Water Harvesting Landscape Design

July 06, 2022

Watershed Management Group

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Outline

1. What: Water Harvesting Principles
2. Where: Getting Started at Your Site
3. How: Water Harvesting Techniques

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WHY?

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How does water harvesting link to watershed health?

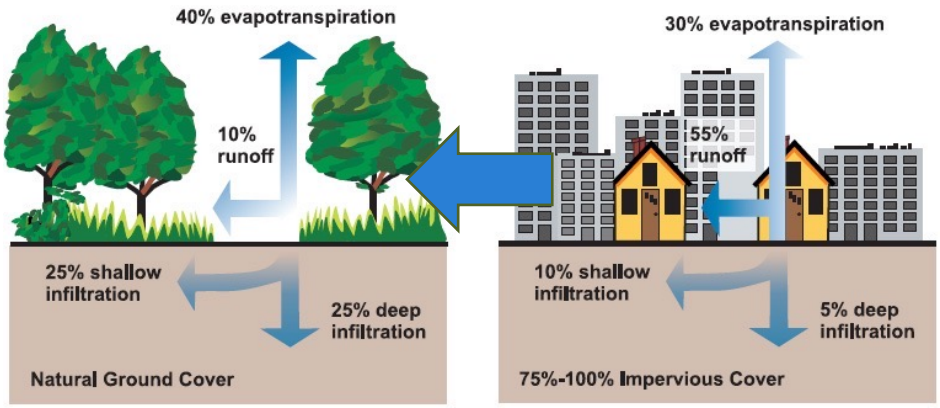

Image source: www.epa.gov

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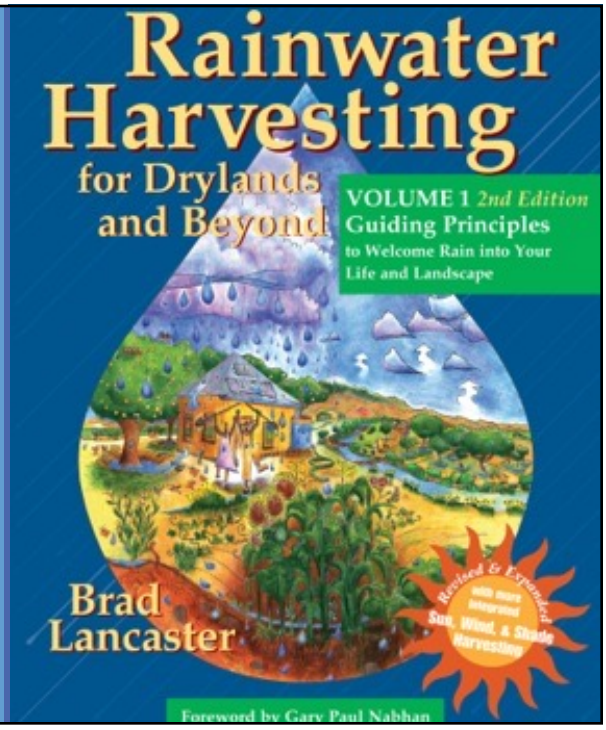
Water Harvesting Principles From Brad Lancaster's, Rainwater Harvesting for Drylands and Beyond



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1. Begin with Long and Thoughtful Observation

Water Harvesting Principles

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2. Start at the Top

Water Harvesting Principles

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3. Start small and simple

Water Harvesting Principles

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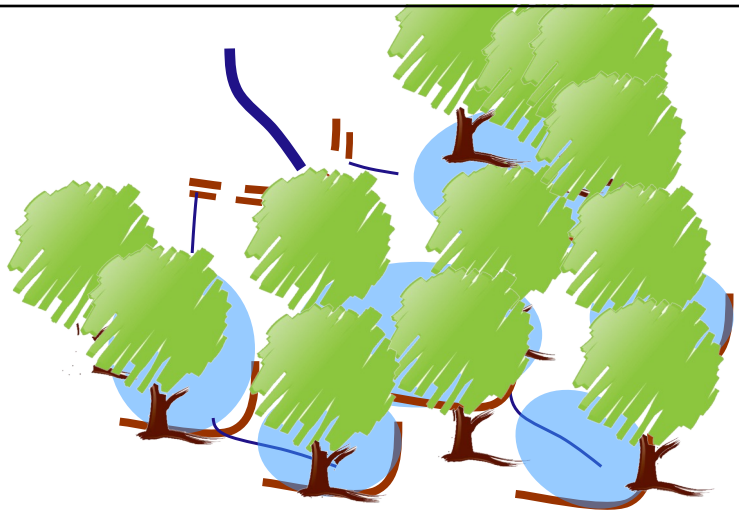

4. Spread and infiltrate the flow of water

Water Harvesting Principles

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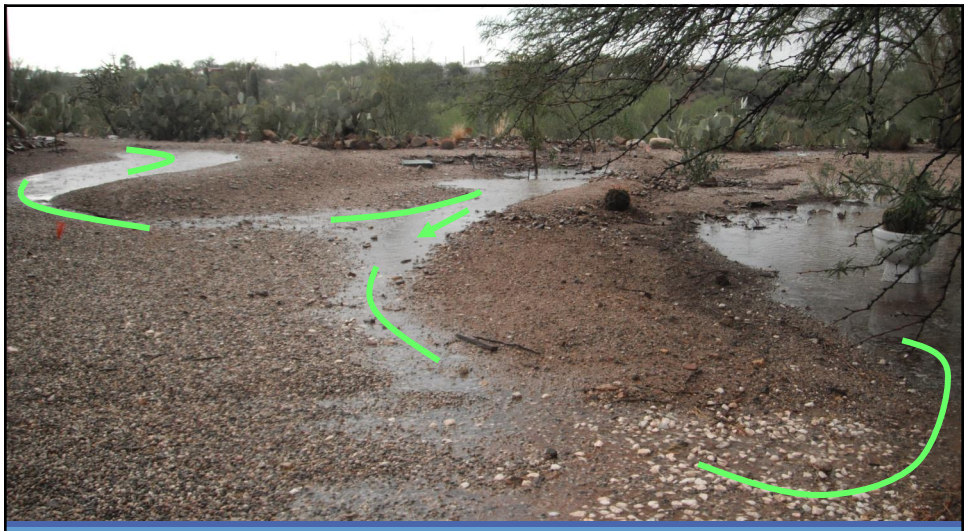

5. Always plan for an overflow route and manage overflow as a resource

Water Harvesting Principles

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6. Maximize living and organic groundcover

Water Harvesting Principles

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7. Maximize beneficial relationships and efficiency – STACKING FUNCTIONS

Water Harvesting Principles

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8. Continually reassess your system

Water Harvesting Principles

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WHERE?

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1. Begin with Long and Thoughtful Observation

Water Harvesting Principles

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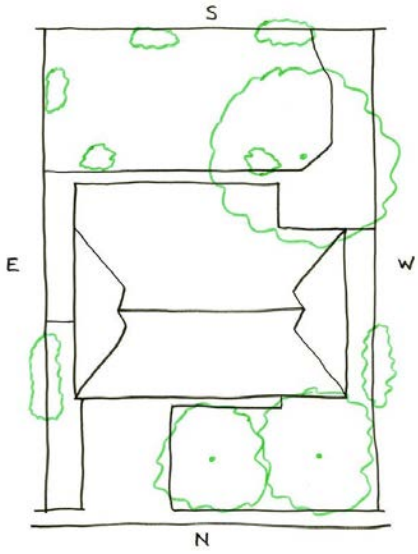

DRAW YOUR SITE

- Property lines
- House
- Other permanent structures (storage sheds, pool, driveway, sidewalks, etc.)
- Existing trees and shrubs
- Mark direction - North, South, East, West

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SECTORS / FACTORS

Sectors deal with the wild energies…from outside our system and pass through it.

Intro to Permaculture pg. 14

- Sun
- Water
- Wind
- Fire
- Wildlife
- Pollution
- View
- Utilities
- Community

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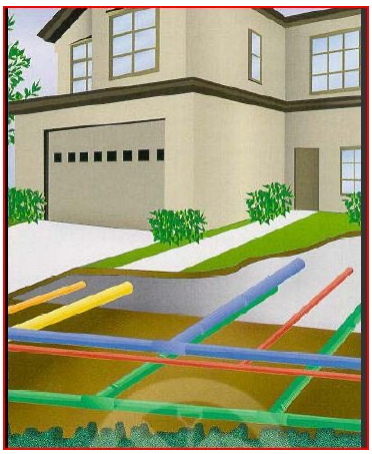
UTILITIES



White = Proposed Excavation

Pink = Temporary Survey Markings

Red = Electric Power Lines, Cables, Conduit and Lighting Cables

Yellow = Gas, Oil, Steam, Petroleum or Gaseous Materials

Orange = Communication, Alarm or Signal Lines, Cables or Conduit

Blue = Potable Water

Purple = Reclaimed Water, Irrigation and Slurry Lines

Green = Sewer and Drain Lines

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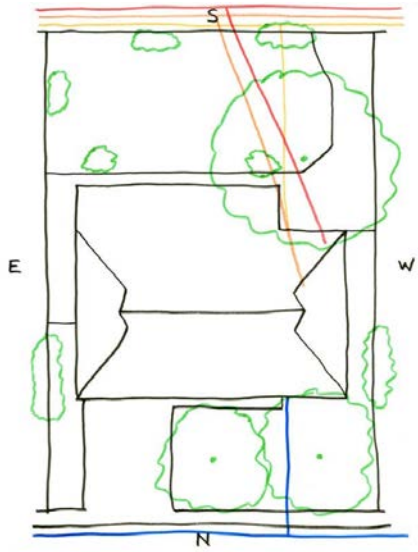

UTILITIES

- Water
- Gas
- Sewer
- Electric
- Cable
- Telephone
- Irrigation

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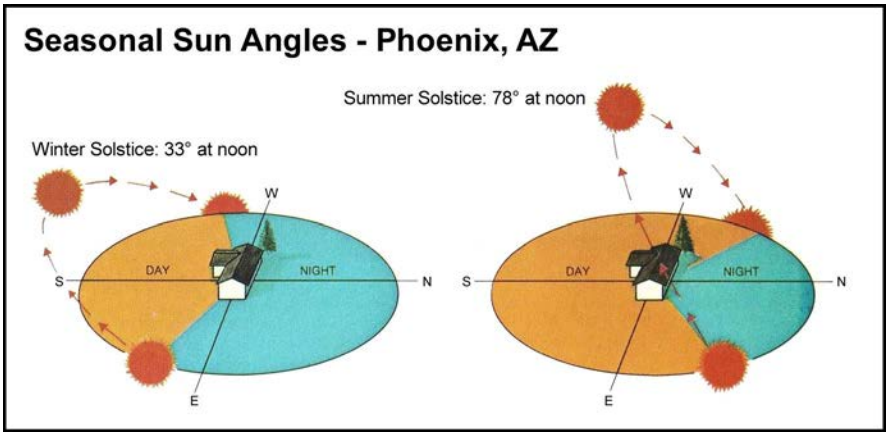
SEASONAL SUN ANGLES



NOAA Solar Calculator
http://www.esrl.noaa.gov/gmd/grad/solcalc/

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SEASONAL SHADE PATTERNS

Winter Solstice 2008

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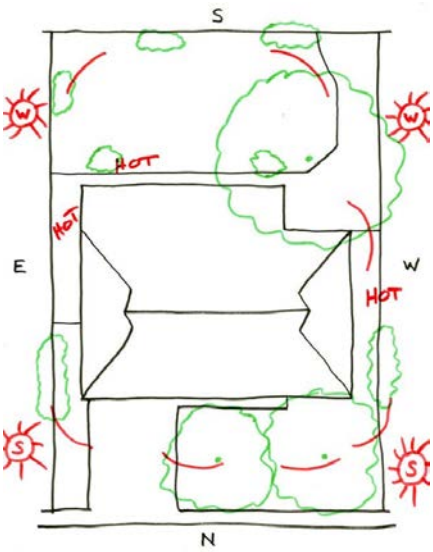

SUN

- Summer
- Winter
- Equinox
- Hot spots
- Shadow patterns
- Microclimates

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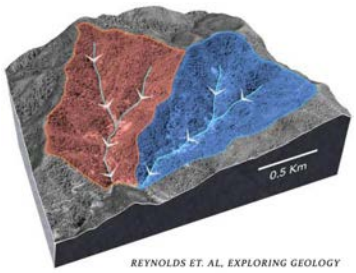
Watersheds

Watershed: a watershed is the land area that drains water to a particular stream, river or lake. An area that drains to a common point.



REYNOLDS ET. AL, EXPLORING GEOLOGY

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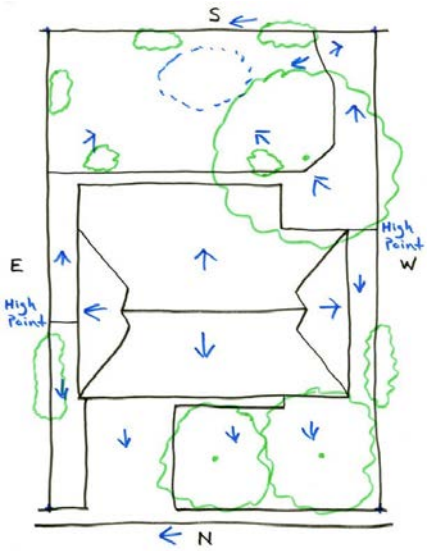

WATER

- Watersheds, subwatersheds
- Water movement
- Slope, topography
- Hose Bibs
- Annual rain fall
- Determine square feet
- Multiply square feet by .623 to convert into gallons for a 1" rain

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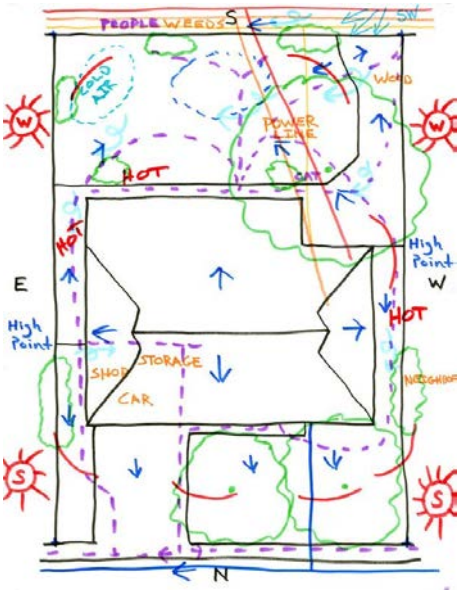

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HOW?

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Water Harvesting (Passive) **Earthworks**

Created features formed from soil, rock, or plant material

Use gravity to distribute rain runoff

- SLOW
- SPREAD
- SINK

Cheapest storage option for large amounts of rainwater

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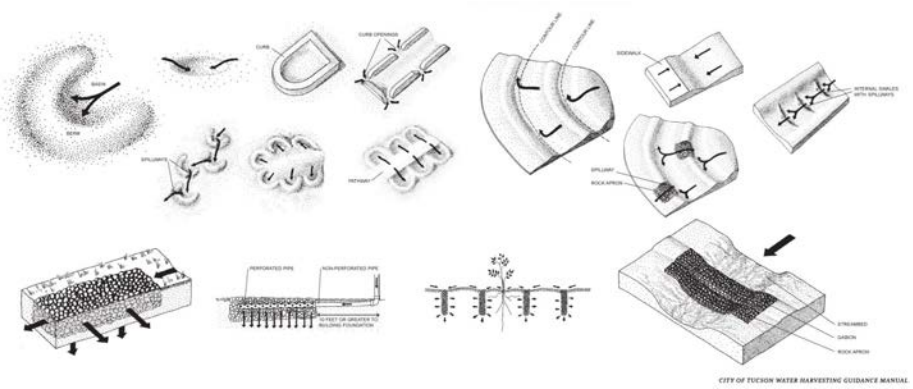
Earthworks
Slow it, Spread it, Sink it!



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Convey: Swales

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Infiltration: Basins

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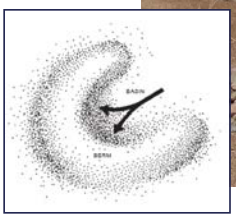
Raised: Berms



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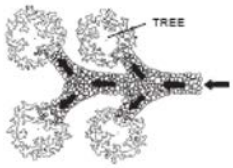
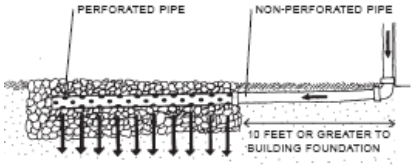
Infiltration: French Drains

> 10ft from structure

Water source needs to be free of sediment & particulates

Use angular, uniform sized rock (~40% porosity)





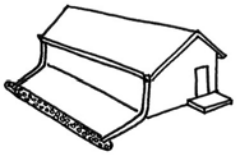


Figure Sources: City of Tucson Water Harvesting Guidance Manual and Watershed Management Group Earthworks Handout

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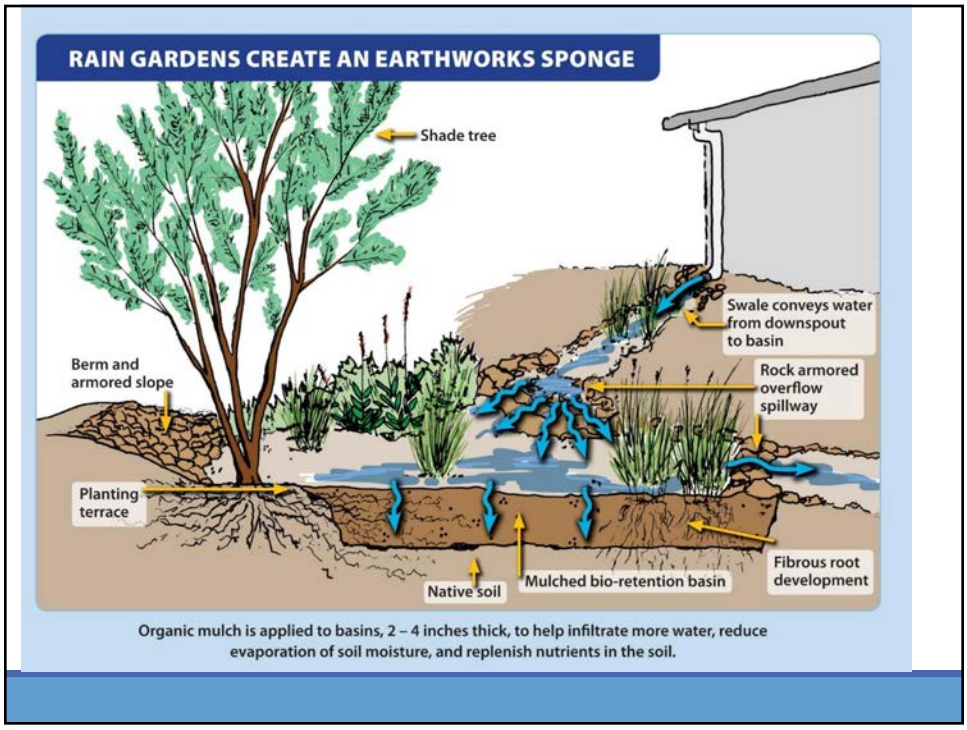
RAIN GARDENS CREATE AN EARTHWORKS SPONGE
Shade tree
Swale conveys water from downspout to basin
Berm and armored slope
Rock armored overflow spillway
Planting terrace
Native soil
Mulched bio-retention basin
Fibrous root development
Organic mulch is applied to basins, 2 – 4 inches thick, to help infiltrate more water, reduce evaporation of soil moisture, and replenish nutrients in the soil.

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Sizing Earthwork Capacity

1. Stormwater retention
   (Design storm event: 25yr, 50yr, 100yr) – Flood control (Lancaster, Vol 2, pg 136)
   - Calculate open capacity of feature
   - Size to meet estimated stormwater runoff
   - Ensure water will percolate in 12 to 24hrs
2. Percolation Rate Method
   Greywater Systems (Ludwig, A., pg 13)
   - Surface area needed to infiltrate peak water volume
   - Based on percolation rate and discharge volume
3. Plant Needs
   Irrigation/Dryland farming (Lancaster, Vol 2, pg 80)
   - Sized to capture sufficient runoff from catchment area to irrigate specific plant(s)

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Sizing Earthwork Capacity

Runoff Coefficients for the Southwest United States

Surface	Runoff Range	Notes
Roof	0.80 – 0.95	Metal: 0.95, Concrete/asphalt: 0.90, Built up tar/gravel: 0.85 – 0.80
Paving	0.90 – .95	Older irregular surfaces may be lower than 0.90.
Bare Soil	0.20 – 0.75	A best guess based on characteristics of soil and experience. Unprotected soil surfaces tend to surface seal easily unless high levels of organic material or a high content of sand is present.
Soil with Vegetation	0.10 – 0.60	Leaf litter, basal area, and roots all help increase infiltration rates and can also absorb water.
Grass/Lawn	0.05 – 0.35	A high density of leaf area and root densities help reduce runoff. If soil underneath is compacted runoff rates can be higher.
Gravel	0.20 – 0.75	Use the coefficient of the ground below the gravel

*Chart adapted from 1) Lancaster, Brad. 2006. Rainwater Harvesting for Drylands, Vol.1.Rainsource Press and 2) Waterfall, Patricia. 2006. Harvesting Rainwater for Landscape Use 2nd Ed. Pima County Cooperative Extension.

Potential Harvested Rainwater Volume (gallons)

Catchment area (ft^2) x rainfall depth (in) x 0.623 (conversion) x Runoff Coef. = Volume (gallons)

Calculating Basin Volume (gallons)

- Quick Estimate: Average Surface Area (ft^2) x Average depth (ft) x 7.48 (gal/ft^3) = Volume (gallons)
- More Accurate Ballpark: Depth (ft) x ([L1 x W1] + [L2 x W2]) / 2 x 7.48 (gal/ft^3) = Volume (gallons)
- Most Accurate: CAD or GIS based delineation and calculation

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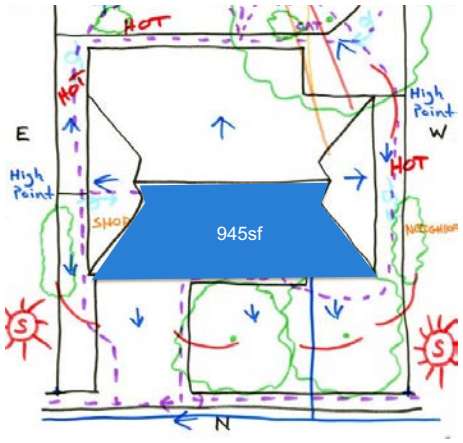

1” Rain x 945 sf x 0.623 x .9 RC = 530 Gal

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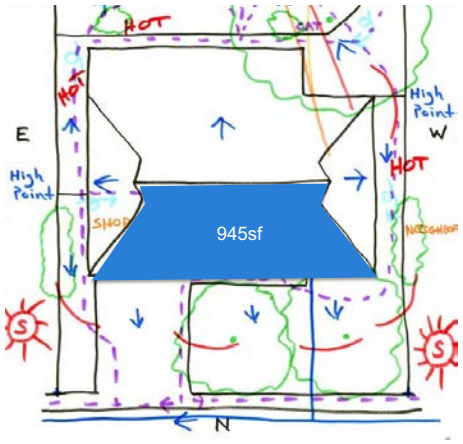
How big should the basin be?



10” Depth x area x 0.623 x .9 RC = 530 Gal

Area = ~100sf = ~ 10’x10’ Basin

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Locating Earthworks

Consider:

- Utility Lines: ~ 2-10ft distance (Call a Utility Locating Service!)
- Structural Foundations: ~10ft distance
- Pathways: raise and use to manage runoff (i.e. berm)
- Right-of-ways (ROW): lookup local restrictions

Remember the 3 Elevations:

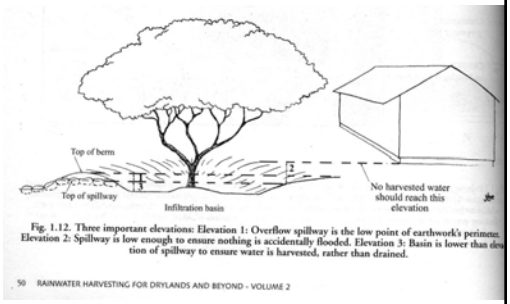

Fig. 1.12. Three important elevations: Elevation 1: Overflow spillway is the low point of earthwork's perimeter. Elevation 2: Spillway is low enough to ensure nothing is accidentally flooded. Elevation 3: Basin is lower than elevation of spillway to ensure water is harvested, rather than drained.

50 RAINWATER HARVESTING FOR DRYLANDS AND BEYOND - VOLUME 2

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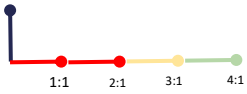
Slope

Run:Rise



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CAUTION!!

Flooding
- Slowing Runoff -> backing up surface flow upstream

Ponding -> standing water risks

Mosquitos -> minimize ponding time

Structural and Utilities -> protect infrastructure

Soil Saturation/Loading -> slope instability/failure

Walkability/Bikeability -> Always promote alternative transportation activities

General Safety -> vertical drops (<18”); excavation and sediment control; traffic visibility; plant types, etc…

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Maintenance

Observe:
- During and after rainfall events
- Seasonally

Check:
- Overflow – Appropriately sized and placed
- Percolation – Duration of standing water
- Capacity – Loss, undersized, …
- Stability – Rocks are secured; soil surface stable
- Plant Productivity – Sufficient water, placement, …
- Mulch Material – Need to add more?

Adjust & Improve:
- Design – capacity, aesthetics, water routing, …
- Plants – species, placement, …
- Soil Improvements – drainage, nutrients, …

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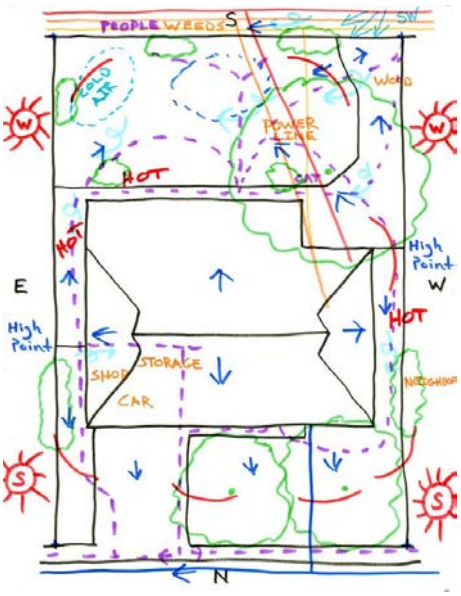
BACK TO SITE ANALYSIS

Where should we add passive rainwater harvesting features?



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Questions?

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Thank You!!!

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