

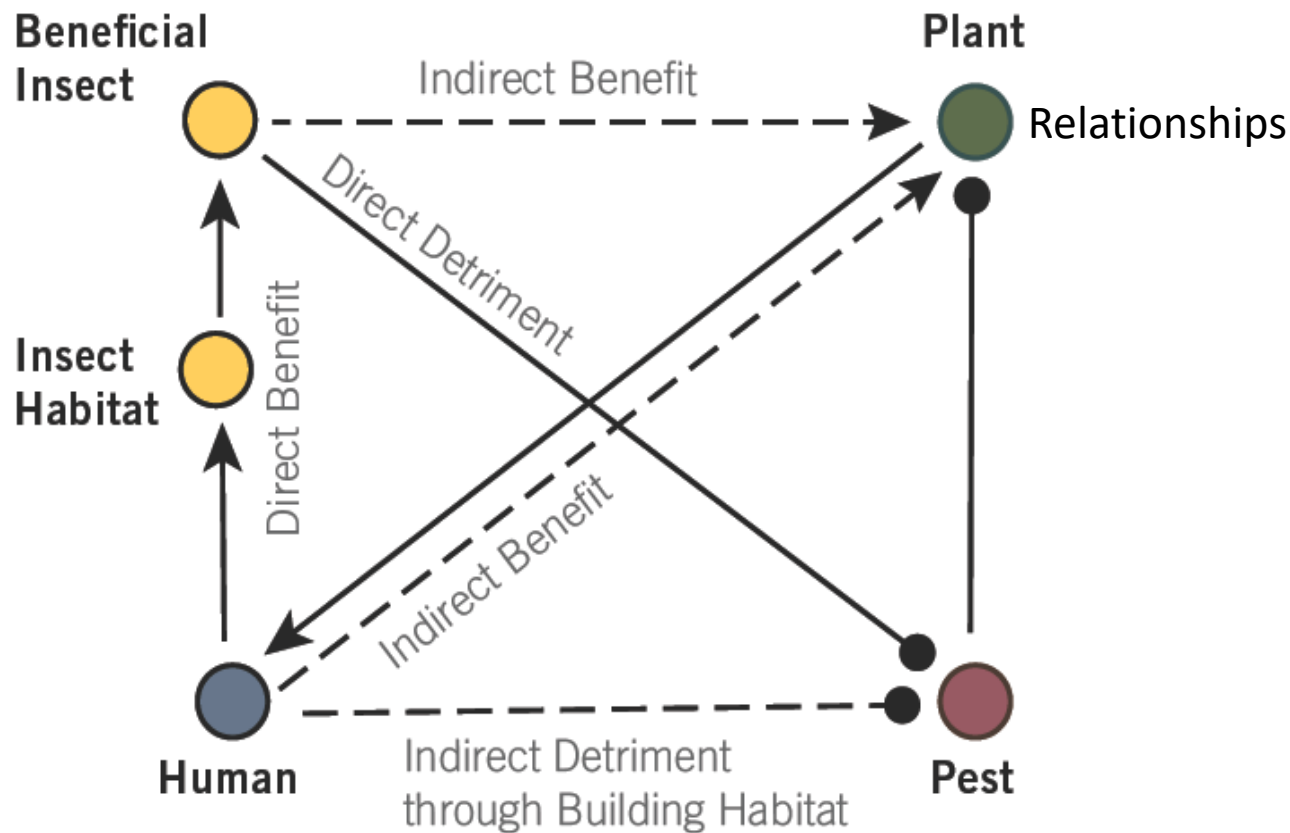


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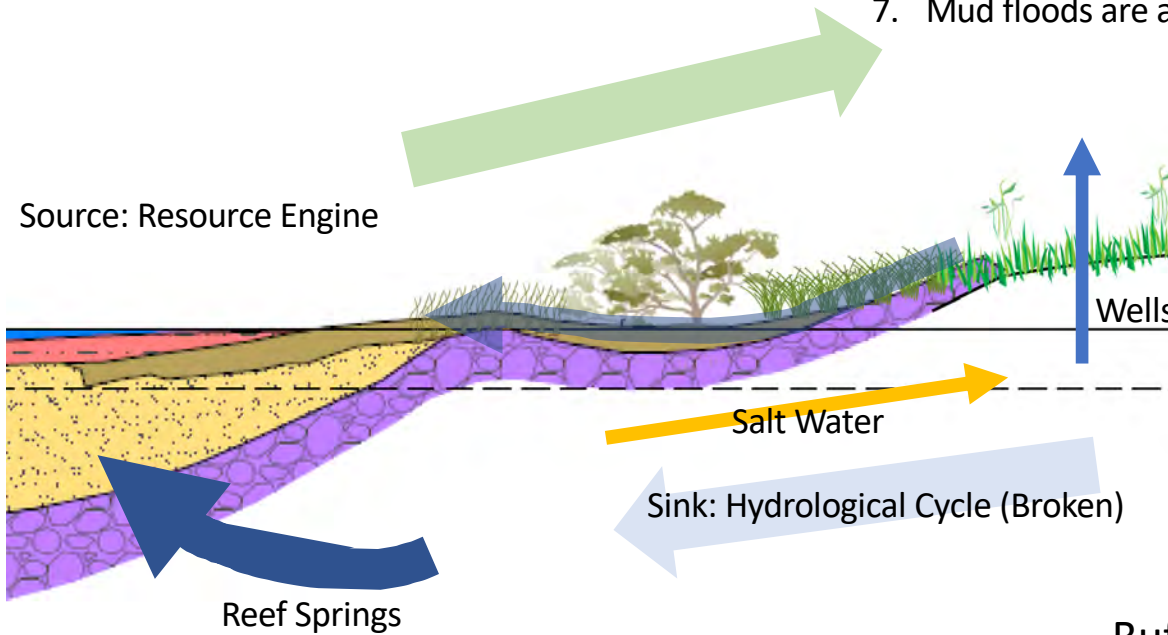




Place components in relative positions to build direct and indirect relationships. Let the plants do the work, giving nature an opportunity to respond.

# The Source and the Sink

1. Increased development closes off the ground from infiltration.
2. This year's rain is the next decade's drinking water.
3. Rain on the forest primarily went into the ground.
4. Higher elevations create the force of run-off.
5. Lower elevations are eroded by destabilized streambeds.
6. Flooding is a inability to manage run-off.
7. Mud floods are a failure to manage the land (development)

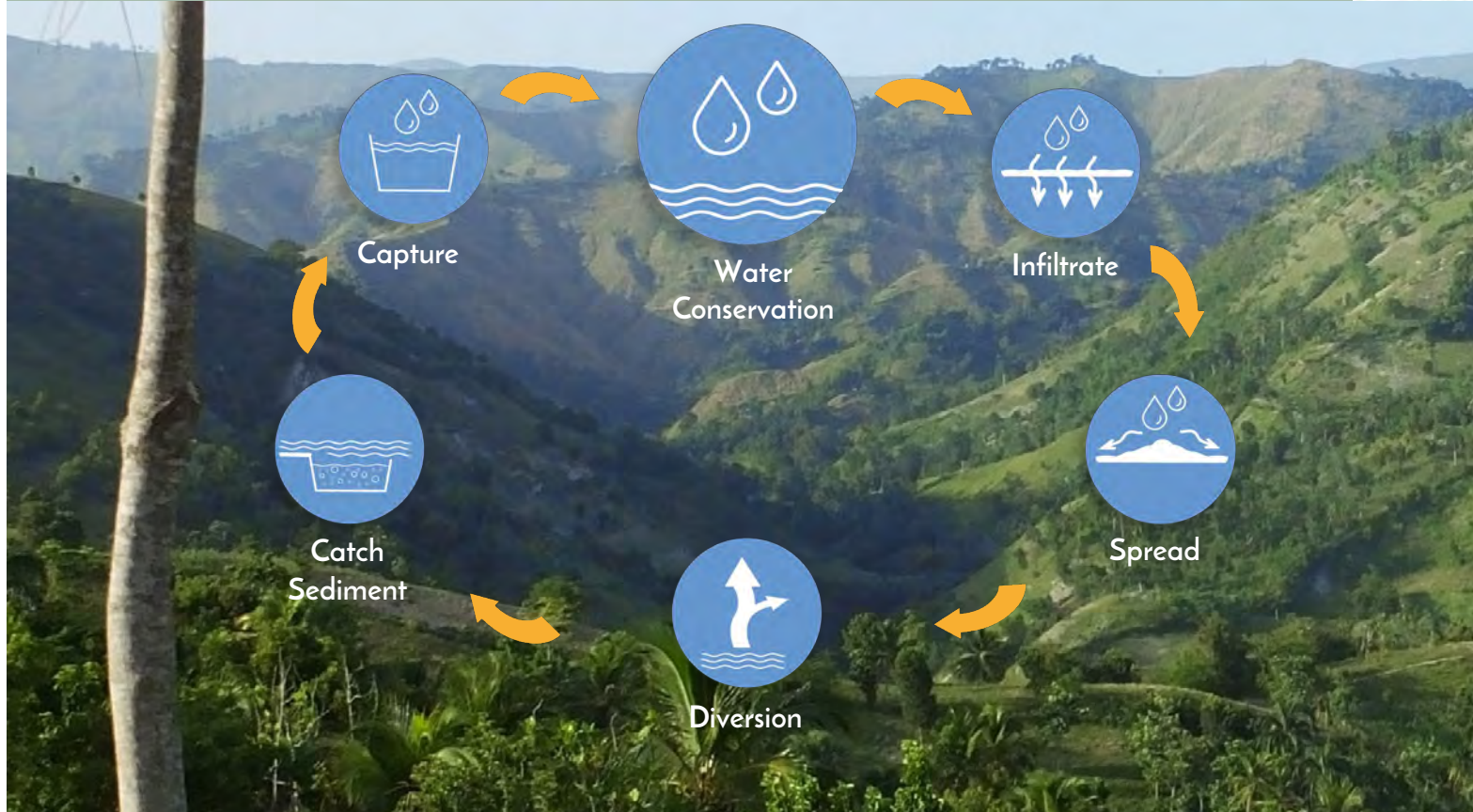


The water table pushes out the salt. A reduced water table causes salt infiltration to wells. Wells are eventually contaminated and undrinkable. *Ref: Ibiza, Beirut, Martha Vineyard*

Buffer the extremes and stay within the carrying capacity



# WATERSHED STRATEGIES - MAUI COUNTY



Wilson 5th Lower  
Catch Yields: 1.1 m<sup>3</sup>/min  
pH: 6.5  
Organic Material: 1.1%  
Clay: 27.3%  
Sand: 42%  
Water Capacity: 1.4



## 2.3 CAPTURE AND COLLECT

The source of all water in the watershed is rainfall. The point at which the water becomes unavailable or is released into a larger water body is called the sink. Between the source and the sink we capture and collect the water for its many uses. Capturing the water means to hold it as long as we can until we can put it to good use. This is behind dams, in ponds and pools, and possibly tanks if they are available. From the single point source of a stream we can capture the water.

By diverting the water from the streambed into a level canal we can move it across the land into various elevated ponds. Outside of the streambed we can collect the water using terraces, bunds, and swales to be captured and held for infiltration. Collecting the water on high elevation creates a longer ecological service as it moves down the watershed underground.





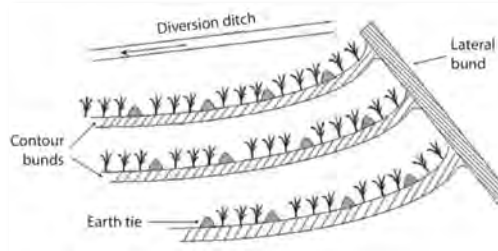
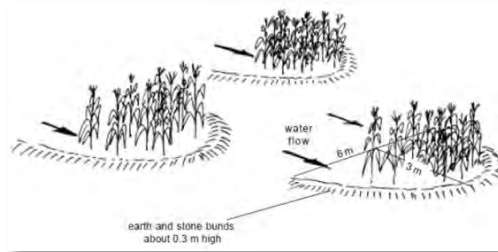


## 3.4 BUNDS

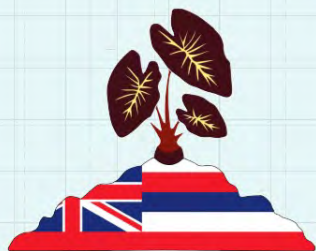
Bunds are long mounds of soil or rounded berms which encompasses a growing space. Much of the time they're used to delineate the growing beds where people are farming. With irrigation the buns make sure that the water stays in the growing area. On a hillside bermed soil-curves facing up hill can collect the water to be used by the plants within the curved space.

Off set rows of these fish scale berms allow for overflow to be caught in the next berm down hill. Bunds can be used in flood plains to collect silt during flood times. This is the cultivated the next season for growing crops. Much like check dams, these are much lower and work passively during the wet seasons of flooding for a long-term soil water resource.

Shape:	NA
Width:	+
Depth:	+
Curve ratio:	NA
Slope:	0 - 20 %
Flow Frequency:	Intermittent
Streambed Material:	3 - 6
Vegetation:	🌱 🌱







# West Molokai Ecosystem Restoration Projects and Training

**University of Hawaii, Molokai  
Maunaloa Campus**  
**Ecological Restoration Research Center**  
 Administration, Research, Development, Data Center  
 Civil Engineering and Ecological Design Dept.  
 Botanical and Wildlife Management Center  
 Reef and Shoreline Restoration Center  
 GIS, Soil and Water Modeling Center  
 Class Rooms and Training Center  
 Guest Housing, Dormitories

1.

## Paniolo Restoration Training Camp

2.

At the top of the Kahinawai Gulch, this camp is the entrance to the south shore system for restoration training and experimentation. It has access to Maunaloa and serves as a transition camp for new trainees prior to remote camps used by restoration crews. This is the largest camp allowing for many training areas and participants. Large group facilities allow for conferences, events, and visiting researcher families. It has 35 established tent platforms, utilities, and communications infrastructure. Farming and subsistence practices are also taught in a working community of Molokai educators.



## Kolo Camp, Implementation Crew Camp

3.

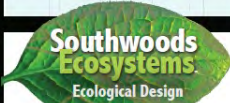
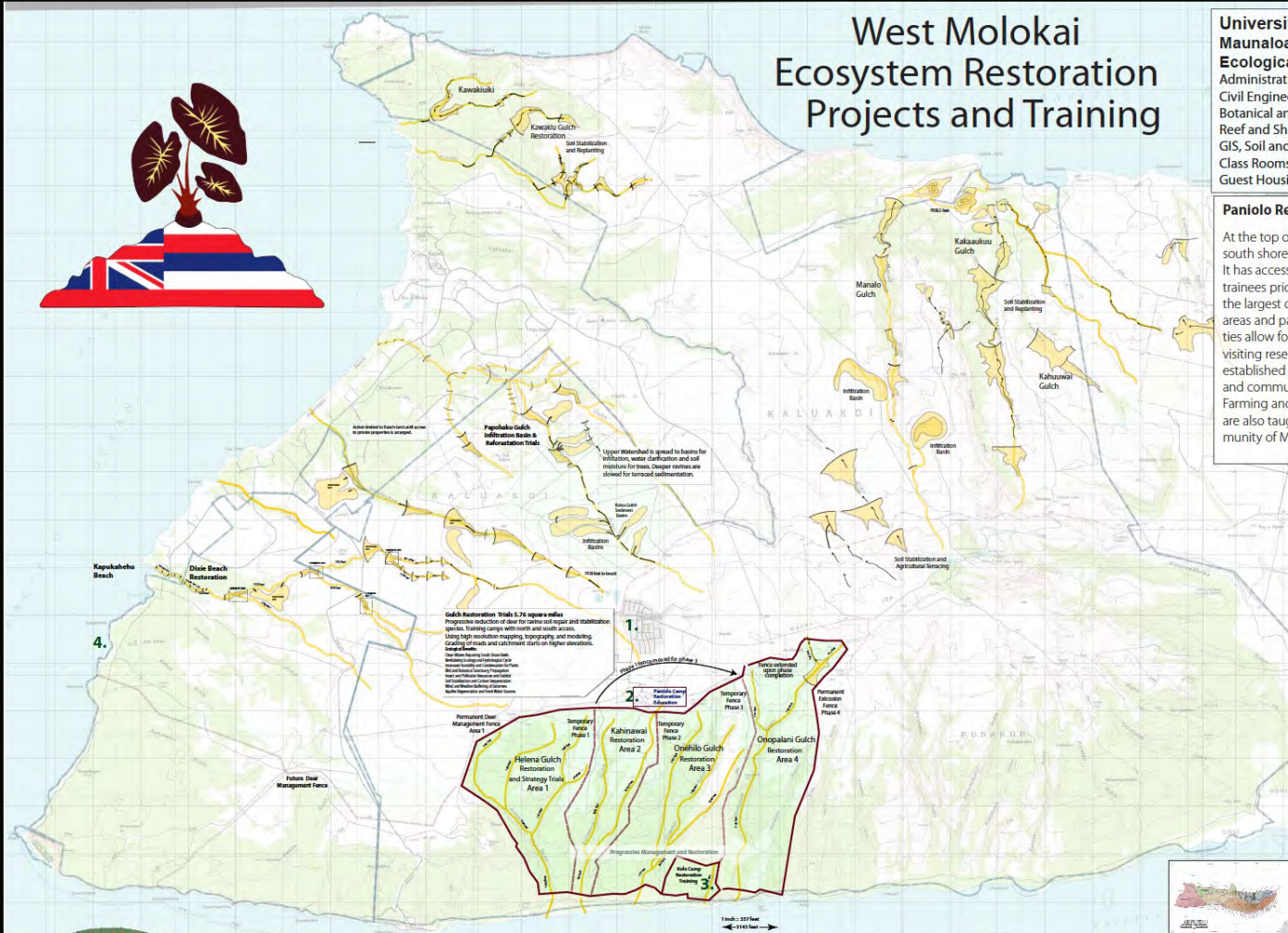
Kolo Camp is for working restoration professionals and trained interns. It is a place of rest and discussion of established and discovered practices. Camp support staff care for crew's physical and mental health. Near the shoreline and Kolo Wharf, it has access to seashore habitat and monitoring of sediment and water quality of gulch streams. Kolo camp is the center of data collection and measurements in the the south shore projects.



## Kaupoa Shoreline and Reef Camp

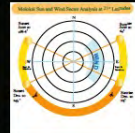
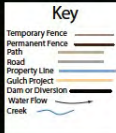
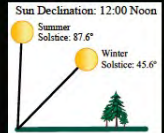
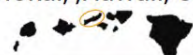
4.

Shoreline restoration is the final component in repairing the western Molokai ecosystem. This remote camp will focus on marine life and the study of habitat remediation from the eroded silt that covers much of the reef system. Advanced crew training delivered here. Support services are housed in Maunaloa.



**Ecological and Economic Restoration**  
**Molokai, Hawaii, USA**

Designer: Daniel Halsey +01, 612-720-5001  
 halse021@umh.edu Southwoodscenter.com



Climate: Pacific Island Coasts Dryland  
 Landform: Island, Volcanic  
 Soil Type: Loam and Eroded Basalt  
 pH: 5.2 - 8  
 Growing Zone: 10A-12A  
 Latitude: 21°N  
 Elevation: 0 - 1500 feet  
 Annual Precipitation: 25 inches  
 Prevailing Winds: Easterly  
 Total Area: 57,000 Acres

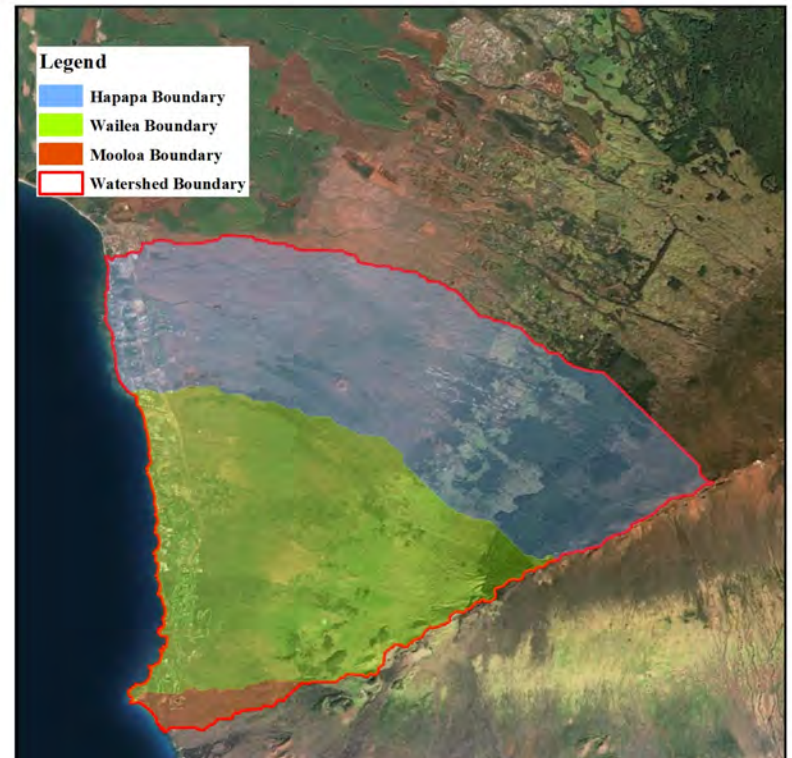
**Date: Sept. 2018**  
**Restoration Concepts**  
**Training Centers**  
**Scale: 1 inch = .5 miles**



# Watershed County Kuleana Ahupua'a

Site Control  
Keep Water High  
Settle Water High  
Green Belts

UGBs



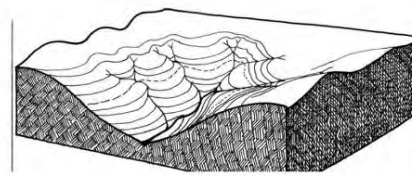
## KEYLINE DESIGN

P.A. Yeomans work had a very strong influence on the concepts of Permaculture design...One of his main approaches, referred to as Keyline design, details the principles, techniques and systems for ecological development of rural and urban landscapes. Keyline methods enable the rapid development of deep biologically fertile soil by converting subsoil into living topsoil. We follow his principles and strategies for restoring and enhancing the hydrological system to rebuild the historical canopy and natural resources of the islands.

Percival Alfred Yeomans was an Australian inventor known for the Keyline system for the development of land and increasing the fertility of that land. As a mining engineer and gold assayer, Yeomans had developed a keen sense of hydrology and equipment design. He developed improved methods and equipment for cultivation.



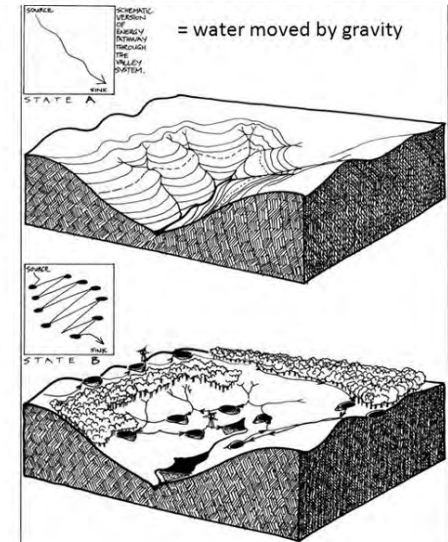
## Contour in a landscape



Although watersheds may seem linear, the underground flow from infiltration webs travel far and wide as well as deep. This creates new springs and recharges hidden ones. One of many benefits is drought proofing the land. Trees grow deeper roots, cooling the soil, and allowing protected native plants to return.

## Creating a new landscape pattern for water flow

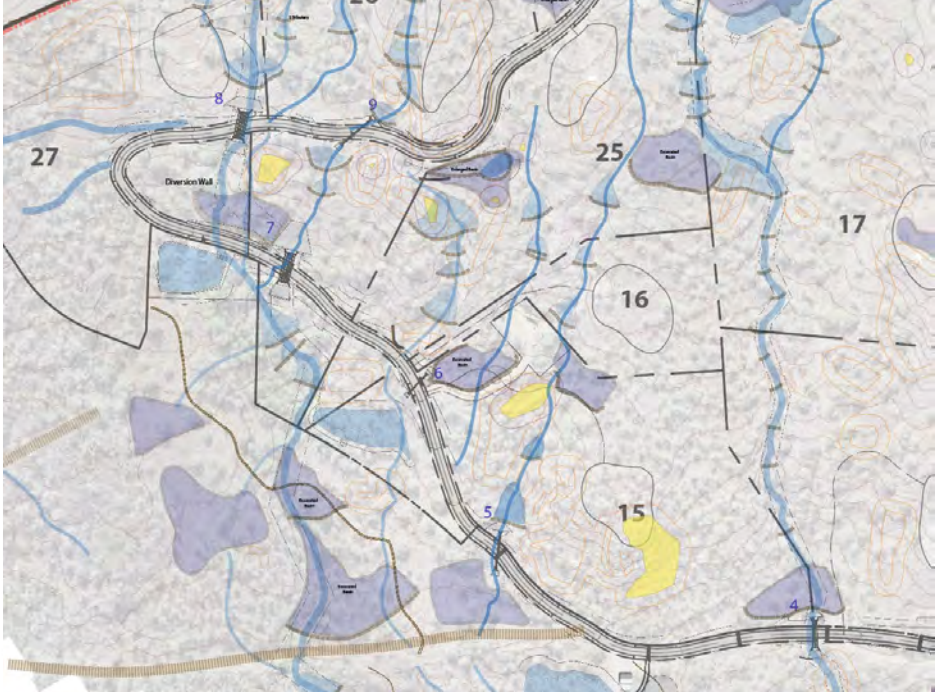
- Make/ facilitate/ allow water to do its duties: Passive (gravity powered) and Positive impact
- Patterns to details: putting it all together in an integrated strategy
- Plan the slowest longest route for water through your system
- Always give water a way out/ onward (or it will find its own!)





Keyline pattern cultivation enables the rapid flood irrigation of undulating land without terracing. Incidental results are the healing of soil erosion, bio-adsorption of salinity and the long-term storage of atmospheric carbon in the soil as humus.

The Keyline Scale of Permanence provides a priority guide to planning the various factors of broad scale development.

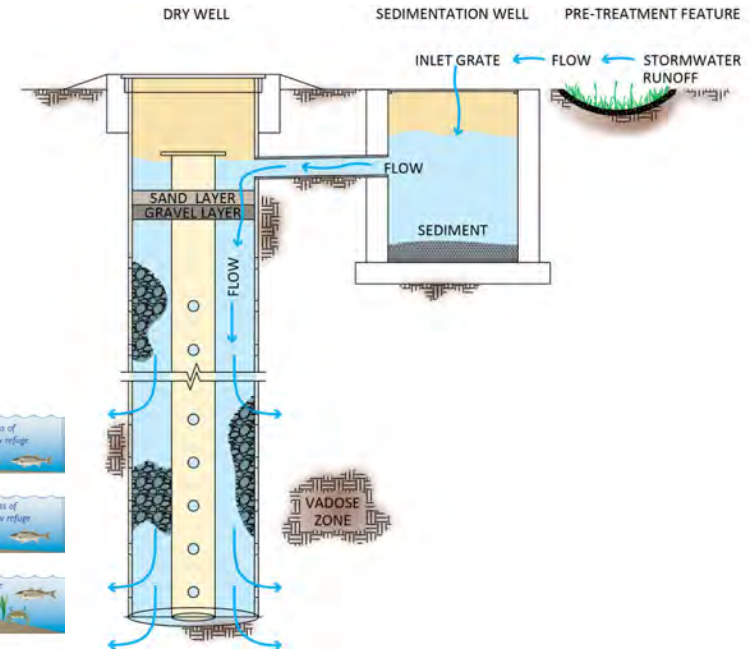
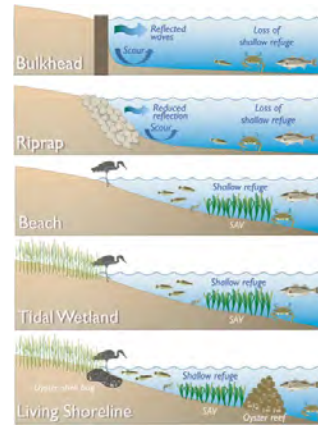


**GOALS**

- Soil is to stay on the mountain
- Water is to be cleaned of soil before entry to stream beds and shoreline
- Water is slowed and allowed time to infiltrate
- Deer population managed to viable carrying capacity
- Aquifer replenished with springs restored
- Sustained Ahupua'a as a stable resource
- Native forest ecosystem restoration

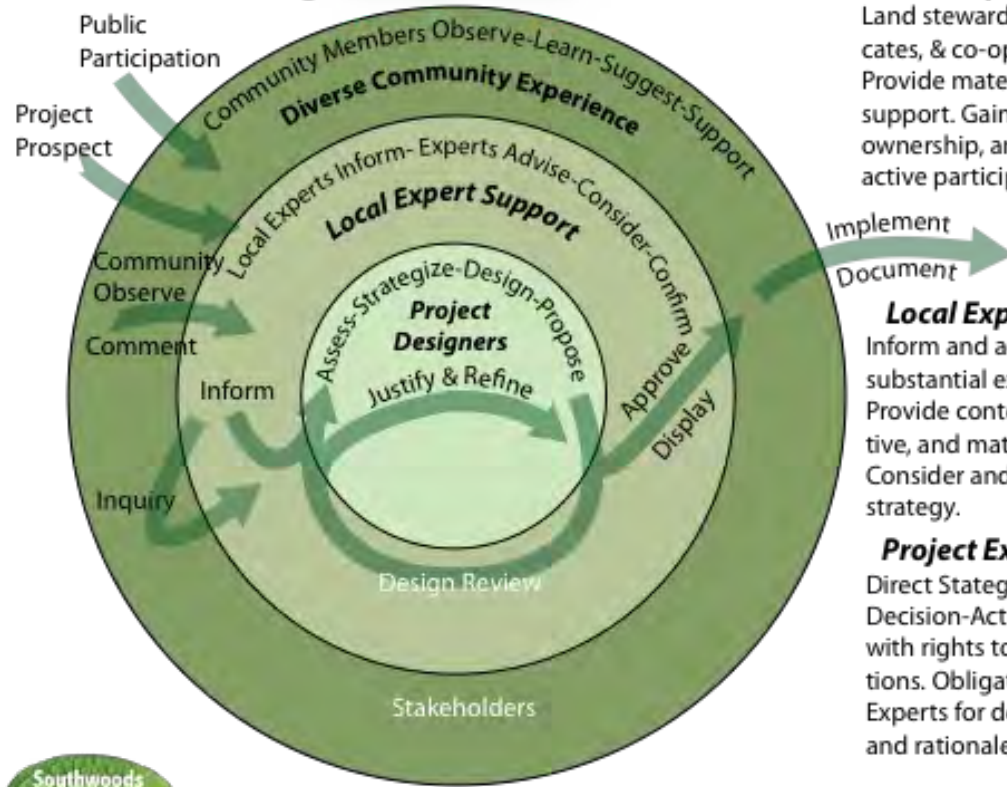
# Shoreline Development and Management

- Reduced foot print, narrow profile on structures.
- Salt Marsh, Sea Grass Patches, & Dunes
- Autonomous irrigation systems
- with Constructed Wetland Basins for run-off
- On-site Compost and plant lots of trees
- Shoreline Hardscapes Setback 100 feet
- Imitate nature, keep slopes gentle
- Employ "soft armoring"
- Grass and shrub layer yards
- No recipe, all solutions are site specific





## Steward Community Design and Refine Process



### Stakeholders & Co-op Members

Land steward(s), local advocates, & co-op members. Provide material and financial support. Gain experience, ownership, and prospects for active participation.

### Local Experts on Deck

Inform and advise from substantial experience. Provide content, administrative, and material support. Consider and validate design strategy.

### Project Experts in Play

Direct Strategy and Decision-Active Contributors with rights to develop solutions. Obligations to Deck Experts for design strategy and rationale.



# THANK YOU! MAHALO NUI



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