2013 Texas Rainwater Revival

Imagine Rainwater as THE Water Supply for Your Whole Development

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Key Concepts

- Integrated water management
- Deep conservation
- Sustainable water
- Zero Net Water

In our *fourth paradigm*, attempts to control pollution originating from diffuse, non-point sources were added to the growing complex of structural water management infrastructure. This paradigm could also be called the "*end-of-pipe control*" because the predominant point of control of both point and diffuse pollution is where the polluted discharge enters the fast conveyance system or the receiving water body.

… no matter how much money is spent to reduce controllable regulated sources of pollution, the integrity of water bodies has been severely impaired and will remain so if the fast conveyance, end of pipe treatment paradigm alone continues to be the prevailing model.

- Paul Brown, *Cities of the Future*

The need for ecological sustainability of watersheds and water resources … leads us to a *fifth paradigm* of water management, a model of sustainable and resilient waters and watersheds. This paradigm adopts a holistic, systems approach to the watershed, rather than a functionally discrete focus on individual components (drinking water, sewage, stormwater) characteristic of earlier models.

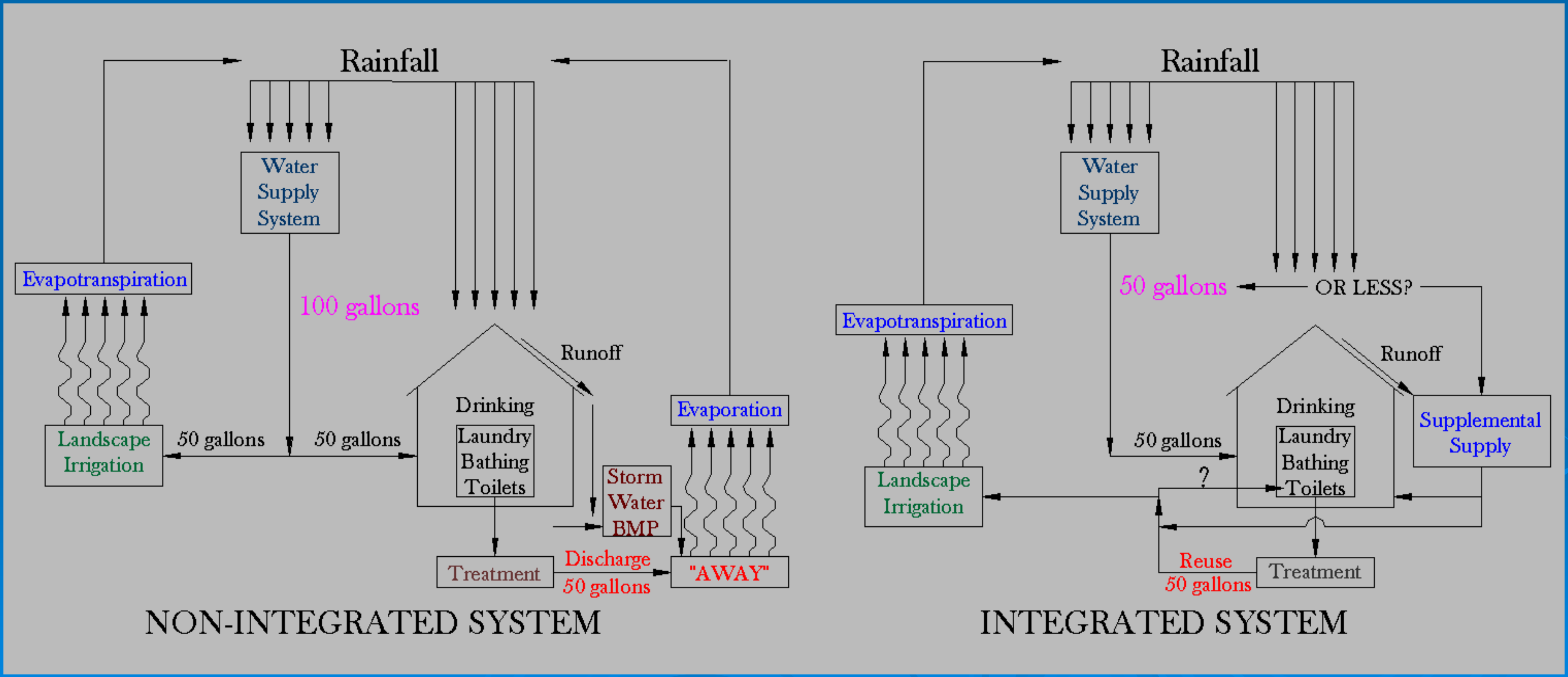
- Paul Brown, *Cities of the Future*

… in the future all components of water supply, stormwater, and wastewater will be managed in a closed loop ….

Closing the water loop may require decentralization of some components of the urban water cycle in contrast to the current highly centralized regional systems employing long distance water and wastewater transfers.

- Paul Brown, *Cities of the Future*

Extractive, once-through use and "disposal" vs. Whole Water – Use it all!



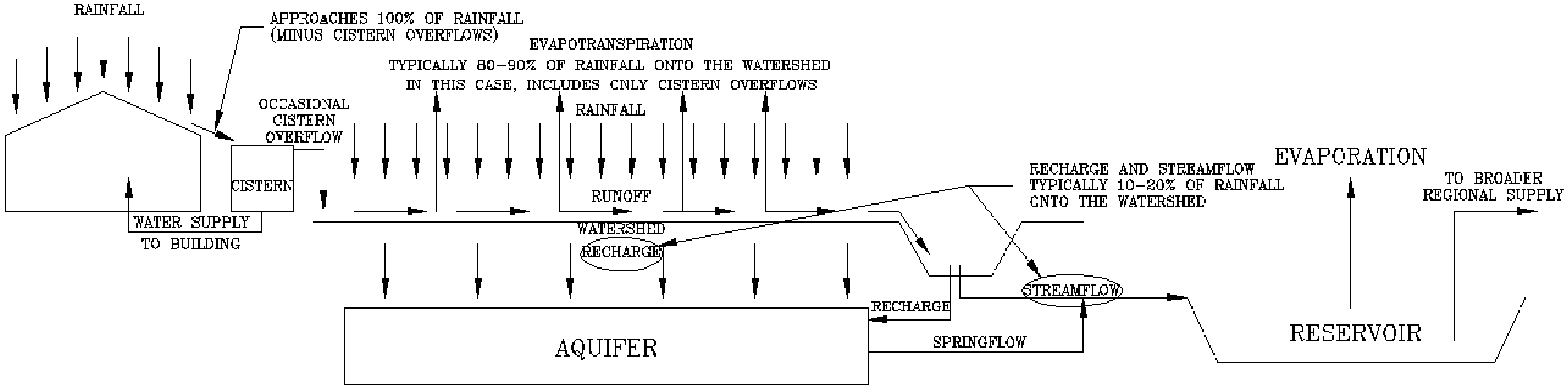
Zero Net Water Development

A model of development that:

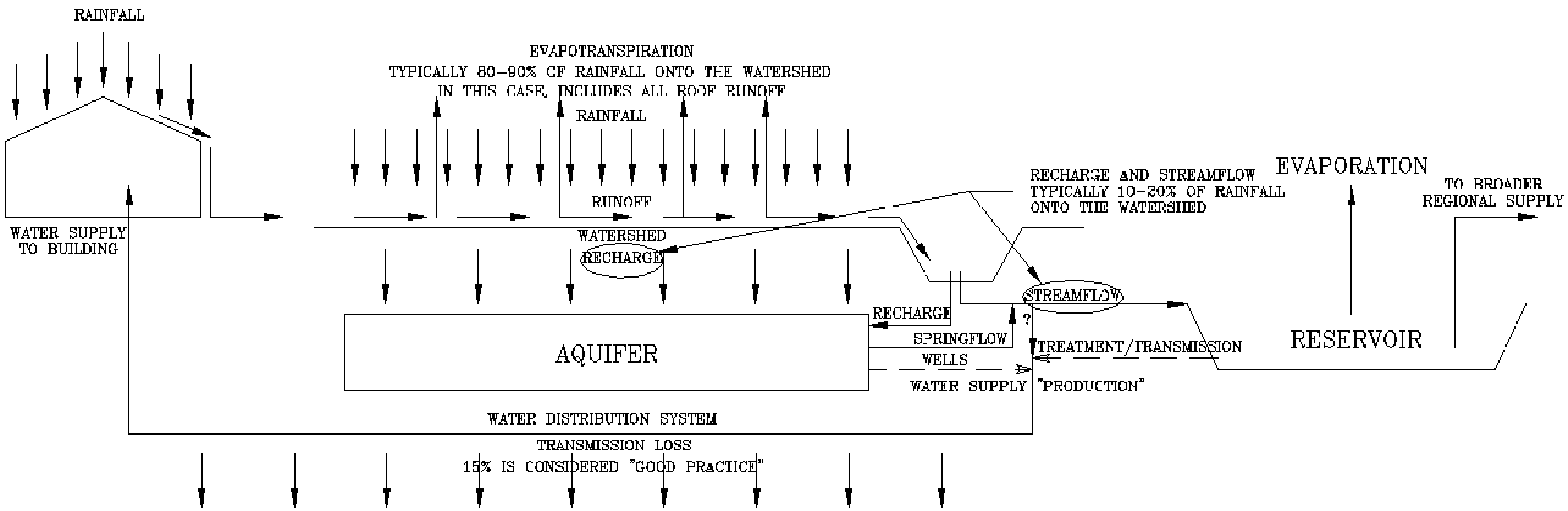
- Minimizes the disturbance of water flow through the watershed.
- Optimizes the usage efficiency of water that is extracted for human use.
- Routes the used water back into the hydrologic cycle with minimum impairment of water quality.

Zero Net Water

begins with
Building-scale Rainwater Harvesting
as the centerpiece
of water supply strategy



BUILDING-SCALE RAINWATER HARVESTING WATER SUPPLY SYSTEM



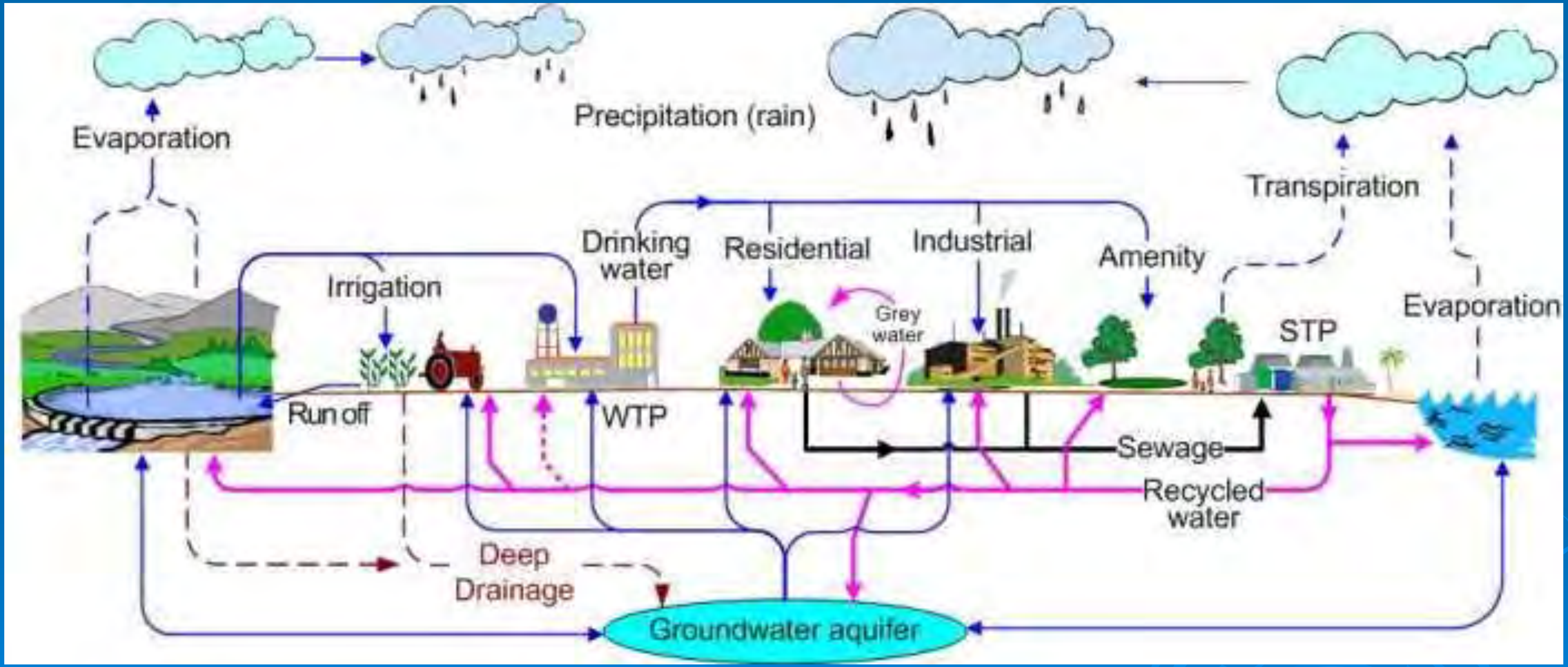
WATERSHED-SCALE RAINWATER HARVESTING WATER SUPPLY SYSTEM

Water Supply Options

- Private well on each lot
- Community well and water system
- Connect to area-wide water system
- Regional pipelines
- Rainwater Harvesting

Rainwater Harvesting is

MORE EFFICIENT



Rainwater Harvesting

REDUCES UP FRONT COST

Developers should like that a lot!

- Small investments, house by house
- System organization is only up-front cost
- “Time value of money”

Rainwater Harvesting

REDUCES FISCAL RISK

Developers should like that a lot!

- Conventional system, large up front cost at risk, carrying costs
- Investment at risk if buildout is slow
- The larger scale the system,

  the bigger the gamble
- Rainwater Harvesting, pay-as-you-go, little money at risk

Rainwater Harvesting is UNDER THE USERS CONTROL

- Water supply “developed” by system users
- System users control COSTS, and TIMING of those costs
- Cost of water is KNOWN
- On-going cost of water is LOW
- Cost of water DOES NOT ESCALATE

Rainwater Harvesting is

MORE RELIABLE

- In large-scale systems
  - System breakdowns have far ranging-consequences
  - Fixing them not in users' control
  - Unpredictable cost impacts
- In a building-scale RWH system
  - Problems isolated to building
  - User in control

Rainwater Harvesting is MORE SUSTAINABLE

- Water capture/utilization more efficient
- Development lives on water falling on it
- Engenders a conservation ethic
- Stimulates efficiency strategies
- Efficiency benefits entire region

Roof-harvested rainwater is

BETTER WATER

- “Soft” and “pure”
- Quality unchanged as watershed develops

Versus …

- Water in wells and reservoirs picks up pollutants
- Quality degrades as watershed develops
- Water from wells may be “hard”
- Piped water heavily chlorinated

→ Water from wells and reservoirs is

DEGRADED

from quality of the original rainwater

Rainwater Harvesting
USES LESS ENERGY

- Water treatment uses a lot of energy
- Distribution uses a lot of energy
- Pumping well water uses a lot of energy
- Energy becoming increasingly expensive

On the other hand …

- Building-scale RWH system consumes FAR LESS energy
- It takes water to make energy, so lower energy demand saves more water

Modeling Locations

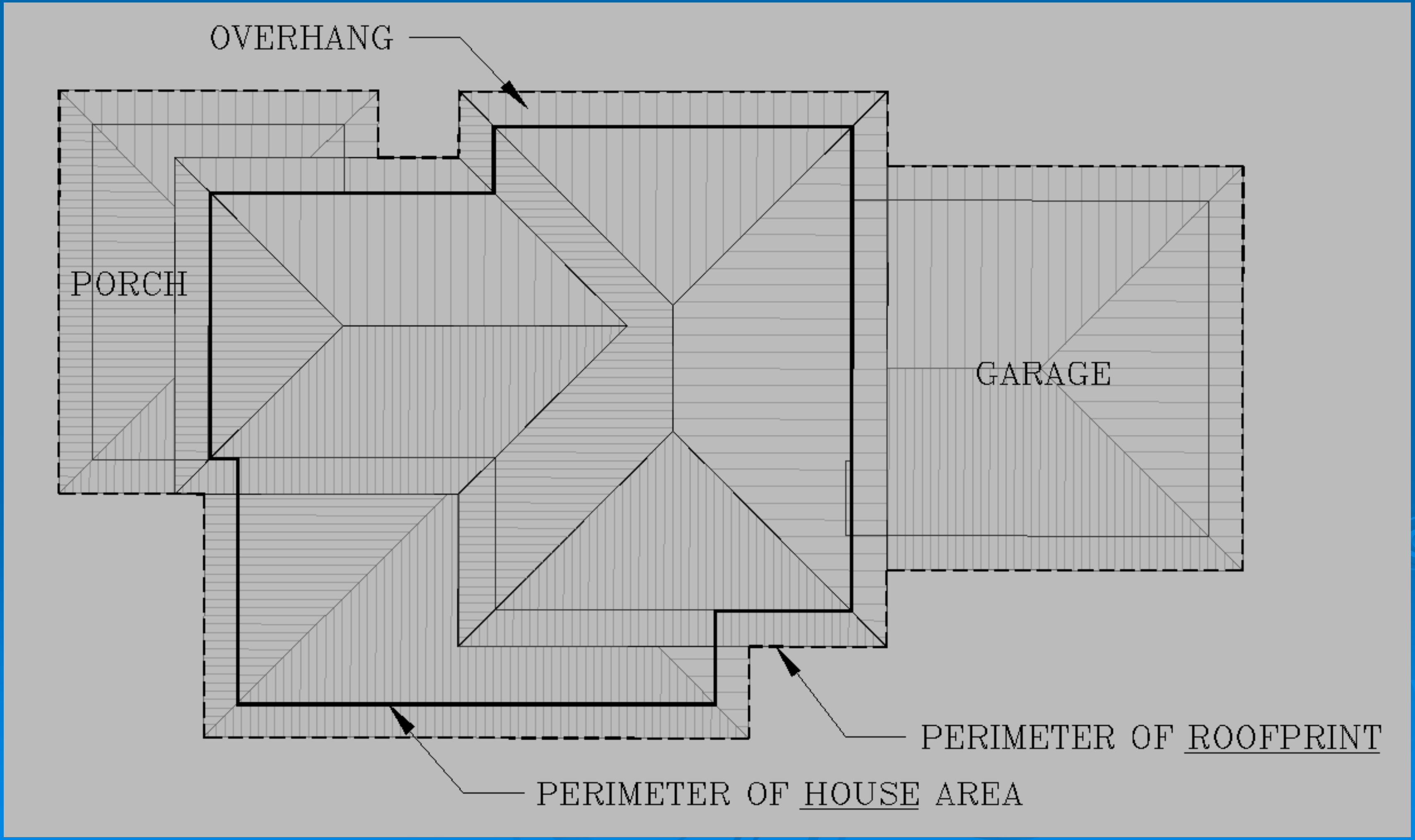
Boerne
Interior Usage Only

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

Backup supply requirements

2008	6,000 gallons
2009	12,000 gallons
2011	8,000 gallons
Total =	26,000 gallons

Roofprint is the plan area of the ROOF, all the roof, NOT the HOUSE area



"RIGHT-SIZED" RWH FACILITIES AT EACH MODELING LOCATION

Modeling Location	2-Person Occupancy Roofprint (sq. ft.)	2-Person Occupancy Cistern Size (gallons)	4-Person Occupancy Roofprint (sq. ft.)	4-Person Occupancy Cistern Size (gallons)
Austin	2,500	15,000	4,500	35,000
Blanco	2,500	15,000	4,500	35,000
Boerne	2,500	15,000	4,500	35,000
Burnet	2,500	15,000	4,500	30,000
Dripping Springs	2,500	15,000	4,500	35,000
Fredericksburg	3,000	20,000	5,000	40,000
Menard	3,000	20,000	5,500	40,000
San Marcos	2,500	15,000	4,500	30,000
Wimberley	2,500	15,000	4,500	30,000

“Right-Sizing” the Roofprint and Cistern

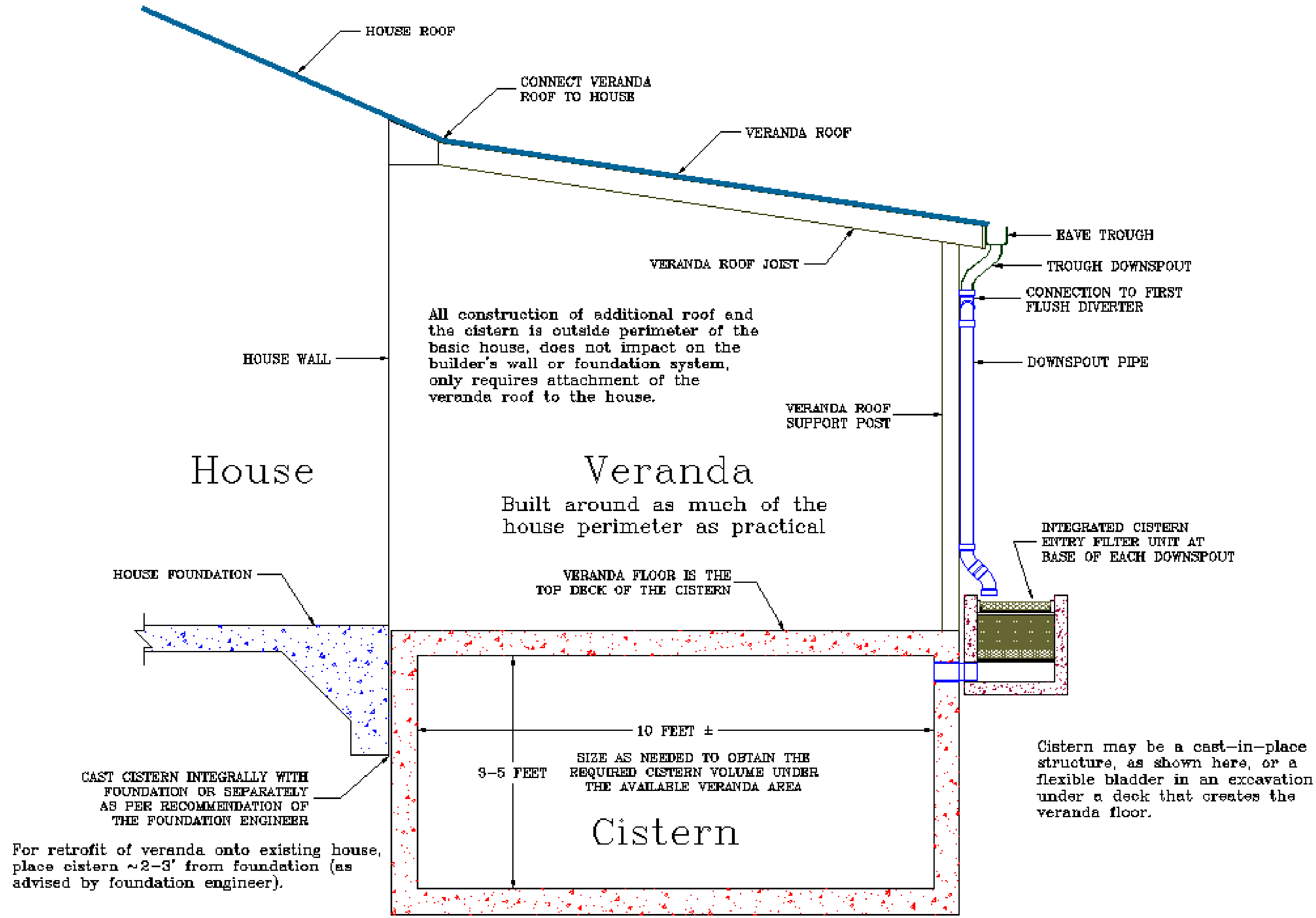
- “Rain barn” separate from house
- Incorporate into building design
- Opportunities to incorporate cistern

The “Veranda Strategy”

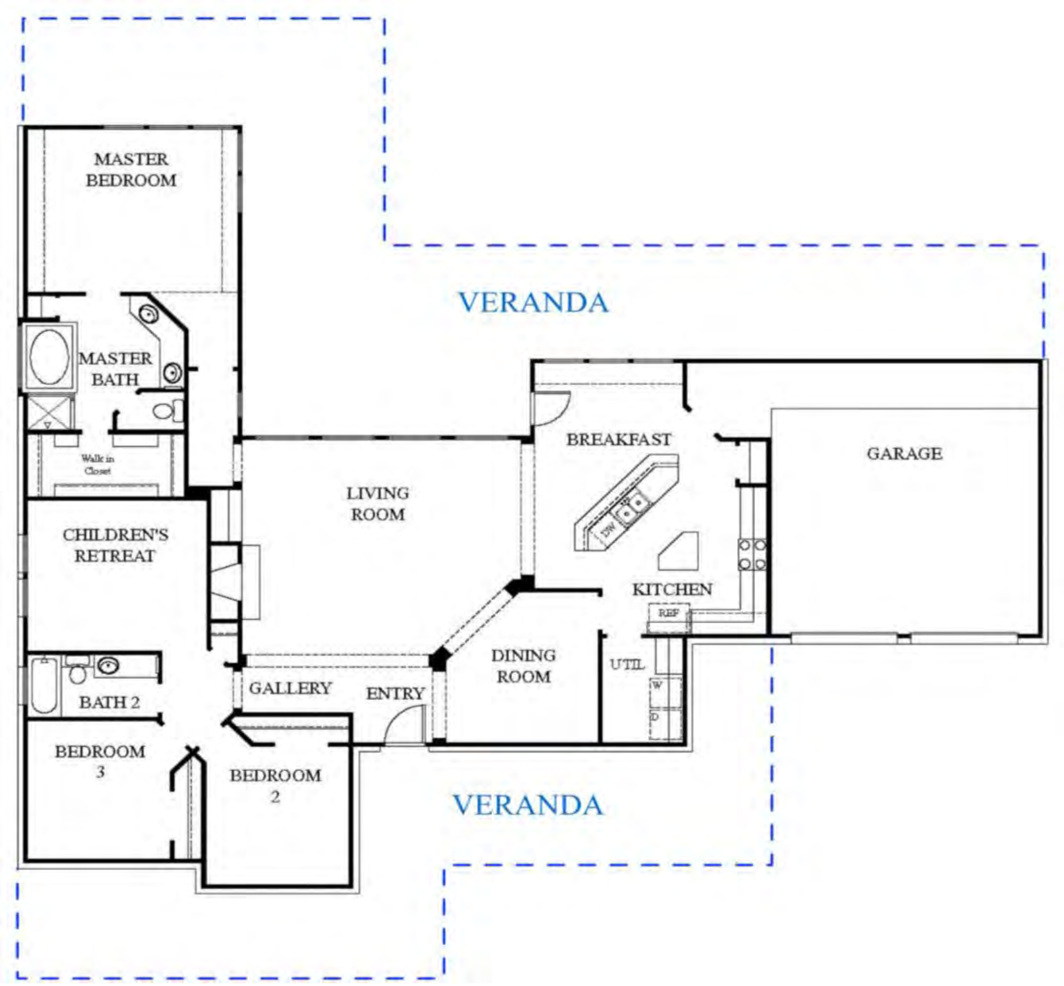
- Verandas (porches, covered patios) around the house
- Relatively inexpensive roof area
- Reduces solar load – smaller air conditioner
- Creates outdoor living spaces

The "Veranda Strategy"

to create the Hill Country Rainwater Harvesting Vernacular House Design



Additional Roofprint with the "Veranda Strategy"



Boerne
Interior Usage Only

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

Backup supply requirements

2008	6,000 gallons
2009	12,000 gallons
2011	8,000 gallons
Total =	26,000 gallons

Boerne
Interior Usage Only

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

Backup supply requirements

2009	6,000 gallons
2011	2,000 gallons
Total =	8,000 gallons

Boerne
Interior Usage Only
with curtailment

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

Curtailed to 40 gpcd when cistern is low

Backup supply requirements

2008	4,000 gallons
2009	8,000 gallons
2011	8,000 gallons
Total =	20,000 gallons

Boerne
Interior + Irrigation Usage
WITHOUT wastewater reuse, no curtailment

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 11 years

Max. yr. = 44,000 gallons in 2011

2nd most = 38,000 gallons in 2008

Total over 26 years = 220,000 gallons

Boerne

Interior + Irrigation Usage

WITHOUT wastewater reuse, with curtailment

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 10 years

Max. yr. = 18,000 gallons in 2008, 2009, 2011

2nd most = 12,000 gallons in 2006

Total over 26 years = 110,000 gallons

Boerne
Interior + Irrigation Usage
WITHOUT wastewater reuse, larger system
with curtailment

Roofprint	6,500 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>

2008	4,000 gallons
2009	12,000 gallons
2011	8,000 gallons
Total =	24,000 gallons

Boerne
Interior + Irrigation Usage
WITH wastewater reuse, no curtailment

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>

2008	8,000 gallons
2009	16,000 gallons
2011	14,000 gallons
Total =	38,000 gallons

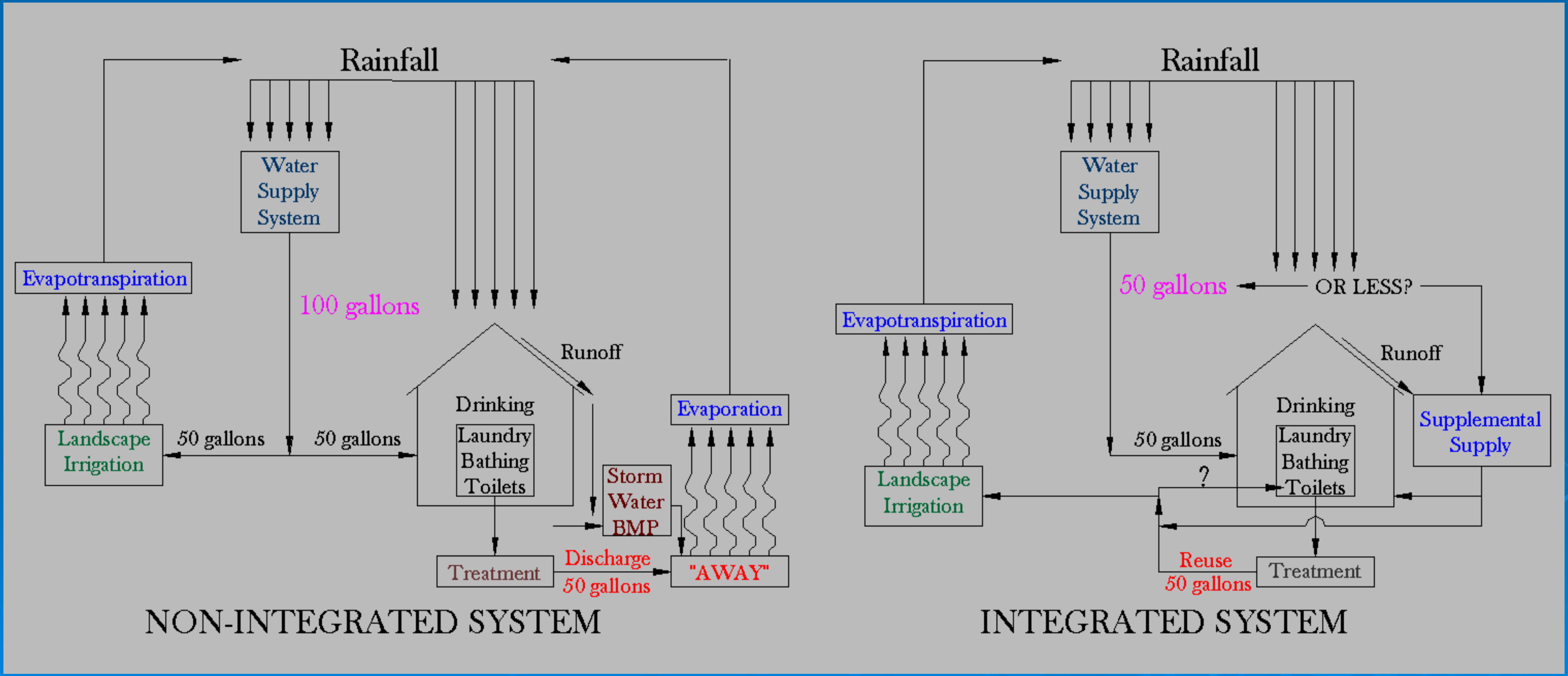
Boerne
Interior + Irrigation Usage
WITH wastewater reuse, with curtailment

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>

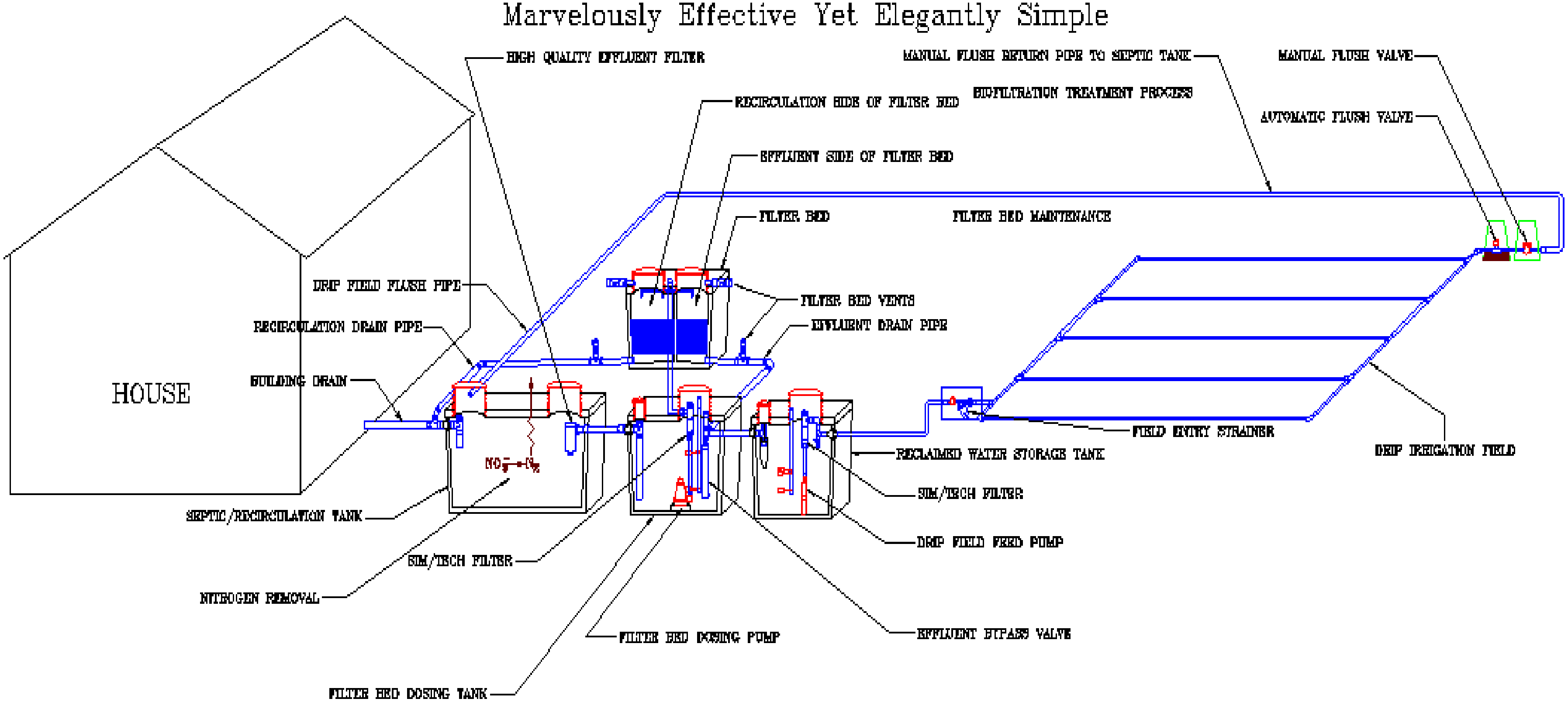
2008	8,000 gallons
2009	12,000 gallons
2011	10,000 gallons
Total =	30,000 gallons

INTEGRATION
Among Water Management Functions Enhances Water Use Efficiency

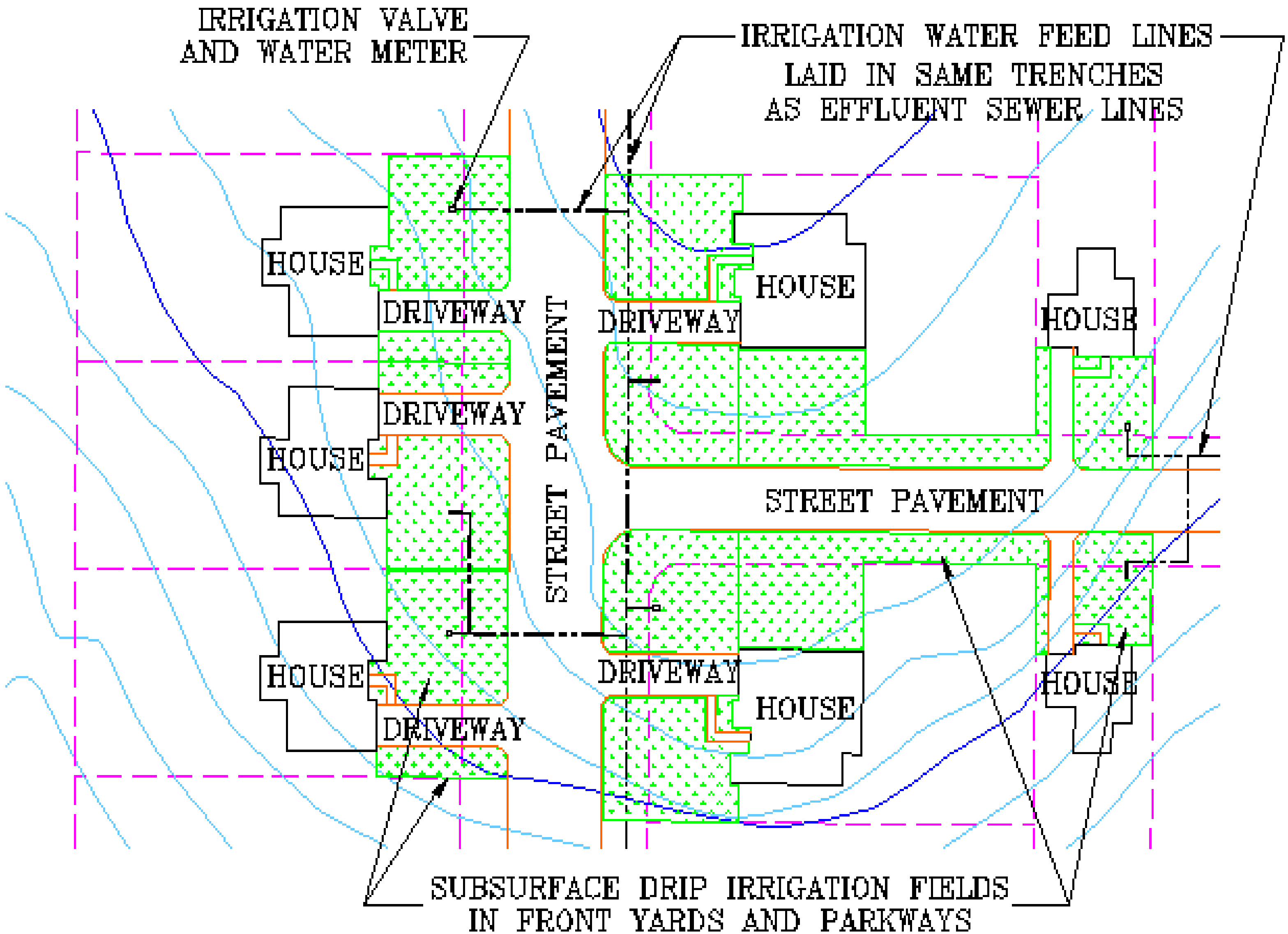


The High Performance Biofiltration/Drip Irrigation System Concept

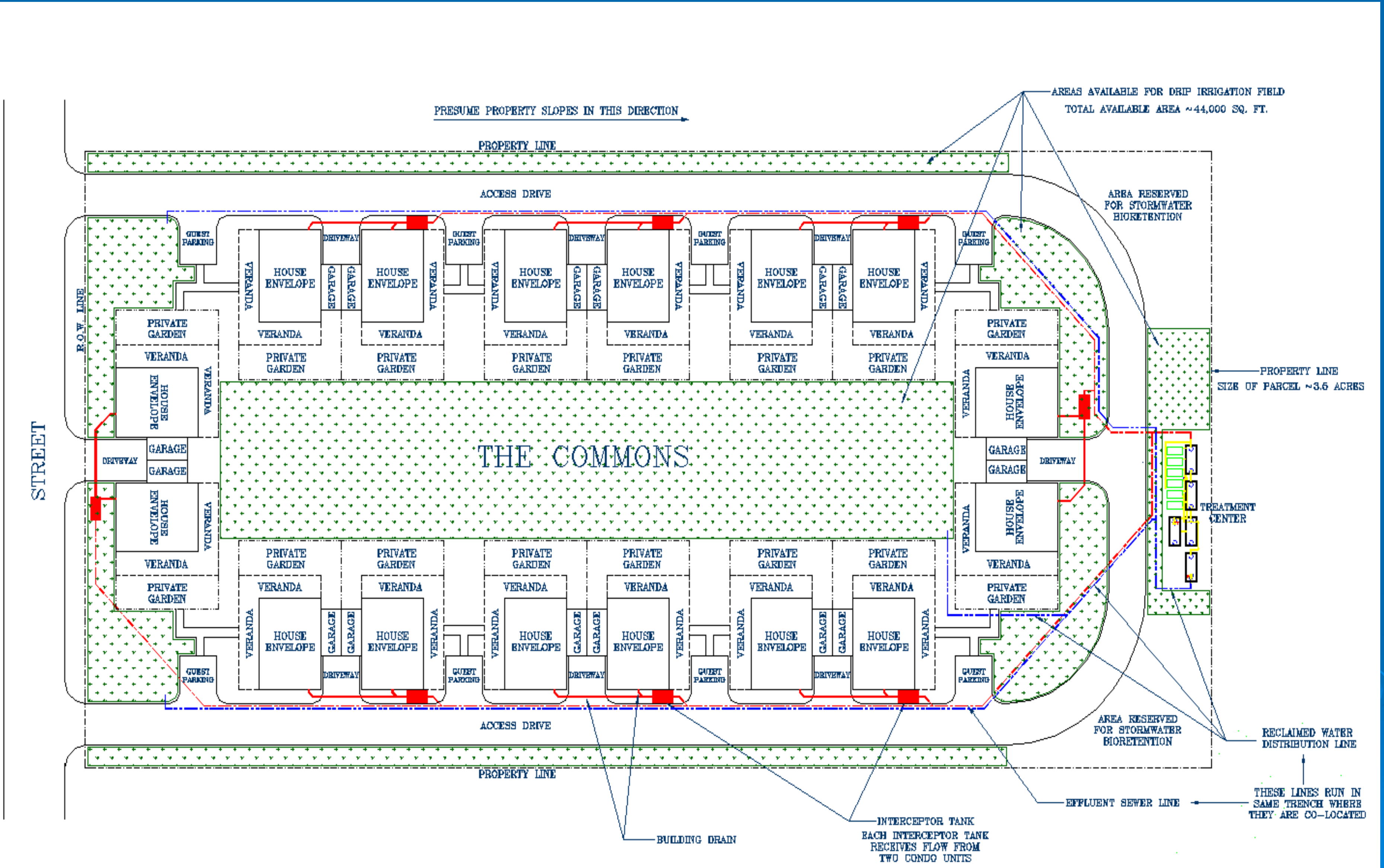
Marvelously Effective Yet Elegantly Simple



SMALL AREA COLLECTION SYSTEM AND TREATMENT CENTER



ON-LOT IRRIGATION SYSTEMS



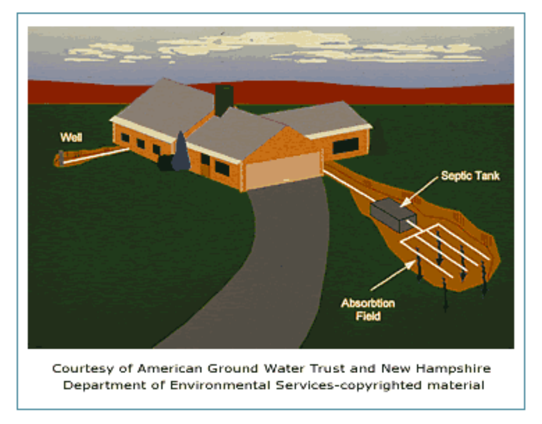
PRESUME PROPERTY SLOPES IN THIS DIRECTION
AREAS AVAILABLE FOR DRIP IRRIGATION FIELD
TOTAL AVAILABLE AREA ~44,000 SQ. FT.
PROPERTY LINE
ACCESS DRIVE
AREA RESERVED FOR STORMWATER BIORETENTION
GUEST PARKING
DRIVEWAY
HOUSE ENVELOPE
GARAGE
VERANDA
PRIVATE GARDEN
R.O.W. LINE
STREET
THE COMMONS
PROPERTY LINE
SIZE OF PARCEL ~3.5 ACRES
TREATMENT CENTER
RECLAIMED WATER DISTRIBUTION LINE
THESE LINES RUN IN SAME TRENCH WHERE THEY ARE CO-LOCATED
EFFLUENT SEWER LINE
INTERCEPTOR TANK
EACH INTERCEPTOR TANK RECEIVES FLOW FROM TWO CONDO UNITS
BUILDING DRAIN

Issues to be Resolved

- Backup water supply system
- Regulation and governance
- Building design issues
- Cost effectiveness analysis
- Marketability
- Sustainability

Options for Backup Supply System

A private well for each building



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Community well, "minimal" distribution system

Community well + tanker truck delivery

Connection to existing PWS system

Tanker truck delivery from potable water supply

Tanker Trucks
Supplied by Public Water System

- Likely to be predominant method
- Favored by developers – no up front costs
- Regulatory issues – requirement for ASSURED supply?
- How formalized?
- What will it cost to set up?

Tanker Trucks
Supplied by Public Water System

- Conditions of service for guaranteed supply
- Cost of guarantee?
- Commercial hauler, or utility/HOA truck
- Supply capacity, number of trucks available
- Regulatory status
- Backup requirement must be very limited

Tanker Truck System: Capacity Limitations

Development with 100 houses

1 House = 1 Truck / Month

= 100 Trips / Month

Tanker Truck System: Capacity Limitations

+

=

22 working days in a month

100/22 = 4.5 truck trips per day

One tanker truck, full time

for *one* development!

Is the private sector ready for this kind of demand?

- Ability to meet intermittent demand
- Ability to expand fleet as number of developments grows
- Further investigation needed

Summary and Comparison Costs of Water Supply Options

Water Supply Option	Capital Cost per House	NPV of Water/ O&M per House	Total NPV per House	RWH "premium" Cap. Cost over option	RWH "premium" NPV over option
Rainwater Harvesting	$ 40,500	$7,640	$ 48,140		
Private Well	$ 35,000	$7,841	$ 42,841	$ 5,500	$ 5,299
Community Well	$ 11,571	$13,873	$ 25,444	$ 28,929	$ 22,696
Waterline Extension	$ 17,451	$8,070	$ 25,521	$ 23,049	$ 22,619

	Capital Cost "premium"	Avoided Cost of Water System	Estimated Lot Cost Reduction*	Net Capital Cost w/ Lot Cost Reduction
RWH vs. Community Well	$ 28,929	$ 11,571	$ 10,000	$ 18,929
RWH vs. Waterline Extension	$ 23,049	$ 17,451	$ 15,000	$ 8,049

*Avoided cost "credited" to lot cost reduction ~85% of avoided water system capital cost.

Building-Scale Rainwater Harvesting can reduce stormwater management costs

Building-Scale Rainwater Harvesting as THE water supply strategy for your whole development.

Yes we can!