500	10,000	0	0	0	0	0	0	0	100%

*thru September

DFW Metroplex Area

Denton

Standard subdivision – 4 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal) 2008	2009	2010	2011	2012	2013	2014*	Portion of Demand from Rainwater
45	3,750	27,500	0	0	0	0	0	0	2,000	99.5%
40	3,250	22,500	0	0	0	0	0	0	6,000	98.5%
35	3,000	17,500	0	0	0	0	0	0	4,000	98.8%

*thru September

Seniors oriented subdivision – 2 person occupancy

Water Usage Rate (gpcd)	Roofprint (sq. ft.)	Cistern Capacity (gal)	Backup Supply Required (gal) 2008	2009	2010	2011	2012	2013	2014*	Portion of Demand from Rainwater
45	2,000	12,500	0	0	0	0	0	0	0	100%
40	1,750	10,000	0	0	0	0	0	0	2,000	99.0%
35	1,500	10,000	0	0	0	0	0	0	2,000	98.8%

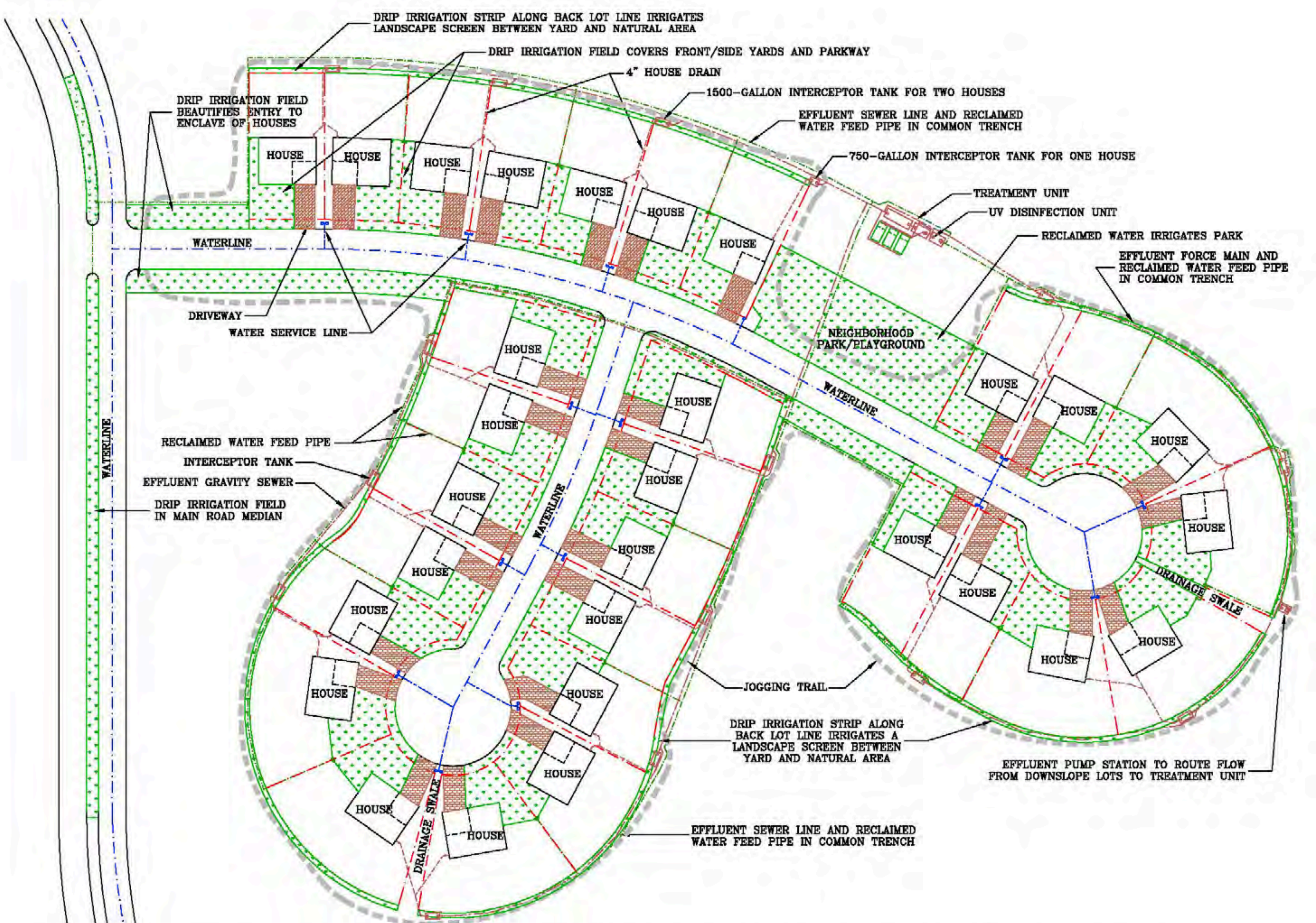
*thru September

Under ***Zero Net Water***
Irrigation needs would be met
mainly by "waste" water reuse

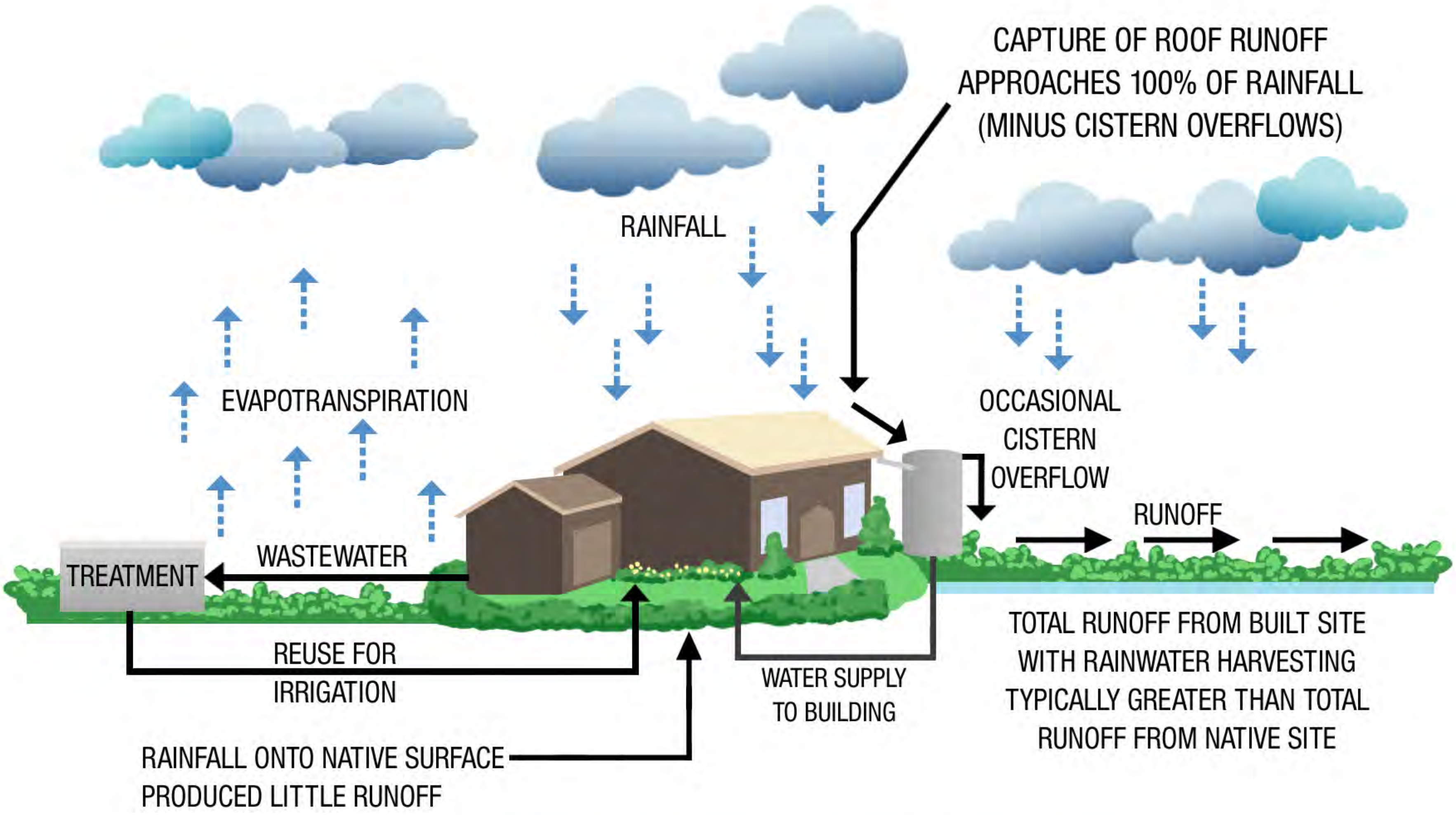
“Waste” water reuse has high value for rainwater harvesters

- A “right-sized” RWH system for interior use only is already “large”
- To provide irrigation supply directly out of the cistern would require a larger system – or *much* more backup
- A flow of water is sitting *right there* we can use for irrigation, that we’ve *already paid* a hefty price to gather – the “waste” water flowing from water used in the house

Don’t lose it – reuse it!



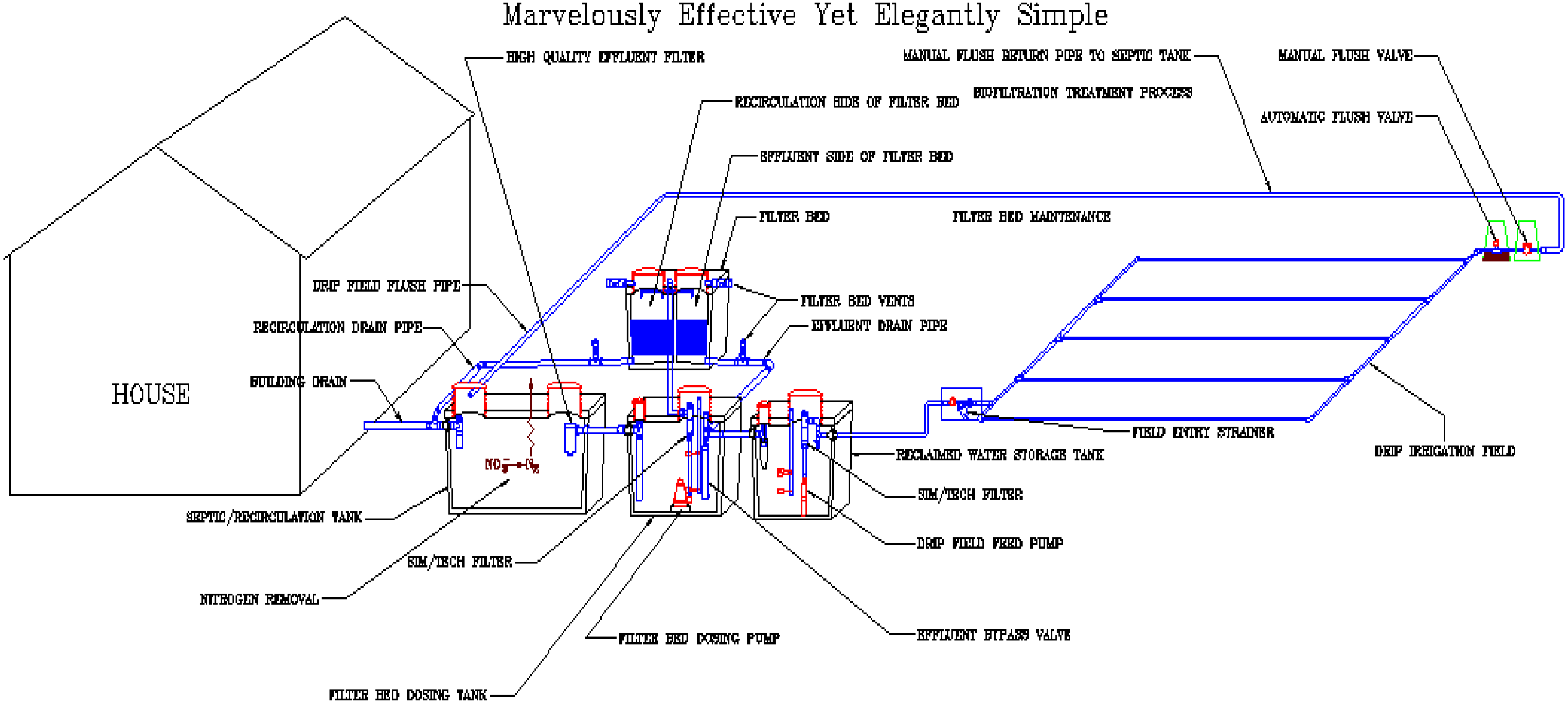
DECENTRALIZED CONCEPT WASTEWATER SERVICE PLAN



BUILDING-SCALE WATER CYCLE

The High Performance Biofiltration/Drip Irrigation System Concept

Marvelously Effective Yet Elegantly Simple






Dripping Springs, 1987-2014
Interior + Irrigation Usage
WITHOUT wastewater reuse

Roofprint	4,500 sq. ft.
Cistern capacity	35,000 gallons
Occupancy	4 persons
Water usage rate	45 gpcd
Irrigated area	2,400 sq. ft.

Backup water supply required in 14 years

Max. yr. = 50,000 gallons in 2011

2nd most = 32,000 gallons in 2009

3rd most = 26,000 gallons in 2008

Total over 28 years = 204,000 gallons

Dripping Springs, 1987-2014
Interior + Irrigation Usage
WITHOUT wastewater reuse, larger system

Roofprint	7,000 sq. ft.
Cistern capacity	45,000 gallons
Occupancy	4 persons
Water usage rate	45 gpcd
Irrigated area	2,400 sq. ft.

<u>Backup supply requirements</u>

2009	2,000 gallons
2011	26,000 gallons
Total =	28,000 gallons

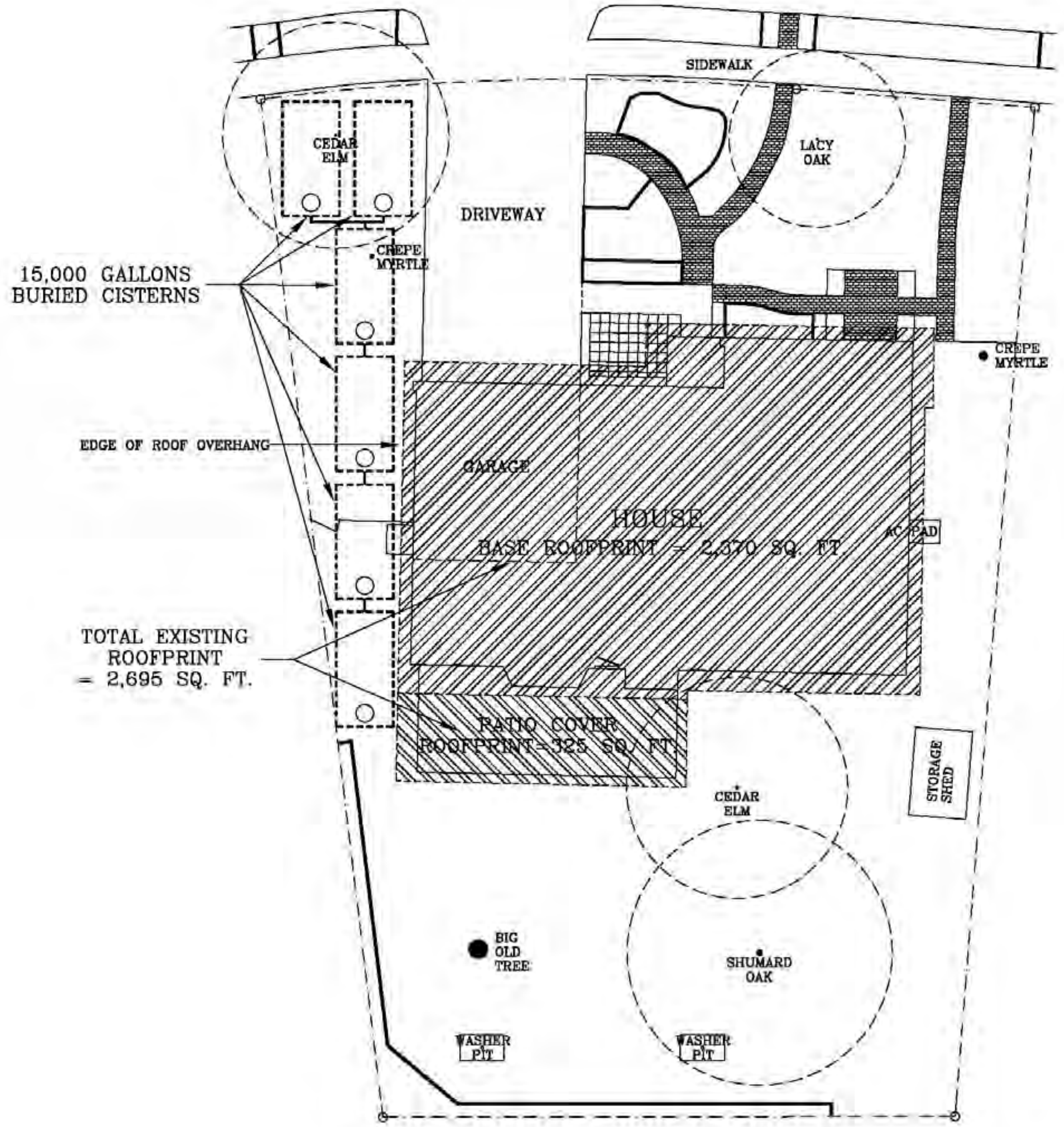
Dripping Springs, 1987-2014 Interior + Irrigation Usage

WITH wastewater reuse

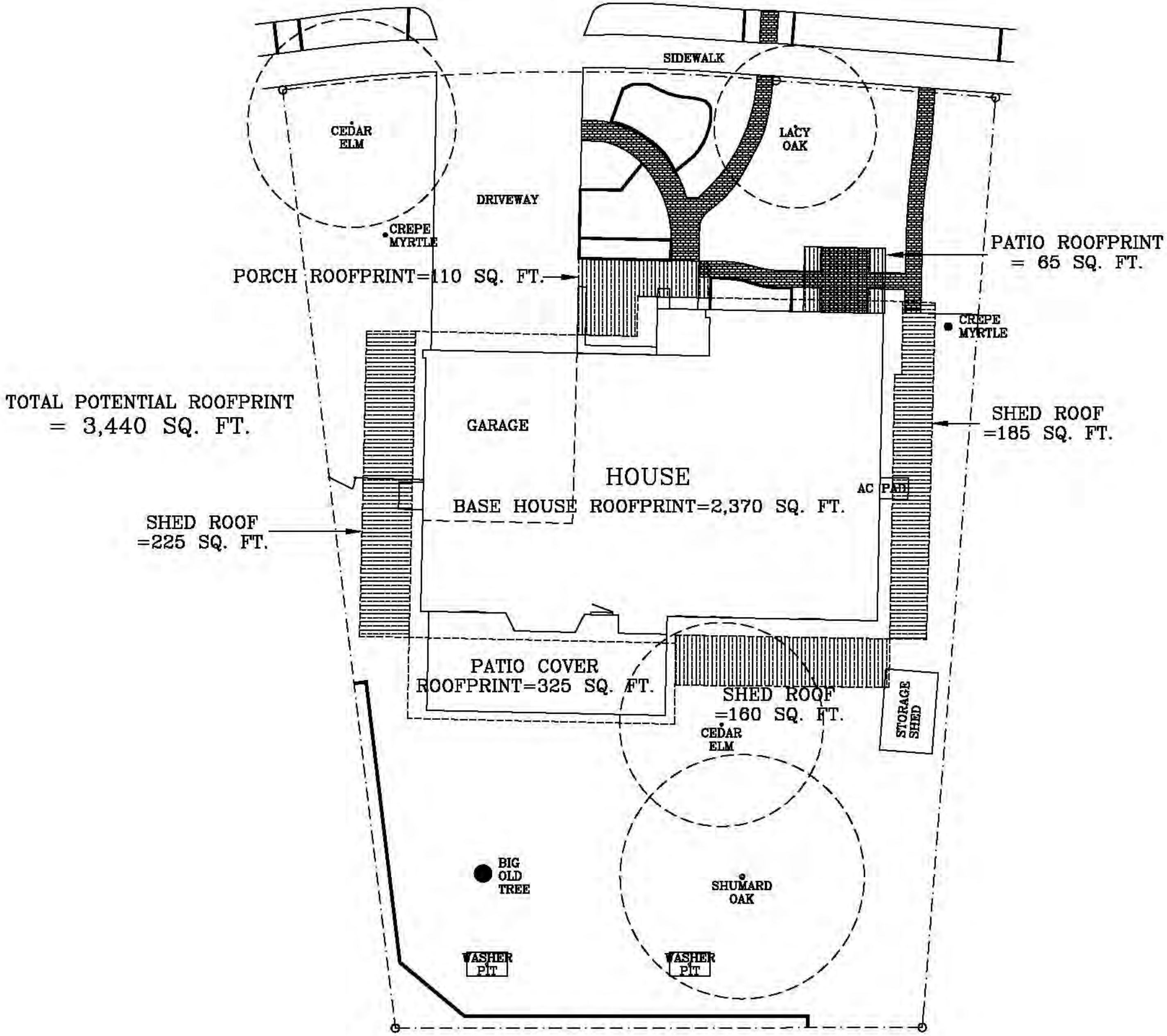
Roofprint	4,500 sq. ft.
Cistern capacity	35,000 gallons
Occupancy	4 persons
Water usage rate	45 gpcd
Irrigated area	2,400 sq. ft.

<u>Backup supply requirements</u>

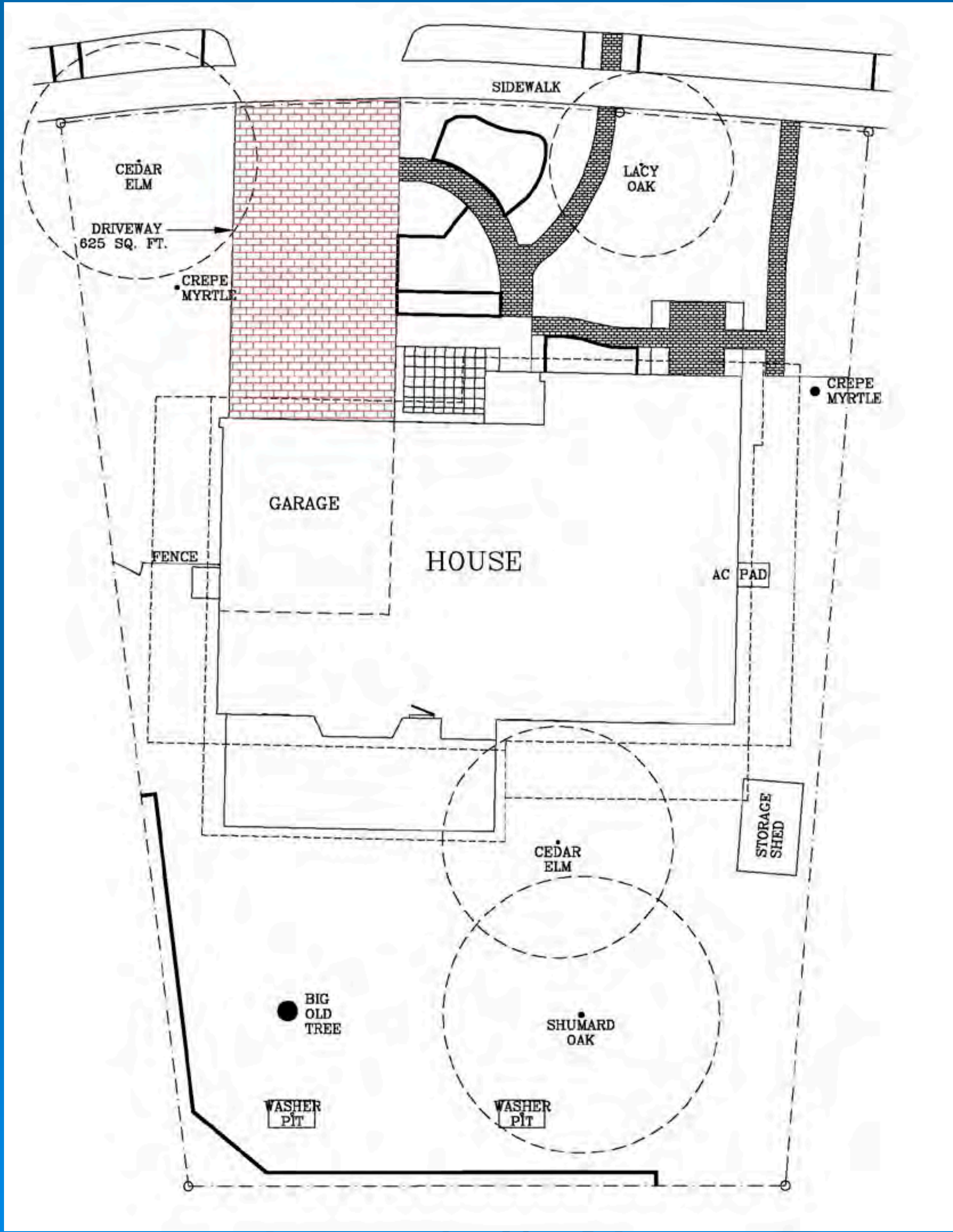
2009	8,000 gallons
2011	16,000 gallons
Total =	24,000 gallons



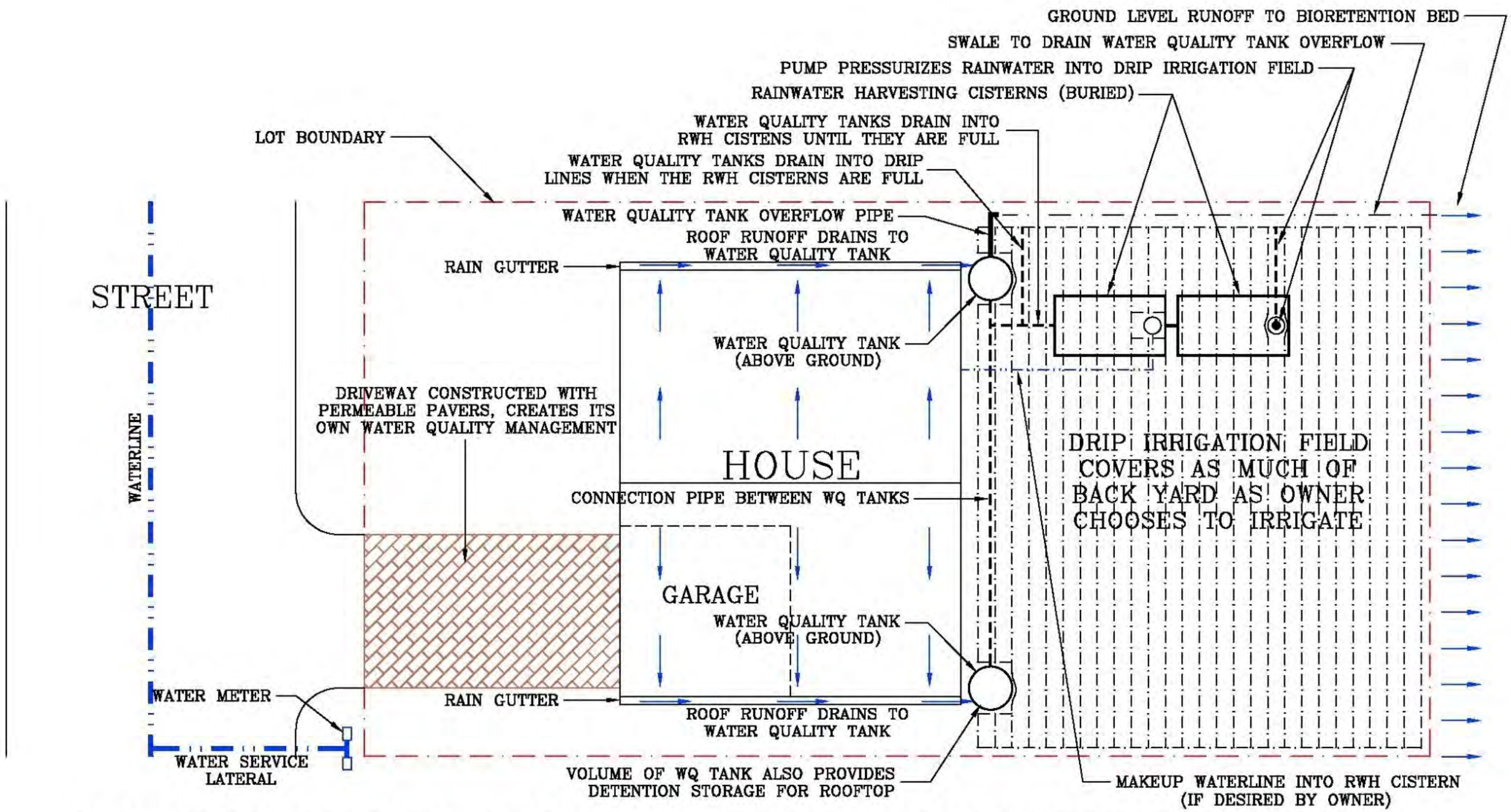
SIDEWALK
CEDAR ELM
LACY OAK
DRIVEWAY
CREPE MYRTLE
15,000 GALLONS BURIED CISTERNS
CREPE MYRTLE
EDGE OF ROOF OVERHANG
GARAGE
HOUSE
BASE ROOFPRINT = 2,370 SQ. FT.
AC PAD
TOTAL EXISTING ROOFPRINT = 2,695 SQ. FT.
PATIO COVER ROOFPRINT=325 SQ. FT.
STORAGE SHED
CEDAR ELM
BIG OLD TREE
SHUMARD OAK
WASHER PIT
WASHER PIT



SIDEWALK
CEDAR ELM
LACY OAK
DRIVEWAY
CREPE MYRTLE
PORCH ROOFPRINT=110 SQ. FT.
PATIO ROOFPRINT = 65 SQ. FT.
CREPE MYRTLE
TOTAL POTENTIAL ROOFPRINT = 3,440 SQ. FT.
GARAGE
SHED ROOF =185 SQ. FT.
HOUSE
AC PAD
BASE HOUSE ROOFPRINT=2,370 SQ. FT.
SHED ROOF =225 SQ. FT.
PATIO COVER ROOFPRINT=325 SQ. FT.
SHED ROOF =160 SQ. FT.
STORAGE SHED
CEDAR ELM
BIG OLD TREE
SHUMARD OAK
WASHER PIT
WASHER PIT


SIDEWALK
CEDAR ELM
LACY OAK
DRIVEWAY 625 SQ. FT.
CREPE MYRTLE
CREPE MYRTLE
GARAGE
FENCE
HOUSE
AC PAD
STORAGE SHED
CEDAR ELM
BIG OLD TREE
SHUMARD OAK
WASHER PIT
WASHER PIT

"Minimum Net Water"
Take irrigation off the potable system



ROOFTOP RUNOFF WATER QUALITY MANAGEMENT INTEGRATED WITH RAINWATER HARVESTING TO IRRIGATE BACK YARD

Commercial and Institutional Buildings A MAJOR Opportunity

- Ratio of roofprint to water use profile typically favorable for RWH
- Condensate capture also a significant source of water
- Project-scale "waste" water reclamation and reuse to provide irrigation water supply
- LID/green infrastructure stormwater system creates landscape elements that don't need routine irrigation

→ Commercial and institutional buildings, or whole campuses of these buildings, could readily be water-independent – "off grid", not drawing on the conventional water system at all

Cost … and VALUE

- By conventional accounting, water from building-scale RWH is very expensive
- On a VALUE basis:
  - Minimizes depletion of local groundwater
  - Blunts "need" to raid remote aquifers or take land to build reservoirs
  - Sustainable over the long term
  - Economically efficient – costs track demand
  - Minimizes public risk

Zero Net Water

ARCSA 2014

Visit my website and read my blog at

www.waterblogue.com

for more information